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RALBO LOCK VALVE FIRST ARTICLE TEST REPORT

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13. ABSTRACT (Maximum 200 words)

This report is a summary fo the first article test conducted on the sample lock valves provided by RALBO in response to contract DAAA-09-B-0813. The test procedures and their results for the three sample valve are provided.

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Lock valve

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CONTENTS

TABLES

INTRODUCTION

To reduce procurement costs of the M109 lock valve (P.N. 11784023), a competitive procurement solicitation (DAAA09-91-B-0813) was issued on 13 November 1991 for a quantity of valves. To evaluate the samples submitted for consideration under the solicitation, a hydraulic test stand to verify compliance of drawing requirements was required. A contract was let to Technical Data Development, Inc. (TDDI) to fabricate the stand which was delivered to the government in August 1993. The sample valves delivered by six bidders under the procurement contract were tested using the stand during the fall of 1993.

All six bidder designs failed, for various reasons, to satisfy drawing requirements. A second procurement iteration phase was undertaken and again bidders were invited to submit samples of proposed designs. RALBO was the sole respondent to this solicitation. The sample of three lock valves were tested on a modified version of the hydraulic test stand fabricated by TDDI.

Test Procedure

The procedure followed while conducting the First Article Test called out in the Quality Assurance Provisions of drawing 11784023 is provided in appendix A.

As required by the First Article Test requirement stated in the Quality Assurance Provisions of drawing 11784023 and the valve cleanliness requirement stated on said drawing, a procedural plan was developed to insure compliance. This plan is provided in appendix B. Functional testing and endurance testing were conducted under all aspects of this plan within the clean room located in Building 3150. The climatic and on-weapon tests could not be conducted within a similar environment due to the size and location of the required environmental test cells. During these tests, precautions were taken to prevent exposure to contaminants while valves were changed and lines broken. Oil samples were taken throughout testing to verify compliance.

During the cold test phase of the climatic test, it was found that -50°F oil could not be supplied in quantity to the valve under test. The valve, valve stand, and the oil in and around the immediate vicinity of the valve stand, was kept within a climatic cell maintained at -50° to -55°F, and could be kept at temperature. Once flow was initiated, oil at an elevated temperature would flow through the valve. This warmer fluid would flow through the valve and raise the temperature of the valve under test. Therefore, only part "a" of tests 3 through 6 were executed, measurement of the required pressure to open the valve for each control port. The measurement of the off pressure requires extended flow of oil through the valve which would have invalidated results and was not attempted. This lack of verification of requirements was in no way held against the sample valves in evaluation of passing the test.

Receiving Inspection

Upon receiving the three sample valves submitted by RALBO in accordance with the solicitation from Rock Island Arsenal, an initial inspection was conducted of the valves. The three valves were received in the original packaging provided by RALBO and was found to have the original sealing tape unbroken. The three valves had been packed in a card board box with each valve individually wrapped in loose brown paper, placed in it's own card board box, and sealed with tape. All three valves were lacking protective back plates or other sealing mechanism to protect the A and B ports. On all three valves and in both ports, non-metallic debris was found in all port openings. This was removed and the valves flushed. Based on these findings, the required cleanliness level 200 per MIL-D-1246 on the drawing was not maintained. It appeared that this would not affect the performance of the valves during the execution of the test.

Visual inspection of the sealing surfaces on all ports found the A and B port spot faces to indicate tool chatter marks exceeding drawing requirements. Measurement of the surface finish on each surface found all but one to meet the drawing requirement. The one surface that did not meet drawing requirements was determined to be insufficient to adversely affect valve functioning.

Test Results

Results of the subtests are presented in table 1. To aid in test summary, passing a requirement was scored 1. Failing a requirement but with the value within measurement accuracy uncertainty was scored .9 to .8. All other failures were scored as 0.

Table 1
Test data

				REQ	SAMPLE					
FUNCT TEST					RALBO2	PASS /FAIL	RALBO3	PASS /FAIL	RALBO5	PASS /FAIL
		START DATE:			7/20/95		7/20/95		7/21/95	
		START TIME:			9:05		14:30		8:48	
	TEST 1									
		P A LEAKAGE	Y/N	N	N	1	N	1	N	1
		P B LEAKAGE	Y/N	N	N	1	N	1	N	1

Table 1
(cont)

	TEST 2									
		PORT M1								
			FLOW (CC)		5.5		8		30	
			TIME (MIN)		5		5		5	
			FLOW (CC/MIN)	1 < X < 6	1.1	1	1.6	1	6	1
		PORT P1								
			FLOW (CC)		7.5		5		6	
			TIME (MIN)		6		5		5	
			FLOW (CC/MIN)	1 < X < 6	1.25	1	1	1	1.2	1
		PORT M2								
			FLOW (CC)		5		7		25	
			TIME(MIN)		5		5		5	
			FLOW (CC/MIN)	1 < X < 6	1	1	1.4	1	5	1
		PORT P2								
			FLOW (CC)		8		6.5		7	
			TIME (MIN)		5		5		5	
			FLOW (CC/MIN)	1 < X < 6	1.6	1	1.3	1	1.4	1
	TEST 3									
		OIL TEMP (DEG F)			88		73		(NR)	
		ON PRES (PSI)		125 - 170	165	1	160	1	220	0
		FLOW (GPM)		2.9 MIN	2.63	0	2.35	0	1.68	0
		AT ? PRES (PSI)		370 MAX	370	1	370	1	370	1
		950 PSI Y/N		Y	N	0	N	0	N	0
		OFF PRES (PSI)		ON P +/- 50	130	1	95	0	> 36	0
	TEST 4									
		OIL TEMP (DEG F)			(NR)		78		100	
		ON PRES (PSI)		125 - 170	190	0	187	0	230	0
		FLOW (GPM)		2.9 MIN	2.12	0	2.12	0	.9/2.46*	0
		AT ? PRES (PSI)		370 MAX	370	1	370	1	370	1
		950 PSI Y/N		Y	N	0	N	0	Y	1
		OFF PRES (PSI)		ON P +/- 50	167	1	115	0	75	0

Table 1
(cont)

	TEST 5									
		OIL TEMP (DEG F)			(NR)		76		104	
		ON PRES (PSI)		125 - 170	187	0	200	0	184	0
		FLOW (GPM)		2.9 MIN	2.12	0	1.96	0	1.96	0
		AT ? PRES (PSI		370 MAX	370	1	370	1	370	1
		950 PSI Y/N		Y	N	0	N	0	N	0
		OFF PRES (PSI)		ON P +/- 50	68	0	175	1	157	1
	TEST 6									
		OIL TEMP (DEG F)			(NR)		86		103	
		ON PRES (PSI)		125 - 170	240	0	167	1	165	1
		FLOW (GPM)		2.9 MIN	1.35	0	1.45	0	2.12	0
		AT ? PRES (PSI)		370 MAX	370	1	370	1	370	1
		950 PSI Y/N		Y	N	0	N	0	N	0
		OFF PRES (PSI)		ON P +/- 50	110	0	145	1	142	1
	TEST 7									
		PORT A (DROPS/4 MIN)		3	13	0	3	1	3	1
		PORT B (DROPS/4 MIN)		3	>> 40	0	10	0	3	1
	TEST 8									
		PORT P1 ON PRES (PSI)		325 - 370	368	1	323	0.9	353	1
		PORT P2 ON PRES (PSI)		325 - 370	325	1	350	1	368	1
	TEST 9									
		PORT M1 ON PRES (PSI)		125 - 170	550	0	542	0	547	0
		PORT M2 ON PRES (PSI)		125 - 170	548	0	545	0	547	0
	TEST 10									
		PORT P1 ON PRES (PSI)		325 - 370	388	0	348	1	368	1
		PORT P2 ON PRES (PSI)		325 - 370	340	1	388	0	340	1

Table 1
(cont)

