AD-A061 408 GRUMMAN AEROSPACE CORP BETHPAGE N Y F/G 13/7
HYPOSH (HYDRAULIC POWER SHARING SYSTEM).(U)
OCT 78 P F MARINO N62269-78-M-8416
UNCLASSIFIED NADC-78089-60 NL

| OF |
AD
A061408

END
DATE
FILMED
1-79
DDC

NADC 78089-60

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER: NADC 78089-60	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle): HYPOSH (Hydraulic Power Sharing System)		5. TYPE OF REPORT & PERIOD COVERED: Final Engineering Rept. 25 Jul - 25 Aug 78
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): Paul F. Marino		8. CONTRACT OR GRANT NUMBER(s): N62269-78-M-8416
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Grumman Aerospace Corporation, Bethpage, New York 11714		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS: Naval Air Development Center, ACSTD 60611, Warminster, Pennsylvania 18974		12. REPORT DATE: 23 October 1978
		13. NUMBER OF PAGES: 25
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): Naval Air Development Center, Warminster, Pennsylvania 18974		15. SECURITY CLASS. (of this report): Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for Public Release
Distribution Unlimited

12 30p.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

16 F41400 17 WF41400000

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Hydraulic	Priority	Output	Reduction
Power Sharing	Stabilizer	Lightweight	Cockpit Isolation
Flow	Rudder	Volume	
Pressure	Pump	Weight	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A one month test program was conducted to investigate the surface response rates of the flight control and combined hydraulic systems utilizing the power sharing concept. The basis for this testing was to establish the feasibility of using power sharing valves to reduce flight control and combined systems pump output requirements. The F-14 simulator was used to evaluate the performance of the power sharing valves.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE
S/N 0102-014-6601

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

388 847

The test results provided verification that by utilizing the HYPOSH (Hydraulic Power Sharing) concept, stabilizer surface rates produced during 100% pump output can be achieved at 50% pump output. Recommendations are made for improvement of the value design and for the flight testing of a prototype power sharing valve with a destroked F-14 pump (1/2 output) performing several missions to demonstrate satisfactory system performance.

CONTENTS

FIGURES

TABLES

SUMMARY

The objective of the test program conducted was to determine the performance characteristics of the power sharing concept. The F-14 simulator, with power sharing valves installed in both the flight control and combined systems, was used to simulate aircraft system performance utilizing the power sharing concept.

Data runs were performed without the prototype power sharing valves installed to determine baseline surface actuator rates for both the stabilizer and rudder. Additional data runs of 100%, 50% and 25% of normal pump speed were conducted with the power sharing valves installed to evaluate valve and system performance. The test program demonstrated that stabilizer surface rates produced during 100% pump output can be achieved at 50% pump output utilizing the HYPOSH system concept.

The result of the HYPOSH (Hydraulic Power Sharing) test program provides the groundwork for continuing the study of the power sharing system concept in order to provide a means of developing a lightweight hydraulic system by the reduction of pump output, line sizes, system weight and volume.

FOREWORD

The Hydraulic Power Sharing System study was conducted by the Grumman Aerospace Corporation, Mechanical Design Section, R. Hagerman, Section Chief, under U.S. Navy Contract Number N62269-78-M-8416.

The project was administered by the:

Naval Air Development Center
Warminster, Pennsylvania 18974

with Mr. Joseph H. Dever as contract monitor.

The work reported herein was conducted during the time frame of 25 July 1978 to 25 August 1978.

Acknowledgements are given to the following individuals for their assistance and support in this test effort:

E. Anderson

D. Katzenstein

Report submittal date is 23 October 1978.

This technical report has been reviewed and approved.

1 - INTRODUCTION

The Grumman power sharing concept is based on reducing engine pump output, line sizes, weight and system cost, without penalizing flight control operation. This is accomplished by installing a solenoid operated priority valve in the combined system pressure line to the right hand side of the primary flight control tandem actuators, and in the flight control system pressure line to the left hand side of the primary flight control tandem actuators. Supply pressure bypasses the solenoid valve spool and is fed to the primary flight control actuators. When the valves are energized, the flow paths are blocked. Flow must pass through the priority valve section; however, this will only occur when the supply pressure of the flight control and combined systems remain above 2000 psi. If system pressure drops below 2000 psi the priority valve closes and blocks flow from the combined system to the right hand of the primary flight control tandem actuators and from the flight control system to the left hand of the primary flight control tandem actuators. This results in the combined system supplying pressure to the left hand side of the primary flight control tandem actuators and the flight control system supplying pressure to the right hand side of the primary flight control tandem actuators. Pressure switches in the primary flight control system would immediately de-energize the solenoid valve in the event of either flight control or combined system failure. The power sharing concept has no influence on safety of flight due to the fail safe features of the system.

2 - TECHNICAL DISCUSSION

2.1 DESCRIPTION OF F-14 HYDRAULIC SYSTEM

The F-14 aircraft hydraulic system is designed in accordance with MIL-H-5440 and MIL-H-8775. Two completely independent 3000 psi closed loop systems are used. The systems are not fluid interconnected, although there is a mechanical power transfer capability from one system to another during emergency conditions.

Pressure is generated by variable delivery pumps which compensate for system demand by increased pump piston stroking. With no system demand, the system pressure remains at 3000 psi and the pump only develops enough flow to compensate for system internal leakage. When control inputs are fed to the flight control actuators, such as the rudder and stabilizer, they respond in relation to the input signal. The actuator demand causes the pump to stroke in an attempt to maintain constant system pressure. The pump will maintain this pressure until the system demand exceeds the capability of the pump and storage devices, at which point system pressure will drop off until a flow equilibrium is reached.

2.2 BACKGROUND

Generally, current pump capability is designed to meet very limited flow requirements; therefore, pump output exceeds system demand during normal operation. Utilizing the power sharing concept will result in optimum pump and system sizing. An example of the operation of the power sharing valve is during takeoff and landing. The power sharing valve is open (de-energized) to allow full flow to both sections of the surface control actuators.