	TEST 11									
		PORT M1 ON PRES (PSI)		125 - 170	550	0	565	0	550	0
		PORT M2 ON PRES (PSI)		125 - 170	540	0	541	0	540	0
	TEST 12									
		TOTAL LEAK (DROPS)			1		27		48	
		TIME (MIN)			4		4		4	
		RATE (DROPS/MIN)		4 MIN	0.25	0	6.75	1	12	1
COLD TEST										
		START DATE			8/14/95		8/14/95		8/14/95	
		START TIME:			(NR)		14:34		(NR)	
		CHAMBER TEMP (DEG F)			-50.1		-49.6		-53	
		OIL TEMP (DEG F)			-50		(NR)		(NR)	
	TEST 3									
		ON PRES (PSI)		125 - 170	210	0	265	0	260	0
	TEST 4									
		ON PRES (PSI)		125 - 170	285	0	235	0	243	0
	TEST 5									
		ON PRES (PSI)		125 - 170	250	0	310	0	360	0
	TEST 6									
		ON PRES (PSI)		125 - 170	170	1	260	0	330	0
		950 PSI Y/N		Y	N	0	(NR)		(NR)	
		OFF PRES (PSI)		ON P +/- 50	120	1	(NR)		(NR)	
HOT TEST										
		TEST DATE:			8/1/95		8/1/95		8/1/95	

Table 1
(cont)

		START OIL TEMP (DEG F)			250		266		251	
	TEST 3									
		OIL TEMP (DEG F)			250		266		251	
		ON PRES (PSI)		125 - 170	174	0.9	157	1	30	0
		FLOW (GPM)		NA	1.8		1.0/> .5*		1.6	
		AT ? PRES (PSI)		NA	370		370		370	
		950 PSI Y/N		Y	Y	1	Y	1	Y	1
		OFF PRES (PSI)		ON P +/- 50	< 25	0	25	0	25	1
		OIL TEMP (DEG F)			252		(NR)		254	
	TEST 4									
		OIL TEMP (DEG F)			252		243		254	
		ON PRES (PSI)		125 - 170	140	1	240	0	240	0
		FLOW (GPM)		NA	2.2		0.6		2.1	
		AT ? PRES (PSI)		NA	370		370		370	
		950 PSI Y/N		Y	Y	1	Y	1	Y	1
		OFF PRES (PSI)		ON P +/- 50	25	0	25	0	25	0
		OIL TEMP (DEG F)			259		(NR)		256	
	TEST 5									
		OIL TEMP (DEG F)			259		(NR)		256	
		ON PRES (PSI)		125 - 170	255	0	185	0	165	1
		FLOW (GPM)		NA	0/1.9*		0.7		1.5	
		AT ? PRES (PSI)		NA	370		370		370	
		950 PSI Y/N		Y	Y	1	Y	1	Y	1
		OFF PRES (PSI)		ON P +/- 50	25	0	25	0	25	0
	TEST 6									
		OIL TEMP (DEG F)			(NR)		(NR)		258	
		ON PRES (PSI)		125 - 170	195	0	155	1	160	1
		FLOW (GPM)		NA	1.4		2.3		1.9	

Table 1
(cont)

		AT ? PRES (PSI)		NA	370		370		370	
		950 PSI Y/N		Y	Y	1	N	0	Y	1
		OFF PRES (PSI)		ON P +/- 50	25	0	136	1	25	0
	TEST 7									
		OIL TEMP (DEG F)			265		248		272	
		PORT A (DROPS/4 MIN)		3	19	0	30	0	10	0
		PORT B (DROPS/4 MIN)		3	40	0	50	0	8	0
		TEST END DATE:			8/1/95		8/1/95		8/1/95	
		FINAL OIL TEMP(DEG F)			260		266		272	
SHOCK										
	X	30 G / 11 msec			30/10.5	1	30/10.5	1	30/10.5	1
		55 G / 2.5msec			50/2.5	1	50/2.5	1	50/2.5	1
		70 G/0.5 msec			93/0.5	1	93/0.5	1	93/0.5	1
	Y	30 G / 11 msec			30/10.5	1	30/10.5	1	30/10.5	1
		55 G / 2.5msec			50/2.5	1	50/2.5	1	50/2.5	1
		70 G/0.5 msec			72/.75	1	72/.75	1	72/.75	1
	Z	30 G / 11 msec			30/10.5	1	30/10.5	1	30/10.5	1
		55 G / 2.5msec			50/2.5	1	50/2.5	1	50/2.5	1
		70 G/0.5 msec			80/.75	1	80/.75	1	80/.75	1
VIBRATION										
	X	5-25 Hz / +/- 1.5G			5.5-25 /1.5	1	5.5-25 /1.5	1	5.5-25 /1.5	1
		25-50 Hz / .03 IN			25-50 /.03	1	25-50 /.03	1	25-50 /.03	1
		50-500 Hz / +/- 5 G			50-500/5	1	50-500 /5	1	50-500 /5	1
	Y	5-25 Hz / +/- 1.5G			5.5-25 /1.5	1	5.5-25 /1.5	1	5.5-25 /1.5	1
		25-50 Hz / .03 IN			25-50 /.03	1	25-50 /.03	1	25-50 /.03	1
		50-500 Hz / +/- 5 G			50-500/5	1	50-500 /5	1	50-500 /5	1
	Z	5-25 Hz / +/- 1.5G			5.5-25 /1.5	1	5.5-25 /1.5	1	5.5-25 /1.5	1

Table 1
(cont)

		25-50 Hz / .03 IN			25-50 /.03	1	25-50 /.03	1	25-50 /.03	1
		50-500 Hz / +/- 5 G			50-500/5	1	50-500 /5	1	50-500 /5	1
ENDURANCE										
		CYCLES SUCCESSFUL			no can do	0	no can do	0	no can do	0
ON-WEAP										
	GUN	DROOP								
		CHANGE IN EL (MILS)			no can do		no can do		no can do	
		TIME DURATION (HOURS)			no can do		no can do		no can do	
		DROOP RATE (MIL/HOUR)			no can do	0	no can do	0	no can do	0
GUN CYCLE TIME										
		TIME 0 - MAX EL (SEC)			no can do	0	no can do	0	no can do	0
		TIME MAX EL - 0 (SEC)			no can do	0	no can do	0	no can do	0
		TIME 0 - MAX EL (SEC)			no can do	0	no can do	0	no can do	0
		TIME MAX EL - 0 (SEC)			no can do	0	no can do	0	no can do	0
		TIME 0 - MAX EL (SEC)			no can do	0	no can do	0	no can do	0
		TIME MAX EL - 0 (SEC)			no can do	0	no can do	0	no can do	0
GUN VEL AT 533 MILS										
		EL RATE OSCILATION	(Y / N)	N	no can do	0	no can do	0	no can do	0
		RATE INFLECTION POINT	(Y / N)	N	no can do	0	no can do	0	no can do	0
		MIN EL/DEP RATE		130 MIL/SEC	no can do	0	no can do	0	no can do	0
		MANUAL HANDLE MOTION	(Y / N)	N	no can do	0	no can do	0	no can do	0

Table 1
(cont)

				TOTALS (85max)		41.9		42.9		46
				TEST -> PASS/ FAIL		FAIL		FAIL		FAIL
SAMPLE IDENT:		RALBO2								
		DAAA09-91-B-081								
		SN:2								
		RALBO3								
		DAAA09-91-B-081								
		SN:3								
		RALBO5								
		DAAA09-91-B-081								
		SN:5								

NOTE:

(NR) - Data element not recorded.

* - Indicates initial value recorded during intial run of test / second value recorded during second run of test following applying a high pressure to either one side or the other of the spool involved.

During functional tests 3 through 6, there is a requirement that the valve port being tested be subjected to a pressure of 950 psi with flow. This pressure could not be applied to any of the ports on two valves because the spool would shift to the closed position at a lower pressure. The third valve exhibited this characteristic on three of the four ports. The fourth port behaved normally. Performance is presented in table 2.

Table 2
Performance against requirements 3c, 4c, 5c, and 6c

Valve SN	Port P1	Port P2	Port M1	Port M2
#2	800 psi (spool shifted off)	775 (spool shifted off)	825 psi (spool shifted off)	825 psi (spool shifted off)
#3	780 psi (spool shifted off)	810 psi (spool shifted off)	780 psi (spool shifted off)	780 psi (spool shifted off)
#5	900 psi (spool shifted off)	950 psi	700 psi (spool shifted off)	750 psi (spool shifted off)

During performance testing, there were several occurrences of spools sticking and failing to fully open or close. When this occurred, the pressure was either increased or brought to zero and then that requirement was retested.

During the hot phase of the climatic test, this problem for the most part ,disappeared. Only during test 6 for valve SN 3, did the spool shift close. This requirement was not tested for during the cold phase as stated before.

During the on-weapon test, the RALBO valves failed to perform sufficiently to start the test.

Prior to installing the RALBO valves, the elevating system was operated using the KEMP lock valve which was on the vehicle. The system operated properly without any irregularities in operation being noted.

To verify compliance to requirement 11 of the lock valve drawing (11780423), three RALBO valves (SN 2, 3, and 5) were installed in accordance with paragraphs 10-8 b. and c. from TM 9-2350-314-20-2-2.

The first valve installed was SN 2. The travel lock was opened and the hydraulic system was activated in preparation for elevating the gun. The Chief-of-Section control handle was slowly actuated to permit gun tube elevation. This resulted in approximately 20 mils of elevation before the gun tube became permanently locked in place. All further attempts to move the gun using the control handle or manual elevation hand pump proved futile. The hydraulic system was shut off and both the elevation and depression chambers of the elevation cylinder were bled using the two bleed valves on the cylinder (TM 9-2350-314-20-2-2, paragraph 18-1 e. with the exception that the hydraulic power was off). This now returned the elevation cylinder to its configuration prior to the attempt of raising the gun tube, i.e., zero internal pressure. The hydraulic system was turned on and the Chief-of-Section handle was slowly depressed resulting in gun movement. The aforementioned process had to be redone once more to ensure that the gun was fully seated in the travel lock.

Valve SN 2 was removed from the cylinder and replaced with valve SN 5. When hydraulic pressure was applied to the valve it performed in a similar manner to the previously installed valve. The last RALBO valve SN 3, did not perform differently than the two previously installed valves.

After the last RALBO valve was removed, the original valve was reinstalled. When hydraulic pressure was applied to the elevation circuit, the system responded properly allowing a full range of unhindered elevation and depression.

As a result of the on-weapon malfunction of the RALBO valves, the amount of data taken for requirements 9 and 11 were increased. The pressure applied to ports A and B was started at 100 psi and increased in 100 psi increments to the drawing requirement of 500 psi. At each of the these pressures, the necessary pressure at the P and M ports to shift the spool was recorded. This data are provided in tables 3 through 5. The additional data are for informational purposes only to help the manufacturer in analyzing the malfunction.

Table 3
Performance of SN 2 for requirement 9 and 11

A-B Applied Pressure (psi)	P1 on Pressure (psi)	P2 on Pressure (psi)	M1 on Pressure (psi)	M2 on Pressure (psi)
100	200	178	245	190
200	228	220	257	225
300	330	345	337	330
400	440	435	445	435
500	550	548	550	540

Table 4
Performance of SN 3 for requirement 9 and 11

A-B Applied Pressure (psi)	P1 on Pressure (psi)	P2 on Pressure (psi)	M1 on Pressure (psi)	M2 on Pressure (psi)
100	182	225	220	195
200	223	235	231	223
300	330	332	328	333
400	442	440	452	436
500	542	545	565	541

Table 5
Performance of SN 5 for requirement 9 and 11

A-B Applied Pressure (psi)	P1 on Pressure (psi)	P2 on Pressure (psi)	M1 on Pressure (psi)	M2 on Pressure (psi)
100	200	228	203	184
200	221	225	230	224
300	339	324	340	335
400	445	449	447	440
500	547	547	550	540

CONCLUSIONS

During the functional test, the RALBO valves passed most leakage tests but failed all of the flow tests. All tests were failed during the cold and hot temperature tests. The endurance test was failed because the valves were unable to perform the test, which requires a system pressure of 1,250 psi. This was unattainable due to the valves abnormal characteristic of shifting closed upon reaching a pressure of 700 to 800 psi. All valves failed the on-weapon test because the valves were unable to perform sufficiently to execute any of the tests.

Based on the performance of the RALBO valve design derived from this test, it is concluded that there is at least one design flaw if not flaws making the valve design nonperforming and unacceptable.

RECOMMENDATION

The current RALBO design should not be procured.

APPENDIX A

TEST PROCEDURES

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Appendix A:

Test Procedures

3 Aug. 1995

Qualification Test Plan
For Lock Valve, PN 11784023

1. Material for test:

   A. Provided by test agency:

      1 Valve Test Stand
      1 Climatic Chamber
      1 Oil Chiller System
      Oil, Hydraulic, Mil-H-6083
      Filter Element,
      Filter Element,
      Wipes, Lint-free
      Jars, Sample, Lint-free
      Cylinder, Graduated

   B. Provided by contractor:

      3 Sample Valves (each vendor)

   C. Calibration hardware to support this TP.

2. Objective of Test: Demonstrate vendor's capability of meeting the design requirements called out on drawing No. 11784023.

3. Safety Precautions in Handling and Testing: TBD

4. Recommended Test Program

   A. Each of the required valve samples supplied by a potential vendor shall be subjected to the following sequence of subtests to satisfy the Qualification Test requirement of paragraph 4.3 of QAP. Valves can be tested individually or as a batch(s) through subtest sequence.

   B. Subtest 1 - Shock/Vibration Test

      1) Test verifies compliance to Note 11.A on drawing 11784023.

      2) Test procedure as depicted in Appendix B shall be followed to perform the test.

      3) The test data form depicted in Appendix B shall be filled out for each execution of test procedure.

C. Subtest 2 - Climatic Test

1) Test verifies compliance to requirements 3.a, b, and c, 4.a, b, and c, 5.a and c, 6.a and c, and 7 of Table and note 11.B.6 on drawing 11784023.

2) Test procedure as depicted in Appendix C shall be followed to perform the test.

3) The test data form depicted in Appendix C shall be filled out for each execution of test procedure.

D. Subtest 3 - Endurance Test

1) Test verifies compliance to Note 11.B.7 on drawing 11784023.

2) Test procedure as depicted in Appendix D shall be followed to perform the test.

3) The test data form depicted in Appendix D shall be filled out for each execution of test procedure.

E. Subtest 4 - Functional Test

1) Test verifies compliance to requirements 1 through 12 of Table I and Note 14 on drawing 11784023.

2) Test procedure as depicted in Appendix A shall be followed to perform the test.

3) The test data form depicted in Appendix A shall be filled out for each execution of test procedure.

F. Subtest 5 - Weapon Elevation Rate/Hold Test

1) Test verifies compliance to Notes 11.B.1, 11.B.1.1, 11.B.2, 11.B.3, and 11.B.4 on drawing 11784023.

2) Test procedure as depicted in Appendix E shall be followed to perform the test.

3) The test data form depicted in Appendix E shall be filled out for each execution of test procedure.

5. References:

Valve Assembly, Lock	Drawing No.	11784023
Quality Assurance Provisions	QAP	11784023

6. Disposition

Sample valves shall be returned to submitter upon completion of test.

7. Type of Report and Security Classification

A. Letter report with copies of all test data forms generated as attachments.

B. Security Classification - Unclassified

8. Report Distribution

A. A copy of this test plan shall be included in the test report.

B. Statement C. Distribution authorized to U.S. Government Agencies and their contractors: Test and Evaluation, June 2, 1993. Other requests for this document shall be referred to OPM PALADIN, ATTN: SFAE-FAS-PAL, Picatinny Arsenal, NJ 07806-5000.

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APPENDIX A - FUNCTIONAL TEST

GENERAL PREPARATION

- Connect pressure and return lines (large and small lines) from test stand to reservoir.

- Fill reservoir with hydraulic fluid conforming to MIL-H-6083 so that fluid is seen in the level gage.

- Plug the power cord #1 into a 120 volt AC grounded wall outlet. The outlet should be capable of supplying 15 amps.

- Plug the power cord #2 into a 220 volt three phase AC grounded wall outlet. The outlet should be capable of supplying 30 amps.

- Turn switches M1, M3, V1, V2, and V3 to OFF position.