At the pilot's option, the solenoid valve is closed (energized) during clean flight. Full flow is still provided to both sections of the surface actuators by passing through the priority valve. (The priority valve is wide open at supply pressures greater than 2400 psi.)

During combat, the momentary high demands of the wing sweep and gun systems are added to the demands of the surface actuators exceeding the flow capacity of the hydraulic power system, supply pressure will drop below 2400 psi and the priority valve will close, blocking flow to the surface actuators. The entire output of the No. 1 hydraulic system is now available for the wing sweep and gun systems. The No. 2 hydraulic system alone powers the stabilizer and rudder surface control actuators with no performance degradation.

The objective of the test program conducted was to determine power sharing valve and system performance response at various pump speeds utilizing the F-14 simulator.

The F-14 simulator was equipped with two prototype power sharing valves. One valve was installed in the flight control system and one in the combined system. The F-14 simulator test setup schematic is shown in Figure 1 with the power sharing valves installed. The flight control system will directly power the right stabilizer and rudder, while the combined system will directly power the left stabilizer and rudder. Figure 2 shows the F-14 simulator which was modified as described above. The right stabilizer and rudder will produce the flow demand required for the power sharing valve to block flow to the right stabilizer and rudder. Instrumentation installed in the simulator will monitor pressures in each section of the control system. Travel indicators at both stabilizer and rudder surfaces will provide the criteria for performance measurement.

2.3 POWER SHARING VALVE

The prototype power sharing valves (Figure 3) supplied by Bendix Electrodynamics division consist of a priority valve portion and a solenoid control valve portion. When the valve is de-energized (Figure 4) supply pressure passes through the valve, past the valve spool and is ported directly to the surface actuators. Energization of the valve (Figure 5) shuttles the valve spool over blocking supply pressure from being ported directly to the surface actuators. Supply pressure must then pass through the priority valve portion in order to be ported to the surface actuators. When system pressure drops below 2000 psi due to increased system demands, the valve closes blocking flow to surface actuators.

2.4 TEST RESULTS

The power sharing valves (Figure 3) were bench checked prior to installation in the simulator to verify pressure settings and pressure drop. The valves were not matched; valve number SN01, which was installed in the flight system, closed at 2100 psi and a leakage rate of 1.1 GPM was recorded; valve number SN02 installed in the combined system closed at 2140 psi and no leakage was recorded. The response rates of the valves were approximately three milliseconds.

In order to determine baseline rates for the stabilizer and rudder, baseline runs were recorded at 100%, 50% and 25% pump output without the power sharing valves installed. The data obtained is presented in Appendix A, Tables A-1 through A-3.

An initial run was then recorded at the same pump outputs with the power sharing valves installed in the de-energized position. This run was performed to establish any variation in system performance due to the installation of the power sharing valves. The data obtained is presented in Appendix A, Tables A-4 through A-9.

The final run was performed at the same pump outputs with the power sharing valves in the energized position. This run was conducted in order to establish the effects of the power sharing valves on the operation of the stabilizer and rudder. The data recorded is presented in Appendix A, Tables A-10 through A-15.

A comparison of the data recorded in Appendix A is presented in Tables 1 and 2 and Figure 6. The following results were obtained with the power sharing valves installed:

- The 25% pump output run with the power sharing valves energized resulted in stabilizer surface rates for trailing edge up and down of approximately the same magnitude as recorded for the baseline run of 50% pump output.
- The 50% pump output run with the power sharing valves energized resulted in stabilizer surface rates which were less than those recorded for the baseline run of 100% pump output. Evaluating the pressures at the inlet ports of the power sharing valves for the 50% output run, Appendix A, Table A-12, revealed pressures that were very close to the priority valve setting pressure. This prevented the power sharing valve from fully closing and blocking flow to the surface actuators during peak system demands.

The above tests were performed by moving the stick and rudder manually. There were no adverse transient effects encountered.