- Verify STOP switch is in ON position (out/released).

- Set cyclic controller switch to "By Passed".

- Press START button to energize stand.

- Make sure the O-rings at the A and B ports of the lock valve are properly installed. Mount the lock valve assembly to the hydraulic manifold so that the port identification markings are up-side-down.

Performance Requirement Number 1

1. Install plugs in ports Ml, M2, Pl and P2.

2. Connect the line from the hand pump to the High Pressure Y Adapter. Connect Y Adapter to Port A and Port B.

3. Close valve at the base of the hand pump by rotating fully clockwise until seated. The hand pump extension handle is notched for this purpose.

4. Operate hand pump until a pressure of 8,000 to 10,000 PSI is achieved.

5. After standing for 2 minutes at 8,000 to 10,000 PSI, check valve for external leakage. Record any leakage observed. No external leakage is permitted.

6. Relieve pressure by rotating valve at the base of the hand pump counter-clockwise.

7. Performance Requirement Number 1 is complete.

Performance Requirement Number 2

1. Remove Y-Adapter from A and B ports. (Quick disconnects should already be installed in M and P ports from Performance Requirement Number 1.)

2. Connect line l to Ml port. Connect line 2 to M2 port.

3. Place switches Sl and V3 in the ON position. (V2 OFF)

4. Rotate the knob at the base of the 200 PSI pressure gage fully counter-clockwise. Also rotate the knob on Throttle Valve 1 fully counter-clockwise.

5. Turn the primary pump on by setting switch M3 to ON and adjust Throttle Valve 1 (TV1) to indicate 75 +5 PSI on the 200 PSI pressure gage. Allow the system to run for 2 to 3 minutes to purge the air from the system.

6. Connect line l to Pl port. Connect line 2 to P2 port.

7. Turn the primary pump on by setting switch M3 to ON and adjust Throttle Valve 1 (TV1) to indicate 75 +5 PSI on the 200 PSI pressure gage. Allow the system to run for 2 to 3 minutes to purge the air from the system.

8. Turn the pump off and remove line 2. Attach the loose drain line to port M2 placing the open end in a graduated cylinder. First configuration in table below.

9. Run the pump for a predetermined period of time. (Suggest 10 minutes.

10. At the end of the predetermined time, turn the pump off and measure the volume of fluid collected. Divide the volume by the time and record the flow rate. Flow in excess of 6 cc per minute or less then 1 cc per minute will not be permitted. No leakage shall be evidenced at either port A or B.

11. Repeat steps 2 through 8 with line connections and switches according to the following table:

Pressure Line	Drain Line	Switches ON	Switches OFF
1 on M1	M2	V1	V2 & V3
1 on P1	P2	V1	V2 & V3
2 on M2	M1	V1 & V3	V2
2 on P2	P1	V1 & V3	V2

10. Performance Requirement Number 2 is complete. Turn switch M3 to OFF position to stop primary pump.

Performance Requirement Number 3

1. Install quick disconnects in all valve ports.

2. Connect lines l, 2, A, and B to their respective ports P1, P2, A, and B. No lines are to be connected to Ml, and M2.

3. Rotate knobs on both Throttle Valves fully counter-clockwise.

4. Rotate knob at the base of the 200 PSI gage fully counterclockwise.

5. Place switch V1 ON position and switches V2 and V3 in the OFF position.

6.* Turn the primary pump on by setting switch M3 ON and adjust Throttle Valve 1 (TV1) clockwise until flow is evident. (Note: Do not exceed 200 PSI. If flow is not evident by 200 PSI, rotate knob at the base of the 200 PSI gage fully clockwise and continue testing using the 600 PSI gage.) Record the pressure at which flow becomes evident.

7. Turn Throttle Valve 1 clockwise until full flow through the lock valve is achieved. Do not exceed 370 PSI. Record maximum flow. Close valve to 600 PSI gage by turning clockwise fully.

8. Continue turning Throttle Valve 1 until the pressure indicated on the 3000 PSI pressure gage reads between 925 PSI and 950 PSI or has seated, if pressure not within range turn Throttle Valve 2 clockwise until required pressure achieved.

9. Turn Throttle Valve 1 counter-clockwise until flow ceases.

10. Record the pressure at which flow ceased. (Note: If the pressure is less then 200 PSI, turn the knob at the base of the 200 PSI gage fully counter-clockwise and read the pressure from the 200 PSI gage.) Pressure when the flow ceases shall be within 50 PSI of the pressure required to initiate flow.

11. Turn off pump by setting switch M3 to OFF and place all switches in the OFF position.

12. Performance Requirement Number 3 is complete.

* If additional pressure is desired on the lock valve, Throttle Valve 2 (TV2) can be rotated clockwise.

Performance Requirement Number 4

1. Install quick disconnects in all valve ports.

2. Connect lines 1, 2, A, and B to their respective ports P1, P2, A, and B. No lines are to be connected to Ml and M2.

3. Rotate knobs on both Throttle Valves fully counter-clockwise.

4. Rotate knob at the base of the 200 PSI gage fully counterclockwise.

5. Place switches V1, V2, and V3 in the ON position.

6.* Turn the primary pump on by setting switch M3 to ON and adjust Throttle Valve 1 (TV1) clockwise until flow is evident. (Note: Do not exceed 200 PSI. If flow is not evident by 200 PSI, rotate knob at the base of the 200 PSI gage fully clockwise and continue testing using the 600 PSI gage.) Record the pressure at which flow becomes evident.

7. Turn Throttle Valve 1 clockwise until full flow through the lock valve is achieved. Do not exceed 370 PSI. Record maximum flow. Close valve to 600 PSI gage by turning clockwise fully.

8. Continue turning Throttle Valve 1 until the pressure indicated on the 3000 PSI pressure gage reads between 925 PSI and 950 PSI or has seated, if pressure not within range turn Throttle Valve 2 clockwise until required pressure achieved.

9. Turn Throttle Valve 1 counter-clockwise until flow ceases.

10. Record the pressure at which flow ceased. (Note: If the pressure is less then 200 PSI, turn the knob at the base of the 200 PSI gage fully counter-clockwise and read the pressure from the 200 PSI gage.) Pressure when the flow ceases shall be within 50 PSI of the pressure required to initiate flow.

11. Turn off pump by setting switch M3 to OFF and place all switches in the OFF position.

12. Performance Requirement Number 4 is complete.

* If additional pressure is desired on the lock valve/ Throttle Valve 2 (TV2) can be rotated clockwise.

Performance Requirement Number 5

1. Install quick disconnects in all valve ports.

2. Connect lines l, 2, A, and B to their respective ports M1, M2, A, and B. No lines are to be connected to Pl, and P2.

3. Rotate knobs on both Throttle Valves fully counter-clockwise.

4. Rotate knob at the base of the 200 PSI gage fully counterclockwise.

5. Place switch V1 in ON position and switches V2 and V3 in the OFF position.

6.* Turn the primary pump on by setting switch M3 to ON and adjust Throttle Valve 1 (TV1) clockwise until flow is evident. (Note: Do not exceed 200 PSI. If flow is not evident by 200 PSI, rotate knob at the base of the 200 PSI gage fully clockwise and continue testing using the 600 PSI gage.) Record the pressure at which flow becomes evident.

7. Turn Throttle Valve 1 clockwise until full flow through the lock valve is achieved. Do not exceed 370 PSI. Record maximum flow. Close valve to 600 PSI gage by turning clockwise fully.

8. Continue turning Throttle Valve 1 until the pressure indicated on the 3000 PSI pressure gage reads between 925 PSI and 950 PSI or has seated, if pressure not within range turn Throttle Valve 2 clockwise until required pressure achieved.

9. Turn Throttle Valve 1 counter-clockwise until flow ceases.

10. Record the pressure at which flow ceased. (Note: If the pressure is less then 200 PSI, turn the knob at the base of the 200 PSI gage fully counter-clockwise and read the pressure from the 200 PSI gage.) Pressure when the flow ceases shall be within 50 PSI of the pressure required to initiate flow.

11. Turn off pump by setting switch M3 to OFF and place all switches in the OFF position.

12. Performance Requirement Number 5 is complete.

* If additional pressure is desired on the lock valve, Throttle Valve 2 (TV2) can be rotated clockwise.

Performance Requirement Number 6

1. Install quick disconnects in all valve ports.

2. Connect lines 1, 2, A, and B to their respective ports M1, M2, A, and B. No lines are to be connected to Pl, and P2.

3. Rotate knobs on both Throttle Valves fully counter-clockwise.

4. Rotate knob at the base of the 200 PSI gage fully counterclockwise.

5. Place switches V1, V2, and V3 in the ON position.

6.* Turn the primary pump on by setting switch M3 to ON and adjust Throttle Valve 1 (TV1) clockwise until flow is evident. (Note: Do not exceed 200 PSI. If flow is not evident by 200 PSI, rotate knob at the base of the 200 PSI gage fully clockwise and continue testing using the 600 PSI gage.) Record the pressure at which flow becomes evident.

7. Turn Throttle Valve 1 clockwise until full flow through the lock valve is achieved. Do not exceed 370 PSI. Record maximum flow. Close valve to 600 PSI gage by turning clockwise fully.

8. Continue turning Throttle Valve 1 until the pressure indicated on the 3000 PSI pressure gage reads between 925 PSI and 950 PSI or has seated, if pressure not within range turn Throttle Valve 2 clockwise until required pressure achieved.

9. Turn Throttle Valve 1 counter-clockwise until flow ceases.

10. Record the pressure at which flow ceased. (Note: If the pressure is less then 200 PSI, turn the knob at the base of the 200 PSI gage fully counter-clockwise and read the pressure from the 200 PSI gage.) Pressure when the flow ceases shall be within 50 PSI of the pressure required to initiate flow.

11. Turn off pump by setting switch M3 to OFF and place all switches in the OFF position.

12. Performance Requirement Number 6 is complete.

* If additional pressure is desired on the lock valve, Throttle Valve 2 (TV2) can be rotated clockwise.

Performance Requirement Number 7

1 . Remove all lines from ports Ml, M2, Pl and P2. Connect line A to port A and line B to port B.

2. Orient valve so ports M1, M2, P1, and P2 are facing down.

3 . Install appropriate adapters in ports Ml, M2, Pl and P2 . (Fill with fluid as necessary.)

4. Adjust throttle valves to full counter clockwise position.

5. Rotate knob at the base of the 200 PSI gage full clockwise.

6. Start primary pump by setting switch M3 to ON. Place switch V2 in the ON position to test the A port.

7. Adjust throttle valve TV1 to obtain pressure of 200+/-10 PSI. Maintain for a minimum of four minutes.

8. Turn off pump by setting switch M3 to OFF and record the number of drops from Ml, M2, Pl and P2 ports. Leakage to be three drops or less.

9. Repeat steps 6 through 8 with switch V2 in the OFF position to test the B port.

10. Performance Requirement Number 7 is complete..

Performance Requirement Number 8

1. Remove adapters from ports M1, M2, P1, and P2 and install quick disconnects.

2. Connect Line A to port A and Line B to port B.

3. Connect line 1 to port P1.

4. Connect line E to any M or P line in bundle and bundle line to port P2.

5. Set switch V1 to ON position and switches V2 and V3 to OFF position.

6. Adjust throttle valves to full counter-clockwise position.

7. Rotate knob at base of 200 PSI gage fully clockwise.

8. Turn primary and secondary pump on by setting switch M3 and M1 to ON.

9. Adjust Throttle Valve 3 (TV3) to indicate 200 PSI on the 600 PSI pressure gage G2 and adjust Throttle Valve 1 (TV1) to indicate 200 PSI on the 600 PSI pressure gage G1. Alternating between the two during pressure increase.

10. Turn Throttle Valve 1 clockwise until flow is evident. Do not exceed 370 PSI. Record pressure when flow becomes evident. Flow evident at pressures below 325 PSI will not be permitted.

11. Rotate Throttle Valve 1 counter-clockwise until 200 PSI is indicated on the 600 PSI pressure gage G1.

12. Turn off pumps by setting switch M3 and M1 to OFF.

13. Disconnect lines 1 and bundle line connected to line E from ports P1 and P2.

14. Connect bundle line connected to line E to port P1 and line 1 to Port P2.

15. Repeat steps 8 through 13.

16. Performance Requirement Number 8 is complete.

Performance Requirement Number 9

1. Connect line G to bundle line B and line F to bundle line A.

2. Connect bundle line B to port B and bundle line A to port A.

3. Connect line 1 to port P1 and line 2 to port P2.

4. Set switch V1 to On and switches V2 and V3 to OFF position.

5. Adjust Throttle Valves to full counter-clockwise position.

6. Rotate knob at base of 200 PSI gage fully counter-clockwise position.

7. Turn primary and secondary pumps on by setting switches M3 and M1 to ON.

8. Adjust Throttle Valve 3 (TV3) to indicate 500 PSI on the 600 PSI pressure gage G2.

9. Adjust Throttle Valve 1 (TV1) to indicate 50 PSI on the 200 PSI pressure gage.

10. Turn Throttle Valve 1 clockwise until flow is evident. Do not exceed 170 PSI. Record pressure when flow becomes evident. Flow evident at pressures below 125 PSI will not be permitted.

11. Rotate Throttle Valve 1 counter-clockwise until 50 PSI is indicated on the 200 PSI pressure gage.

12. Turn off pumps by setting switches M3 and M1 to OFF.

13. Disconnect line 1 from port P1.

14. Disconnect line 2 from port P2.

15. Connect line 1 to port P2 and line 2 to Port P1.

16. Repeat steps 7 through 12.

17. Performance Requirement Number 9 is complete.

Performance Requirement Number 10

1. Remove adapters from ports M1, M2, P1, and P2 and install quick disconnects.

2. Connect line A to port A and line B to port B.

3. Connect line 1 to port M1.

4. Connect line E to any M or P line in bundle and bundle line to port M2.

5. Set switch to ON position and switches V2 and V3 to OFF position.

6. Adjust Throttle Valves to full counter-clockwise position.

7. Rotate knob at base of 200 PSI gage fully clockwise.

8. Turn primary and secondary pump on by setting switches M3 and M1 to ON.

9. Adjust Throttle Valve 3 (TV3) to indicate 200 PSI on the 600 PSI pressure gage G2 and adjust Throttle Valve 1 (TV1) to indicate 200 PSI on the 600 PSI pressure gage G1. Alternating between the two during pressure increase.

10. Turn Throttle Valve 1 clockwise until flow is evident. Do not exceed 370 PSI. Record pressure when flow becomes evident. Flow evident at pressures below 325 PSI will not be permitted.

11. Rotate Throttle Valve 1 counter-clockwise until 200 PSI is indicated on the 600 PSI pressure gage G1.

12. Turn off pumps by setting switches M3 and M1 to OFF.

13. Disconnect lines 1 and bundle line connected to line E from ports M1 and M2.

14. Connect bundle line connected to line E to port M2 and line 1 to Port M1.

15. Repeat steps 8 through 13.

16. Performance Requirement Number 10 is complete.

Performance Requirement Number 11

1. Connect line G to bundle line B and line F to bundle line A.

2. Connect bundle line B to port B and bundle line A to port A.

3. Connect line 1 to port M1 and line 2 to port P2.

4. Set switch V1 to On and switches V2 and V3 to OFF position.

5. Adjust Throttle Valves to full counter-clockwise position.

6. Rotate knob at base of 200 PSI gage fully counter-clockwise position.

7. Turn primary and secondary pump on by setting switches M3 and M1 to ON.

8. Adjust Throttle Valve 3 (TV3) to indicate 500 PSI on the 600 PSI pressure gage G2.

9. Adjust Throttle Valve 1 (TV1) to indicate 50 PSI on the 200 PSI pressure gage.

10. Turn Throttle Valve 1 clockwise until flow is evident. Do not exceed 170 PSI. Record pressure when flow becomes evident. Flow evident at pressures below 125 PSI will not be permitted.