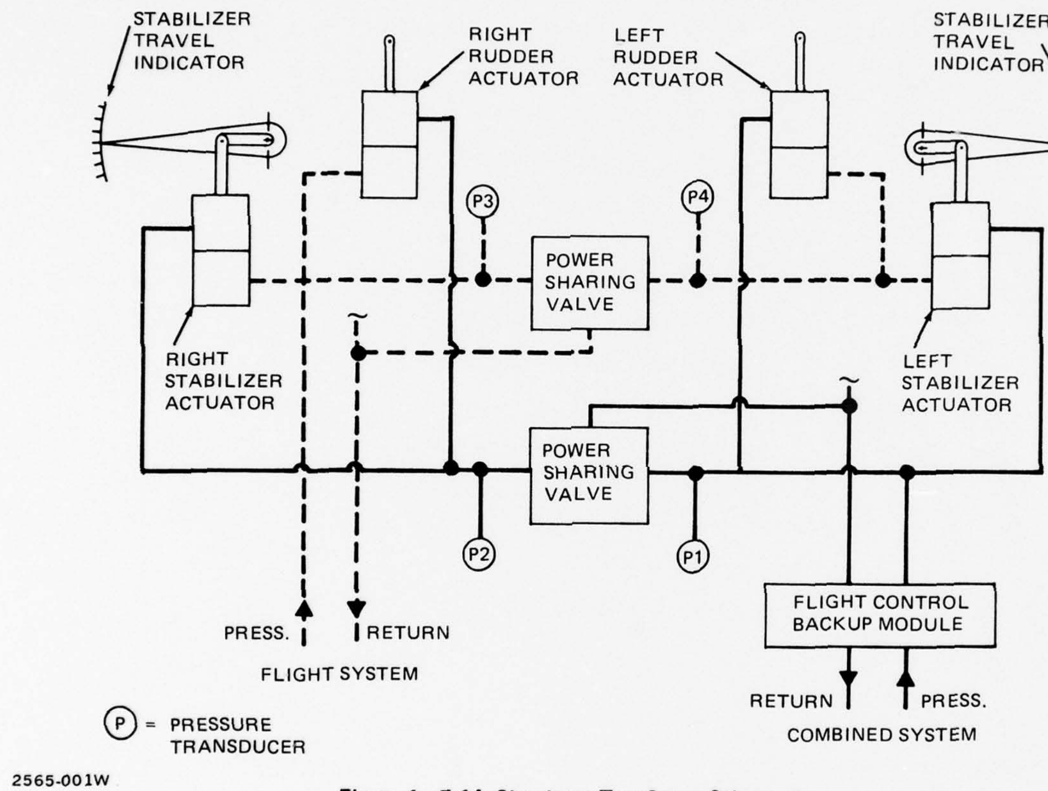
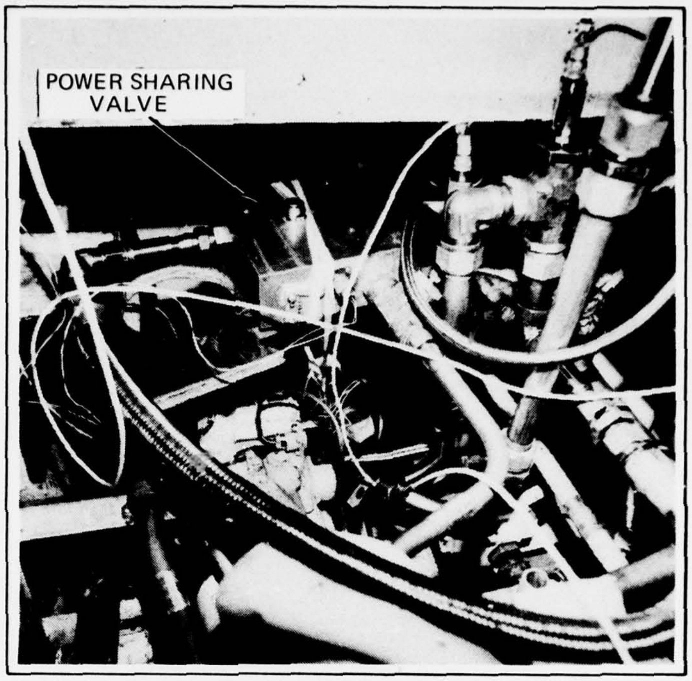
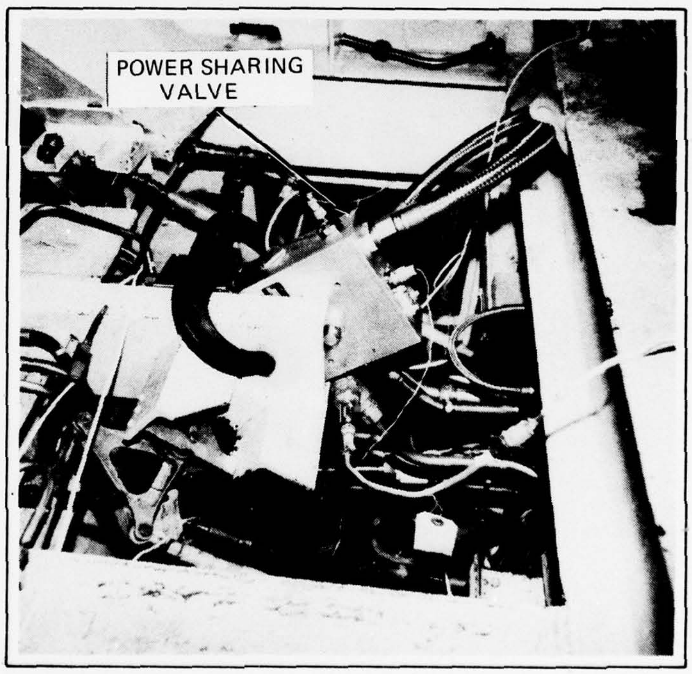