11. Rotate Throttle Valve 1 counter-clockwise until 50 PSI is indicated on the 200 PSI pressure gage.

12. Turn off pumps by setting switches M3 and M1 to OFF.

13. Disconnect line 1 from port M1.

14. Disconnect line 2 from port M2.

15. Connect line 1 to port M2 and line 2 to Port M1.

16. Repeat steps 7 through 12.

17. Performance Requirement Number 11 is complete.

Performance Requirement Number 12

1. Connect Line A to Y adapter and Y adapter to Ports A and B.

2. Install male quick disconnects on ports M1, M2, P1, and P2 if not already installed.

3. Install quick disconnects with tubes to ports P1 and M1.

4. Place graduated receptacle under the two tubes to collect fluid.

5. Rotate the knob at the base of the 200 PSI pressure gage and the 600 PSI pressure gage G1 fully counter-clockwise. Also, rotate the knob on Throttle Valve 1 fully counter-clockwise.

6. Place switches V1 and V3 in the ON position and switch V2 to Off position.

7. Turn primary pump on by setting switch M3 to ON and adjust Throttle Valve 1 (TV1) to indicate 2000 PSI on the 3000 PSI pressure gage or has seated, if pressure not within range turn Throttle Valve 2 clockwise until required pressure achieved. Run pump for a predetermined time.

8. At the end of the predetermined time, turn the pump off by setting switch M3 to OFF and measure the volume of fluid collected. Divide the volume collected by the time and multiply by the number of drops per graduation. Record rate. Flow less than 4 drops per minute will not be permitted.

9. Transfer quick disconnects with tubes from ports M1 and P1 to M2 and P2.

10. Repeat steps 4 through 8.

11. Performance Requirement Number 12 is complete.

Test Documentation Sheet
for Lock Valve PN 11784023

FUNCTIONAL TEST

Contract:_____ Test Date:_____

Manufacturer:_____

Sample #:_____ Test Time:_____

Test 1:

PORT A:	Leakage	or	No Leakage
PORT B:	Leakage	or	No Leakage

Test 2:

Port	Flow(cc)	Duration(sec.)	Flow Rate(cc/sec)
M1	_____	_____	_____
P1	_____	_____	_____
M2	_____	_____	_____
P2	_____	_____	_____

Test 3: P1 to B

a. On Pressure (psi) _____

b. Flow (gpm)_____ at psi_____

c. Off Pressure (psi)_____

d. Off Pressure (psi)_____

Test 4: P2 to A

a. On Pressure (psi) _____

b. Flow (gpm)_____ at psi_____

c. Off Pressure (psi)_____

d. Off Pressure (psi)_____

Test 5: M1 to B

a. On Pressure (psi) _____

b. Flow (gpm)_____ at psi_____

c. Off Pressure (psi)_____

d. Off Pressure (psi)_____

Test 6: M2 to A

a. On Pressure (psi) _____

b. Flow (gpm)_____ at psi_____

c. Off Pressure (psi)_____

d. Off Pressure (psi)_____

Test 7:

At 200 psi

Port A _____ drops / 4 minutes

Port B _____ drops / 4 minutes

Test 8:

a. Port P1 On Pressure (psi)_____

b. Port P2 On Pressure (psi)_____

Test 9:

a. Port P1 On Pressure (psi)_____

b. Port P2 On Pressure (psi)_____

Test 10:

a. Port M1 On Pressure (psi)_____

b. Port M2 On Pressure (psi)_____

Test 11:

a. Port M1 On Pressure (psi)_____

b. Port M2 On Pressure (psi)_____

Test 12:

Total Leakage Volume (cc):_____

Duration: _____

Leakage Rate (cc/sec.):_____

APPENDIX B - SHOCK/VIBRATION TEST

1. Shock and vibration testing shall be conducted in accordance with Mil-Std-810E which is entitled "Environmental Test Methods and Engineering Guidelines".

2. The shock shall be conducted in accordance with method 516.4, procedure 1. The vibration shall be conducted in accordance with method 514.4, category 8.

3. All the requirements of Mil-Std-810E apply with the exception that the tolerance on time in paragraph 5.1.1 be changed from +/- 1% to +/- 10%.

4. The following tables are provided for easy reference for the magnitude, frequency, time duration, and tolerances.

Shock

Each valve hall be subjected to 3 half-sine wave impulses for each combination in table 1.

Axis	Magnitude (g's)	Duration (millisec.)
X	30 +/- 3	11 +/- 1.1
Y	30 +/- 3	11 +/- 1.1
Z	30 +/- 3	11 +/- 1.1
X	55 +/- 5.5	2.5 +/- 0.25
Y	55 +/- 5.5	2.5 +/- 0.25
Z	55 +/- 5.5	2.5 +/- 0.25
X	70 +/- 7	0.5 +/- 0.05
Y	70 +/- 7	0.5 +/- 0.05
Z	70 +/- 7	0.5 +/- 0.05

TABLE 1

Vibration

Each valve hall be subjected to each combination in table 2.

Axis	Frequency (Hz)	Frequency Tolerance	Magnitude	Magnitude Tolerance
X	5 - 25	+/- 2%	+/- 1.5 G	+/- 0.15 G
Y	5 - 25	+/- 2%	+/- 1.5 G	+/- 0.15 G
Z	5 - 25	+/- 2%	+/- 1.5 G	+/- 0.15 G
X	25 - 50	+/- 2%	0.030 IN	+/- 0.003 IN
Y	25 - 50	+/- 2%	0.030 IN.	+/- 0.003 IN
Z	25 - 50	+/- 2%	0.030 IN.	+/- 0.003 IN
X	50 - 500	+/- 2%	+/- 5.0 G	+/- 0.5 G
Y	50 - 500	+/- 2%	+/- 5.0 G	+/- 0.5 G
Z	50 - 500	+/- 2%	+/- 5.0 G	+/- 0.5 G

TABLE 2

Shock and Vibration
Test Document Sheet

Manufacturer:_____
Sample #:_____ Test date:_____

Shock

Axis	Magnitude	Duration

Vibration

Axis	Frequency	Magnitude

APPENDIX C - CLIMATIC TEST

GENERAL PREPARATION

- Connect pressure and return lines (large and small lines) from test stand to reservoir.

- Fill reservoir with hydraulic fluid conforming to MIL-H-6083 so that fluid is seen in the circular "bulls eye" level gage.

- Plug the power cord #1 into a 120 volt AC grounded wall outlet. The outlet should be capable of supplying 15 amps.

- Plug the power cord #2 into a 220 volt three phase AC grounded outlet. The outlet should be capable of supplying 30 amps.

- Make sure the O-rings at the A and B ports of the lock valve are properly installed. Mount the lock valve assembly to the hydraulic manifold so that the port identification markings are up-side-down.

- Plug the power cord of the Fluid Chiller into a 220 volt single phase AC grounded wall outlet. The outlet should be capable of supplying 30 amps.

- Remove valve stand from test stand and connect Valve Stand Remote Bundle. Place Valve Stand in a suitable climatic cell.

- Remove reservoir from cart and install into climatic cell after installing Reservoir Remote Bundle to reservoir and test stand.

- Condition reservoir, valve stand, and valves to be tested to -50 deg. Fahrenheit until temperature uniform throughout items.

- Remove Reservoir from chamber and install into insulated enclosure.

- Install Fluid Chiller Probe into reservoir.

- Install insulation on lines and reservoir.
- Turn switches M1, M3, V1, V2, and V3 to OFF position.

- Ensure STOP switch is in ON position (out/released).

- Set cyclic controller switch to "By Passed".

- Press START button to energize stand.

- Run Fluid Chiller until fluid temperature stabilizes at -50 degrees Fahrenheit. Circulate fluid and adjust Chiller so that the fluid temperature as it enters the Valve Stand Remote Bundle is at -50 degrees Fahrenheit.

Performance Requirement Number 3

1. Install quick disconnects in all valve ports.

2. Connect lines l, 2, A, and B to their respective ports P1, P2, A, and B. No lines are to be connected to Ml, and M2.

3. Rotate knobs on both Throttle Valves fully counter-clockwise.

4. Rotate knob at the base of the 200 PSI gage fully counterclockwise.

5. Place switch V1 ON position and switches V2 and V3 in the OFF position.

6.* Turn the primary pump on by setting switch M3 ON and adjust Throttle Valve 1 (TV1) clockwise until flow is evident. (Note: Do not exceed 200 PSI. If flow is not evident by 200 PSI, rotate knob at the base of the 200 PSI gage fully clockwise and continue testing using the 600 PSI gage.) Record the pressure at which flow becomes evident.

7. Continue turning Throttle Valve 1 until the pressure indicated on the 3000 PSI pressure gage reads between 925 PSI and 950 PSI or has seated, if pressure not within range turn Throttle Valve 2 clockwise until required pressure achieved.

8. Turn Throttle Valve 1 counter-clockwise until flow ceases.

9. Record the pressure at which flow ceased. (Note: If the pressure is less then 200 PSI, turn the knob at the base of the 200 PSI gage fully counter-clockwise and read the pressure from the 200 PSI gage.) Pressure when the flow ceases shall be within 50 PSI of the pressure required to initiate flow.

10. Turn off pump by setting switch M3 to OFF and place all switches in the OFF position.

11. Performance Requirement Number 3 is complete.

* If additional pressure is desired on the lock valve, Throttle Valve 2 (TV2) can be rotated clockwise.

Performance Requirement Number 4

1. Install quick disconnects in all valve ports.

2. Connect lines 1, 2, A, and B to their respective ports P1, P2, A, and B. No lines are to be connected to Ml and M2.

3. Rotate knobs on both Throttle Valves fully counter-clockwise.

4. Rotate knob at the base of the 200 PSI gage fully counterclockwise.

5. Place switches V1, V2, and V3 in the ON position.

6.* Turn the primary pump on by setting switch M3 to ON and adjust Throttle Valve 1 (TV1) clockwise until flow is evident. (Note: Do not exceed 200 PSI. If flow is not evident by 200 PSI, rotate knob at the base of the 200 PSI gage fully clockwise and continue testing using the 600 PSI gage.) Record the pressure at which flow becomes evident.

7. Continue turning Throttle Valve 1 until the pressure indicated on the 3000 PSI pressure gage reads between 925 PSI and 950 PSI or has seated, if pressure not within range turn Throttle Valve 2 clockwise until required pressure achieved.

8. Turn Throttle Valve 1 counter-clockwise until flow ceases.

9. Record the pressure at which flow ceased. (Note: If the pressure is less then 200 PSI, turn the knob at the base of the 200 PSI gage fully counter-clockwise and read the pressure from the 200 PSI gage.) Pressure when the flow ceases shall be within 50 PSI of the pressure required to initiate flow.

10. Turn off pump by setting switch M3 to OFF and place all switches in the OFF position.

11. Performance Requirement Number 4 is complete.

* If additional pressure is desired on the lock valve/ Throttle Valve 2 (TV2) can be rotated clockwise.

Performance Requirement Number 5

1. Install quick disconnects in all valve ports.

2. Connect lines l, 2, A, and B to their respective ports M1, M2, A, and B. No lines are to be connected to Pl, and P2.

3. Rotate knobs on both Throttle Valves fully counter-clockwise.

4. Rotate knob at the base of the 200 PSI gage fully counterclockwise.

5. Place switch V1 in ON position and switches V2 and V3 in the OFF position.

6.* Turn the primary pump on by setting switch M3 to ON and adjust Throttle Valve 1 (TV1) clockwise until flow is evident. (Note: Do not exceed 200 PSI. If flow is not evident by 200 PSI, rotate knob at the base of the 200 PSI gage fully clockwise and continue testing using the 600 PSI gage.) Record the pressure at which flow becomes evident.

7. Continue turning Throttle Valve 1 until the pressure indicated on the 3000 PSI pressure gage reads between 925 PSI and 950 PSI or has seated, if pressure not within range turn Throttle Valve 2 clockwise until required pressure achieved.

8. Turn Throttle Valve 1 counter-clockwise until flow ceases.

9. Record the pressure at which flow ceased. (Note: If the pressure is less then 200 PSI, turn the knob at the base of the 200 PSI gage fully counter-clockwise and read the pressure from the 200 PSI gage.) Pressure when the flow ceases shall be within 50 PSI of the pressure required to initiate flow.

10. Turn off pump by setting switch M3 to OFF and place all switches in the OFF position.

11. Performance Requirement Number 5 is complete.

* If additional pressure is desired on the lock valve, Throttle Valve 2 (TV2) can be rotated clockwise.

Performance Requirement Number 6

1. Install quick disconnects in all valve ports.

2. Connect lines 1, 2, A, and B to their respective ports M1, M2, A, and B. No lines are to be connected to Pl, and P2.

3. Rotate knobs on both Throttle Valves fully counter-clockwise.

4. Rotate knob at the base of the 200 PSI gage fully counterclockwise.

5. Place switches V1, V2, and V3 in the ON position.

6.* Turn the primary pump on by setting switch M3 to ON and adjust Throttle Valve 1 (TV1) clockwise until flow is evident. (Note: Do not exceed 200 PSI. If flow is not evident by 200 PSI, rotate knob at the base of the 200 PSI gage fully clockwise and continue testing using the 600 PSI gage.) Record the pressure at which flow becomes evident.

7. Continue turning Throttle Valve 1 until the pressure indicated on the 3000 PSI pressure gage reads between 925 PSI and 950 PSI or has seated, if pressure not within range turn Throttle Valve 2 clockwise until required pressure achieved.

8. Turn Throttle Valve 1 counter-clockwise until flow ceases.

9. Record the pressure at which flow ceased. (Note: If the pressure is less then 200 PSI, turn the knob at the base of the 200 PSI gage fully counter-clockwise and read the pressure from the 200 PSI gage.) Pressure when the flow ceases shall be within 50 PSI of the pressure required to initiate flow.

10. Turn off pump by setting switch M3 to OFF and place all switches in the OFF position.

11. Performance Requirement Number 6 is complete.

* If additional pressure is desired on the lock valve, Throttle Valve 2 (TV2) can be rotated clockwise.

Test Documentation Sheet
for Lock Valve PN 11784023

CLIMATIC TEST

COLD PHASE

Contract:_____ Test Date:_____

Manufacturer:_____

Sample #:_____ Test Time:_____

Chamber Temperature (At Start of Test):_____

Oil Temperature (At Start of Test):_____

Test 3: P1 to B

a. On Pressure (psi) _____

b. Flow (gpm)_____ at psi_____

c. Off Pressure (psi)_____

d. Off Pressure (psi)_____

Test 4: P2 to A

a. On Pressure (psi) _____

b. Flow (gpm)_____ at psi_____

c. Off Pressure (psi)_____

d. Off Pressure (psi)_____

Test 5: M1 to B

a. On Pressure (psi) _____

b. Flow (gpm)_____ at psi_____

c. Off Pressure (psi)_____

d. Off Pressure (psi)_____

Test 6: M2 to A

a. On Pressure (psi) _____

b. Flow (gpm)_____ at psi_____

c. Off Pressure (psi)_____

d. Off Pressure (psi)_____

Chamber Temperature (At End of Test):_____ Test End Date:_____

Oil Temperature (At End of Test):_____ Test End Time:_____

GENERAL PREPARATION

- Connect pressure and return lines (large and small lines) from test stand to reservoir.

- Fill reservoir with hydraulic fluid conforming to MIL-H-6083 so that fluid is seen in the circular "bulls eye" level gage.

- Plug the power cord into a 120 volt AC grounded wall outlet. The outlet should be capable of supplying 15 amps.

- Make sure the O-rings at the A and B ports of the lock valve are properly installed. Mount the lock valve assembly to the hydraulic manifold so that the port identification markings are up-side-down.

- Mount Valve Stand onto the test stand.

- Wire each Fluid Heater into a 220 volt single phase AC grounded Breaker box. The Breaker box should be capable of supplying 12 amps.

- Turn switches M1, M3, V1, V2, and V3 to OFF position.

- Ensure STOP switch is in on position (out/released).

- Set cyclic controller switch to "By Passed".

- Press START button to energize stand.

- Install insulation on lines and reservoir.