Figure 1. F-14 Simulator Test Setup Schematic



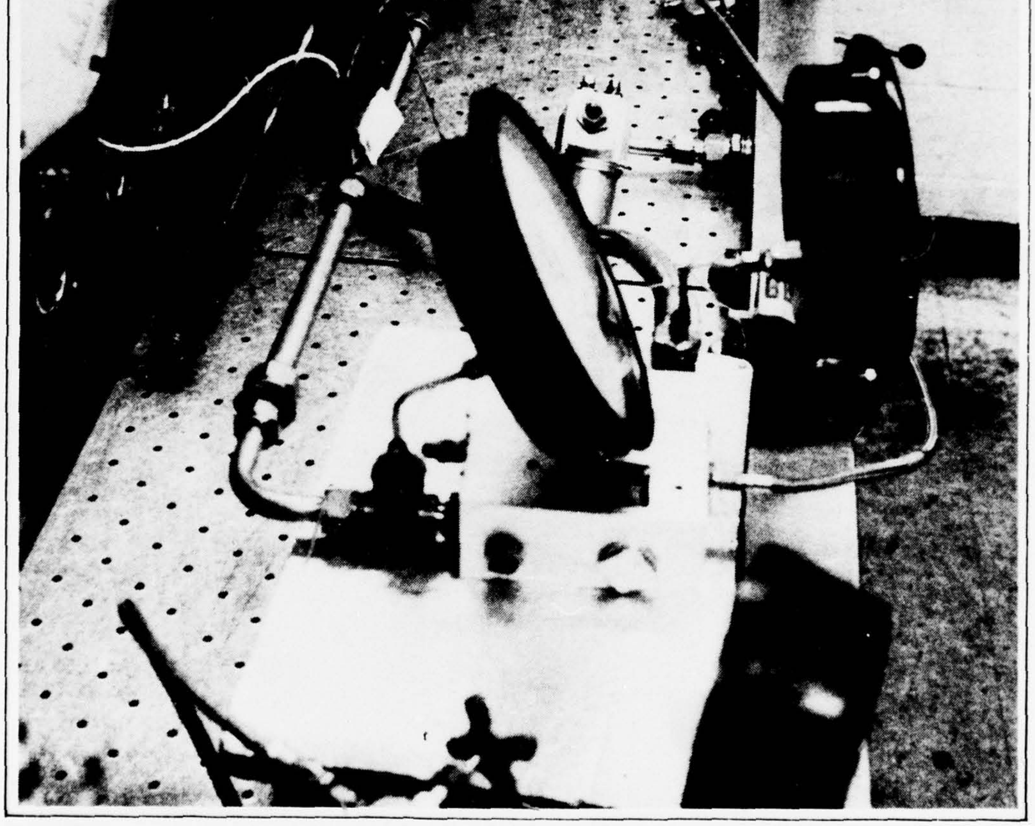
A. COMBINED SYSTEM



B. FLIGHT CONTROL SYSTEM

2565-002W

Figure 2. Power Sharing Valve Installation



2565-003W

Figure 3. Bench Test Setup

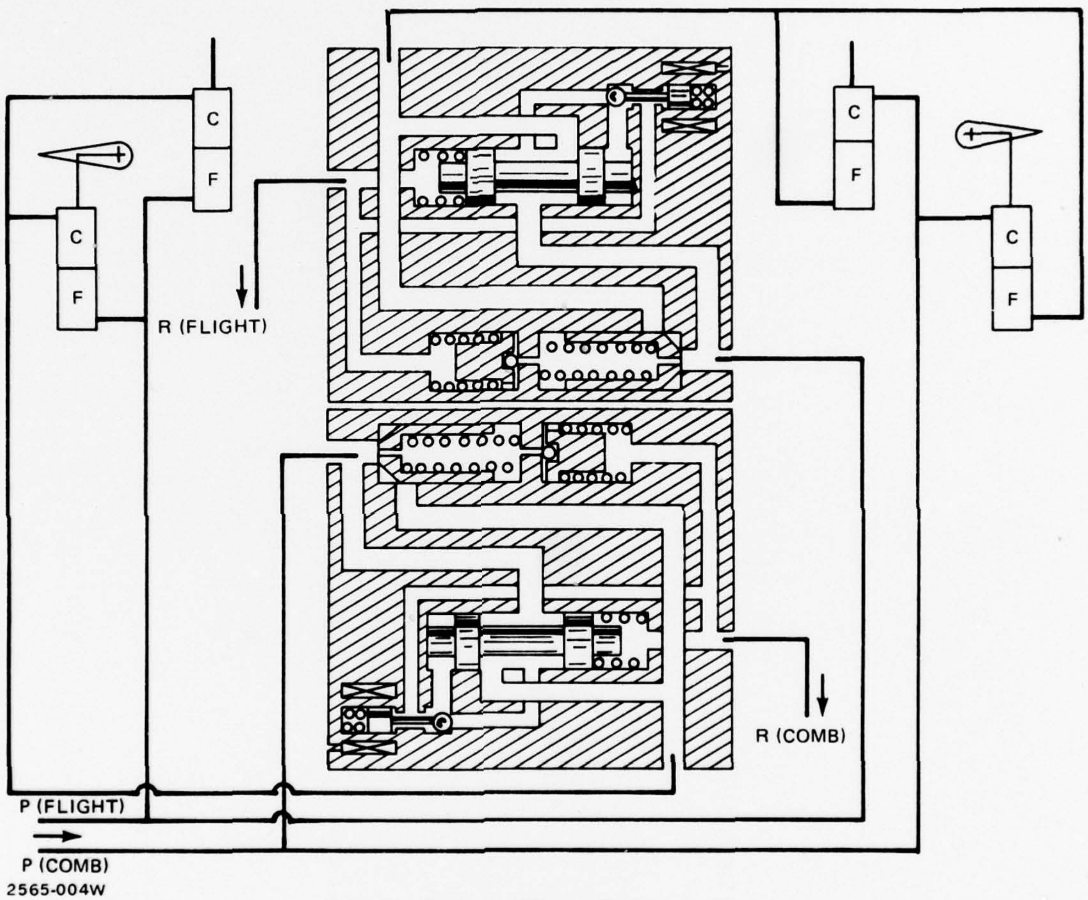


Figure 4. Section of Power Sharing Valve

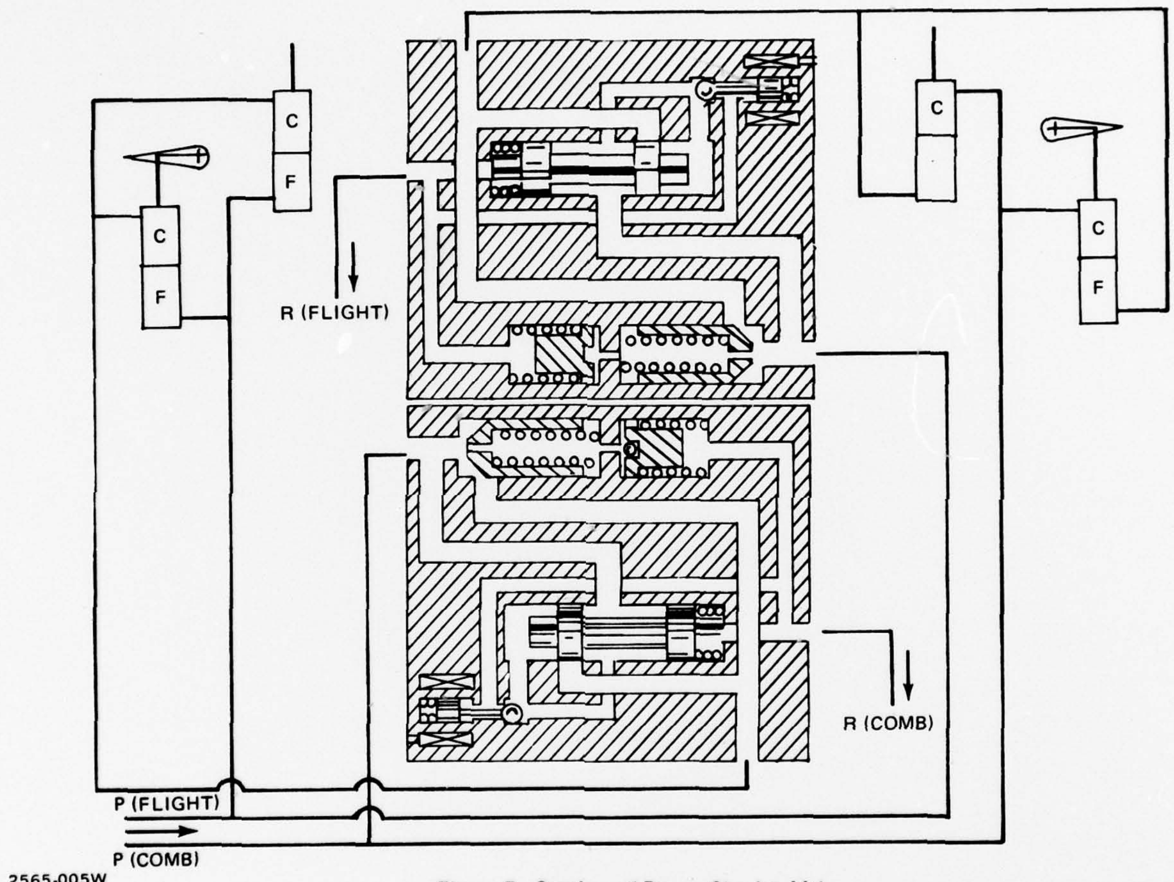


Figure 5. Section of Power Sharing Valve

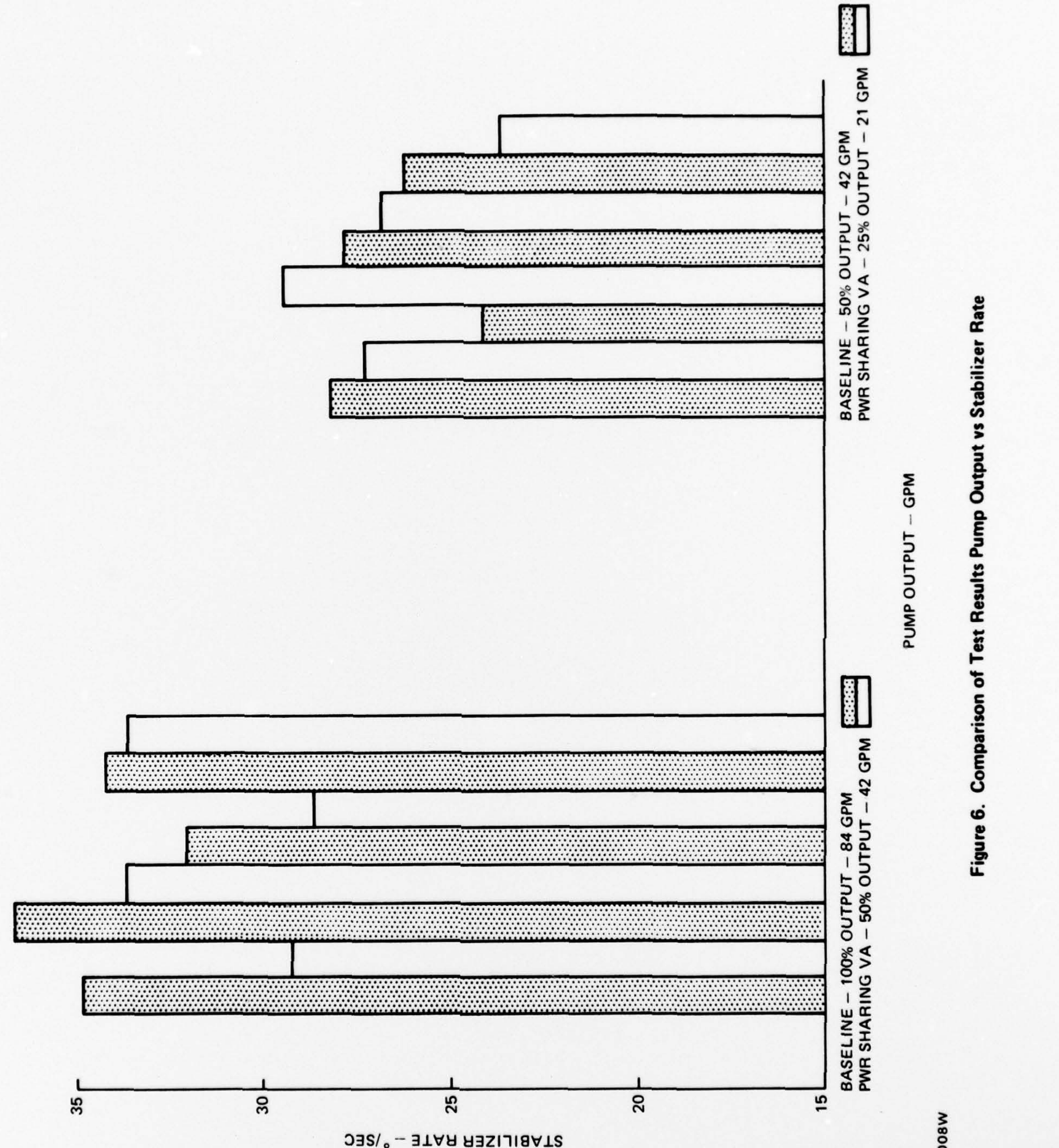


Figure 6. Comparison of Test Results Pump Output vs Stabilizer Rate

2565-008W

Table 1. Comparison of Stabilizer Test Results

STABILIZER	LEFT STABILIZER		RIGHT STABILIZER	
	TE UP DEG/SEC	TE DOWN DEG/SEC	TE UP DEG/SEC	TE DOWN DEG/SEC
BASELINE – NO VALVE 100% PUMP OUTPUT – 84 GPM	34.84	36.69	32.09	34.25
POWER SHARING VALVE – ENERGIZED 50% PUMP OUTPUT – 42 GPM	29.23	33.66	28.74	33.64
BASELINE – NO VALVE 50% PUMP OUTPUT – 42 GPM	28.29	24.22	27.85	26.31
POWER SHARING VALVE – ENERGIZED 25% PUMP OUTPUT – 21 GPM	26.31	29.41	26.96	23.65

2565-006W

Table 2. Comparison of Rudder Test Results

RUDDER	LEFT RUDDER		RIGHT RUDDER	
	LEFT DEG/SEC	RIGHT DEG/SEC	LEFT DEG/SEC	RIGHT DEG/SEC
BASELINE – NO VALVE 100% PUMP OUTPUT – 84 GPM	115.67	116.59	109.13	115.90
POWER SHARING VALVE – ENERGIZED 50% PUMP OUTPUT – 42 GPM	111.99	113.62	120.75	123.06
BASELINE – NO VALVE 50% PUMP OUTPUT – 42 GPM	113.21	116.54	106.36	115.69
POWER SHARING VALVE – ENERGIZED 25% PUMP OUTPUT – 21 GPM	107.63	106.21	116.14	116.36

2565-007W

3 - CONCLUSIONS

The HYPOSH test program has shown that the implementation of power sharing valves in the flight control and combined system pressure lines to the primary flight control tandem actuators will produce a reduction in system pump output requirements. This was accomplished without any interference with system operation and with no influence on safety of flight. Operating the flight control and combined systems at 50% of the pump output requirement produce stabilizer surface rates comparable to those achieved at 100% of pump output.

The advantages to be gained by the implementation of the Grumman power sharing concept in an advanced hydraulic system would result in the following:

- Optimum sizing of hydraulic pumps for both systems. The test results show that the hydraulic system can sustain output reduction of approximately 50% (see para. 2.4, Tables 1 and 2 and Figure 6) without compromising system performance.
- Reduction of tube sizes
- Reduction of total weight and volume
- Reduction in system cost.

For the prototype and production versions of the Grumman power sharing concept the following fail safe features are incorporated:

- Pressure switches in either flight control system would immediately de-energize the solenoid valve in the event of flight control or combined system failure.
- Dual switches and series relays would protect against electrical malfunctions.
- In the event that the bypass valve jams, pressure is provided for maneuverability and control through the priority valve, provided other non-essential system demands do not lower system pressure below the priority valve setting.
- System isolation by a cockpit controllable switch.

The power sharing concept deviates from MIL-H-5440G, para. 3.8.2, and must be approved by the procuring agency. The content of para. 3.8.2 is presented below with the applicable statements underlined.

3.8.2 System isolation: Whenever hydraulic power is required for primary flight controls, a completely separate, integral and adequate hydraulic system shall be provided to supply only the primary flight controls. This hydraulic system shall not be used to supply any other system or component in the aircraft, unless approval is obtained from the procuring activity. This hydraulic system shall be as simple as practicable and shall contain a minumum number of components. Dual actuator systems may employ the combined flight-control/utility system for one-half of the power, in which case the flight control system shall be given pressure priority by means of a suitable valve. In addition, the combined flight control/utility system shall be so designed that the portions of the system required for operation only during the takeoff and landing phases of flight (e.g. landing gear or wing flaps) may be isolated from the rest of the system by means of a suitable shutoff valve in the pressure line, controllable from the cockpit, and check valves in the return lines so located that a rupture in any portion of the utility system will not cause loss of fluid from the reservoir when the system isolation valve is closed. When isolation valves are used in a combined flight-control/utility system to isolate nonessential flight functions, the system shall be designed to preclude inadvertent isolation, during taxi or ground operation, that would result in loss of wheel braking, nosegear steering, or other critical functions.

4 - RECOMMENDATIONS

The HYPOSH test program demonstrated the feasibility of the power sharing concept. The test program established the basis for investigating the reduction of pump outputs and the resulting reduction of line sizes, system volume and weight.

The following recommendations are proposed based on the successful empirical data obtained from the HYPOSH testing:

- Determine optimum power sharing pressure setting with the existing valves, then re-running the program to establish an improvement in efficiency.
- Develop a prototype power sharing valve for flight testing on an F-14 aircraft following simulator verification and test.
- Flight test a prototype power sharing valve with a destroked F-14 pump (1/2 output) performing several combat missions to demonstrate no deterioration of combat capability.

APPENDIX A

Table A-1. Baseline Run

F-14 SIMULATOR – 100% PUMP OUTPUT
5440 RPM
84 GPM

STABILIZER				RUDDER			
LEFT SIDE DEG/SEC			RIGHT SIDE DEG/SEC	LEFT RUDDER DEG/SEC			RIGHT RUDDER DEG/SEC
35.25		TE UP	32.05	107.69		LEFT	107.69
37.63		TE DOWN	36.67	123.08		RIGHT	123.08
35.70		TE UP	34.20	124.65		LEFT	112.00
35.75		TE DOWN	31.78	110.34		RIGHT	110.34
33.57		TE UP	30.03	114.68		LEFT	107.69
				116.36		RIGHT	114.29
34.84	AVG	TE UP	32.09	115.67	AVG	LEFT	109.13
36.69	AVG	TE DOWN	34.23	116.59	AVG	RIGHT	115.90

2565-009W

Table A-2. Baseline Run

F-14 SIMULATOR – 50% PUMP OUTPUT
2720 RPM
42 GPM

STABILIZER				RUDDER			
LEFT SIDE DEG/SEC			RIGHT SIDE DEG/SEC	LEFT RUDDER DEG/SEC			RIGHT RUDDER DEG/SEC
29.38		TE UP	28.23	114.68		LEFT	107.69
24.25		TE DOWN	25.54	125.00	THRU NEUTRAL		122.45
28.20		TE UP	27.94	110.27		LEFT	103.70
23.83		TE DOWN	27.40	110.34		RIGHT	110.34
28.28		TE UP	27.38	114.68		LEFT	107.69
24.59		TE DOWN	26.00	114.28		RIGHT	114.28
28.29	AVG	TE UP	27.85	113.21	AVG	LEFT	106.36
24.22	AVG	TE DOWN	26.31	116.54	AVG	RIGHT	115.69

2565-010W

Table A-3. Baseline Run

F-14 SIMULATOR – 25% PUMP OUTPUT
1360 RPM
21 GPM

STABILIZER			RUDDER		
LEFT SIDE DEG/SEC		RIGHT SIDE DEG/SEC	LEFT RUDDER DEG/SEC		RIGHT RUDDER DEG/SEC
16.11	TE UP	15.93	107.96	LEFT	103.70
19.32	TE DOWN	18.82	110.79	RIGHT	107.10
16.59	TE UP	16.18	98.25	LEFT	96 55
19.46	TE DOWN	17.88	110.34	RIGHT	110.34
16.89	TE UP	16.38	100.00	LEFT	96.55
19.32	TE DOWN	19.07	122.45	THRU NEUTRAL	120.00
16.53	AVG TE UP	16.16	102.07	AVG LEFT	98.93
19.37	AVG TE DOWN	18.59	114.53	AVG RIGHT	112.48

2565-011W

Table A-4. Power Sharing Valve Installed

VALVE DE-ENERGIZED – 100% PUMP OUTPUT
5440 RPM
84 GPM

STABILIZER			PRESSURE READINGS – PSI			
LEFT SIDE DEG/SEC		RIGHT SIDE DEG/SEC	COMBINED SYSTEM		FLIGHT SYSTEM	
			P_{in}	P_{out}	P_{in}	P_{out}
35.00	TE UP	34.24	1950	1900	2475	2400
37.14	TE DOWN	36.75	1900	1850	2300	2175
35.35	TE UP	34.24	1950	1900	2500	2475
38.14	TE DOWN	37.14	2000	1900	2400	2300
35.28	TE UP	33.81	2000	1900	2575	2500
37.24	TE DOWN	35.28	1900	1875	2400	2300
35.21	TE UP (AVG)	34.10				
37.51	TE DOWN (AVG)	36.39				

2565-012W

Table A-5. Power Sharing Valve Installed

VALVE DE-ENERGIZED – 100% PUMP OUTPUT
5440 RPM
84 GPM

RUDDER			PRESSURE READINGS – PSI			
LEFT RUDDER DEG/SEC		RIGHT RUDDER DEG/SEC	COMBINED SYSTEM P_{in}	COMBINED SYSTEM P_{out}	FLIGHT SYSTEM P_{in}	FLIGHT SYSTEM P_{out}
106.74	LEFT	115.28	2550	2550	2700	2700
108.07	RIGHT	121.18	2500	2525	2800	2800
108.35	LEFT	119.61	2600	2600	2825	2800
108.08	RIGHT	121.18	2500	2500	2700	2700
110.19	LEFT	114.63	2550	2550	2700	2700
108.08	RIGHT	121.18	2500	2500	2800	2800
108.43	LEFT (AVG)	116.51				
108.08	RIGHT (AVG)	121.18				

2565-013W

Table A-6. Power Sharing Valve Installed

VALVE DE-ENERGIZED – 50% PUMP OUTPUT
2720 RPM
42 GPM

STABILIZER			PRESSURE READINGS – PSI			
LEFT SIDE DEG/SEC		RIGHT SIDE DEG/SEC	COMBINED SYSTEM P_{in}	COMBINED SYSTEM P_{out}	FLIGHT SYSTEM P_{in}	FLIGHT SYSTEM P_{out}
28.80	TE UP	27.60	1450	1375	1850	1775
26.13	TE DOWN	28.80	1750	1650	850	750
29.40	TE UP	27.93	1500	1400	1900	1800
26.13	TE DOWN	27.30	1700	1600	800	700
29.75	TE UP	28.47	1475	1400	1900	1800
25.79	TE DOWN	25.34	1700	1650	800	700
29.32	TE UP (AVG)	28.00				
26.02	TE DOWN (AVG)	27.15				

2565-014W

Table A-7. Power Sharing Valve Installed

VALVE DE-ENERGIZED – 50% PUMP OUTPUT
2720 RPM
42 GPM

RUDDER			PRESSURE READINGS – PSI			
LEFT RUDDER DEG/SEC		RIGHT RUDDER DEG/SEC	COMBINED SYSTEM P_{in}	COMBINED SYSTEM P_{out}	FLIGHT SYSTEM P_{in}	FLIGHT SYSTEM P_{out}
111.59	LEFT	108.33	2500	2500	2600	2600
112.90	RIGHT	117.60	2500	2500	2750	2700
109.17	LEFT	117.90	2600	2600	2800	2800
113.53	RIGHT	122.27	2500	2500	2725	2725
113.97	LEFT	121.03	2500	2500	2650	2650
108.40	RIGHT	117.67	2475	2475	2650	2650
111.58	LEFT (AVG)	115.75				
111.61	RIGHT (AVG)	119.18				

2565-015W

Table A-8. Power Sharing Valve Installed

VALVE DE-ENERGIZED – 25% PUMP OUTPUT
1360 RPM
21 GPM

STABILIZER			PRESSURE READINGS – PSI			
LEFT SIDE DEG/SEC		RIGHT SIDE DEG/SEC	COMBINED SYSTEM P_{in}	COMBINED SYSTEM P_{out}	FLIGHT SYSTEM P_{in}	FLIGHT SYSTEM P_{out}
16.20	TE UP	15.50	800	750	400	400
17.60	TE DOWN	17.60	650	625	200	200
16.20	TE UP	14.90	775	750	450	400
17 60	TE DOWN	19.20	650	600	200	200
15.80	TE UP	14.90	800	750	425	400
17.00	TE DOWN	17.60	650	625	200	200
16.07	TE UP (AVG)	15.10				
17.40	TE DOWN (AVG)	18.13				

2565-016W

Table A-9. Power Sharing Valve Installed

VALVE DE-ENERGIZED – 25% PUMP OUTPUT
1360 RPM
21 GPM

RUDDER			PRESSURE READINGS – PSI			
LEFT RUDDER DEG/SEC		RIGHT RUDDER DEG/SEC	COMBINED SYSTEM P_{in}	COMBINED SYSTEM P_{out}	FLIGHT SYSTEM P_{in}	FLIGHT SYSTEM P_{out}
108.33	LEFT	108.33	2350	2350	2300	2300
104.80	RIGHT	116.40	2350	2350	2500	2500
108.33	LEFT	108.33	2400	2400	2400	2400
108.41	RIGHT	122.19	2400	2400	2600	2600
104.30	LEFT	114.63	2450	2450	2600	2600
108.08	RIGHT	117.90	2400	2400	2650	2650
106.99	LEFT (AVG)	110.43				
107.10	RIGHT (AVG)	118.83				

2565-017W

Table A-10. Power Sharing Valve Installed

VALVE ENERGIZED – 100% PUMP OUTPUT
5440 RPM
84 GPM

STABILIZER			PRESSURE READINGS – PSI			
LEFT SIDE DEG/SEC		RIGHT SIDE DEG/SEC	COMBINED SYSTEM P_{in}	COMBINED SYSTEM P_{out}	FLIGHT SYSTEM P_{in}	FLIGHT SYSTEM P_{out}
35.28	TE UP	31.92	2050	1000	2600	2400
38.22	TE DOWN	35.28	2100	1100	2400	2000
35.81	TE UP	31.82	2050	1000	2550	2300
38.23	TE DOWN	35.28	2100	1000	2500	2100
35.28	TE UP	32.20	2100	950	2700	2400
37.63	TE DOWN	35.28	2100	1125	2450	2000
35.73	TE UP	32.20	2050	950	2600	2400
39.20	TE DOWN	37.24	2100	1150	2500	2100
35.52	TE UP (AVG)	32.03				
38.32	TE DOWN (AVG)	35.77				

2565-018W

Table A-11. Power Sharing Valve Installed

VALVE ENERGIZED – 100% PUMP OUTPUT
5440 RPM
84 GPM

RUDDER			PRESSURE READINGS – PSI			
LEFT RUDDER DEG/SEC		RIGHT RUDDER DEG/SEC	COMBINED SYSTEM P_{in}	COMBINED SYSTEM P_{out}	FLIGHT SYSTEM P_{in}	FLIGHT SYSTEM P_{out}
120.08	LEFT	120.08	2600	2600	2750	2700
125.76	RIGHT	125.76	2600	2550	2725	2800
113.53	LEFT	117.90	2600	2600	2825	2800
112.29	RIGHT	123.44	2575	2525	2800	2800
109.60	LEFT	122.46	2600	2600	2800	2800
112.29	RIGHT	112.29	2575	2550	2800	2800
114.40	LEFT (AVG)	120.15				
116.78	RIGHT (AVG)	120.50				

2565-019W

Table A-12. Power Sharing Valve Installed

VALVE ENERGIZED – 50% PUMP OUTPUT
2720 RPM
42 GPM

STABILIZER			PRESSURE READINGS – PSI			
LEFT SIDE DEG/SEC		RIGHT SIDE DEG/SEC	COMBINED SYSTEM P_{in}	COMBINED SYSTEM P_{out}	FLIGHT SYSTEM P_{in}	FLIGHT SYSTEM P_{out}
29.74	TE UP	29 29	2000	200	2150	800
33.60	TE DOWN	35.28	2000	600	2100	50
29.40	TE UP	28.47	2000	450	2200	975
33.40	TE DOWN	32.82	2000	500	2100	50
28.56	TE UP	28.47	2000	300	2200	900
33.97	TE DOWN	32.82	2000	525	2100	50
29.23	TE UP (AVG)	28.74				
33.66	TE DOWN (AVG)	33.64				

2565-020W

Table A-13. Power Sharing Valve Installed

VALVE ENERGIZED – 50% PUMP OUTPUT
2720 RPM
42 GPM

RUDDER			PRESSURE READINGS – PSI			
LEFT RUDDER DEG/SEC		RIGHT RUDDER DEG/SEC	COMBINED SYSTEM P_{in}	COMBINED SYSTEM P_{out}	FLIGHT SYSTEM P_{in}	FLIGHT SYSTEM P_{out}
108.33	LEFT	121.03	2500	2500	2700	2650
112.29	RIGHT	117.89	2550	2525	2800	2800
117.35	LEFT	121.03	2525	2525	2700	2700
112.29	RIGHT	124.45	2600	2575	2900	2900
108.33	LEFT	118.46	2500	2500	2700	2700
116.44	RIGHT	123.27	2550	2525	2800	2750
113.96	LEFT	122.46	2550	2500	2750	2700
113.46	RIGHT	126.63	2600	2575	2800	2800
111.99	LEFT (AVG)	120.75				
113.62	RIGHT (AVG)	123.06				

2565-021W

Table A-14. Power Sharing Valve Installed

VALVE ENERGIZED – 25% PUMP OUTPUT
1360 RPM
21 GPM

STABILIZER			PRESSURE READINGS – PSI			
LEFT SIDE DEG/SEC		RIGHT SIDE DEG/SEC	COMBINED SYSTEM P_{in}	COMBINED SYSTEM P_{out}	FLIGHT SYSTEM P_{in}	FLIGHT SYSTEM P_{out}
27.03	TE UP	27.57	1700	0	1800	0
29.98	TE DOWN	24.10	1750	0	1200	0
25.59	TE UP	26.78	1800	0	2000	0
29.40	TE DOWN	23.33	1800	0	1200	0
26.32	TE UP	26.52	1800	0	1950	0
28.85	TE DOWN	23.52	1800	0	1200	0
26.31	TE UP (AVG)	26.96				
29.41	TE DOWN (AVG)	23.65				

2565-022W

Table A-15. Power Sharing Valve Installed

VALVE ENERGIZED – 25% PUMP OUTPUT
1360 RPM
21 GPM

RUDDER			PRESSURE READINGS – PSI			
LEFT RUDDER DEG/SEC		RIGHT RUDDER DEG/SEC	COMBINED SYSTEM P_{in}	COMBINED SYSTEM P_{out}	FLIGHT SYSTEM P_{in}	FLIGHT SYSTEM P_{out}
103.70	LEFT	112.00	2350	2325	2300	2300
110.30	RIGHT	118.00	2400	2400	2600	2600
110.85	LEFT	113.97	2450	2450	2600	2600
104.80	RIGHT	116.44	2400	2400	2600	2600
108.33	LEFT	122.46	2500	2500	2700	2700
103.53	RIGHT	114.63	2350	2350	2500	2500
107.63	LEFT (AVG)	116.14				
106.21	RIGHT (AVG)	116.36				

2565-023W