- Run Fluid Heater until fluid temperature stabilizes at 250 degrees Fahrenheit while circulating the fluid. Adjust Heater so that the fluid temperature as it enters the Valve Stand is at 250 degrees Fahrenheit.

Performance Requirement Number 3

1. Install quick disconnects in all valve ports.

2. Connect lines l, 2, A, and B to their respective ports P1, P2, A, and B. No lines are to be connected to Ml, and M2.

3. Rotate knobs on both Throttle Valves fully counter-clockwise.

4. Rotate knob at the base of the 200 PSI gage fully counterclockwise.

5. Place switch V1 ON position and switches V2 and V3 in the OFF position.

6.* Turn the primary pump on by setting switch M3 ON and adjust Throttle Valve 1 (TV1) clockwise until flow is evident. (Note: Do not exceed 200 PSI. If flow is not evident by 200 PSI, rotate knob at the base of the 200 PSI gage fully clockwise and continue testing using the 600 PSI gage.) Record the pressure at which flow becomes evident.

7. Continue turning Throttle Valve 1 until the pressure indicated on the 3000 PSI pressure gage reads between 925 PSI and 950 PSI or has seated, if pressure not within range turn Throttle Valve 2 clockwise until required pressure achieved.

8. Turn Throttle Valve 1 counter-clockwise until flow ceases.

9. Record the pressure at which flow ceased. (Note: If the pressure is less then 200 PSI, turn the knob at the base of the 200 PSI gage fully counter-clockwise and read the pressure from the 200 PSI gage.) Pressure when the flow ceases shall be within 50 PSI of the pressure required to initiate flow.

10. Turn off pump by setting switch M3 to OFF and place all switches in the OFF position.

11. Performance Requirement Number 3 is complete.

* If additional pressure is desired on the lock valve, Throttle Valve 2 (TV2) can be rotated clockwise.

Performance Requirement Number 4

1. Install quick disconnects in all valve ports.

2. Connect lines 1, 2, A, and B to their respective ports P1, P2, A, and B. No lines are to be connected to Ml and M2.

3. Rotate knobs on both Throttle Valves fully counter-clockwise.

4. Rotate knob at the base of the 200 PSI gage fully counterclockwise.

5. Place switches V1, V2, and V3 in the ON position.

6.* Turn the primary pump on by setting switch M3 to ON and adjust Throttle Valve 1 (TV1) clockwise until flow is evident. (Note: Do not exceed 200 PSI. If flow is not evident by 200 PSI, rotate knob at the base of the 200 PSI gage fully clockwise and continue testing using the 600 PSI gage.) Record the pressure at which flow becomes evident.

7. Continue turning Throttle Valve 1 until the pressure indicated on the 3000 PSI pressure gage reads between 925 PSI and 950 PSI or has seated, if pressure not within range turn Throttle Valve 2 clockwise until required pressure achieved.

8. Turn Throttle Valve 1 counter-clockwise until flow ceases.

9. Record the pressure at which flow ceased. (Note: If the pressure is less then 200 PSI, turn the knob at the base of the 200 PSI gage fully counter-clockwise and read the pressure from the 200 PSI gage.) Pressure when the flow ceases shall be within 50 PSI of the pressure required to initiate flow.

10. Turn off pump by setting switch M3 to OFF and place all switches in the OFF position.

11. Performance Requirement Number 4 is complete.

* If additional pressure is desired on the lock valve/ Throttle Valve 2 (TV2) can be rotated clockwise.

Performance Requirement Number 5

1. Install quick disconnects in all valve ports.

2. Connect lines l, 2, A, and B to their respective ports M1, M2, A, and B. No lines are to be connected to Pl, and P2.

3. Rotate knobs on both Throttle Valves fully counter-clockwise.

4. Rotate knob at the base of the 200 PSI gage fully counterclockwise.

5. Place switch V1 in ON position and switches V2 and V3 in the OFF position.

6.* Turn the primary pump on by setting switch M3 to ON and adjust Throttle Valve 1 (TV1) clockwise until flow is evident. (Note: Do not exceed 200 PSI. If flow is not evident by 200 PSI, rotate knob at the base of the 200 PSI gage fully clockwise and continue testing using the 600 PSI gage.) Record the pressure at which flow becomes evident.

7. Continue turning Throttle Valve 1 until the pressure indicated on the 3000 PSI pressure gage reads between 925 PSI and 950 PSI or has seated, if pressure not within range turn Throttle Valve 2 clockwise until required pressure achieved.

8. Turn Throttle Valve 1 counter-clockwise until flow ceases.

9. Record the pressure at which flow ceased. (Note: If the pressure is less then 200 PSI, turn the knob at the base of the 200 PSI gage fully counter-clockwise and read the pressure from the 200 PSI gage.) Pressure when the flow ceases shall be within 50 PSI of the pressure required to initiate flow.

10. Turn off pump by setting switch M3 to OFF and place all switches in the OFF position.

11. Performance Requirement Number 5 is complete.

* If additional pressure is desired on the lock valve, Throttle Valve 2 (TV2) can be rotated clockwise.

Performance Requirement Number 6

1. Install quick disconnects in all valve ports.

2. Connect lines 1, 2, A, and B to their respective ports M1, M2, A, and B. No lines are to be connected to Pl, and P2.

3. Rotate knobs on both Throttle Valves fully counter-clockwise.

4. Rotate knob at the base of the 200 PSI gage fully counterclockwise.

5. Place switches V1, V2, and V3 in the ON position.

6.* Turn the primary pump on by setting switch M3 to ON and adjust Throttle Valve 1 (TV1) clockwise until flow is evident. (Note: Do not exceed 200 PSI. If flow is not evident by 200 PSI, rotate knob at the base of the 200 PSI gage fully clockwise and continue testing using the 600 PSI gage.) Record the pressure at which flow becomes evident.

7. Continue turning Throttle Valve 1 until the pressure indicated on the 3000 PSI pressure gage reads between 925 PSI and 950 PSI or has seated, if pressure not within range turn Throttle Valve 2 clockwise until required pressure achieved.

8. Turn Throttle Valve 1 counter-clockwise until flow ceases.

9. Record the pressure at which flow ceased. (Note: If the pressure is less then 200 PSI, turn the knob at the base of the 200 PSI gage fully counter-clockwise and read the pressure from the 200 PSI gage.) Pressure when the flow ceases shall be within 50 PSI of the pressure required to initiate flow.

10. Turn off pump by setting switch M3 to OFF and place all switches in the OFF position.

11. Performance Requirement Number 6 is complete.

* If additional pressure is desired on the lock valve, Throttle Valve 2 (TV2) can be rotated clockwise.

Test Documentation Sheet
for Lock Valve PN 11784023

CLIMATIC TEST

HOT PHASE

Contract:_____ Test Date:_____

Manufacturer:_____

Sample #:_____

Chamber Temperature (At Start of Test):_____

Oil Temperature (At Start of Test):_____

Test 3: P1 to B

a. On Pressure (psi) _____

b. Flow (gpm)_____ at psi_____

c. Off Pressure (psi)_____

d. Off Pressure (psi)_____

Test 4: P2 to A

a. On Pressure (psi) _____

b. Flow (gpm)_____ at psi_____

c. Off Pressure (psi)_____

d. Off Pressure (psi)_____

Test 5: M1 to B

a. On Pressure (psi) _____

b. Flow (gpm)_____ at psi_____

c. Off Pressure (psi)_____

d. Off Pressure (psi)_____

Test 6: M2 to A

a. On Pressure (psi) _____

b. Flow (gpm)_____ at psi_____

c. Off Pressure (psi)_____

d. Off Pressure (psi)_____

Test 7:

At 200 psi

Port A _____ drops / 4 minutes

Port B _____ drops / 4 minutes

Chamber Temperature (At End of Test):_____ Test End Date:_____

Oil Temperature (At End of Test):_____ Test End Time:_____

APPENDIX D - ENDURANCE TEST

GENERAL PREPARATION

- Connect pressure and return lines (large and small lines) from test stand to reservoir.

- Fill reservoir with hydraulic fluid conforming to MIL-H-6083 so that fluid is seen in the circular "bulls eye" level gage.

- Plug the power cord #1 into a 120 volt AC grounded wall outlet. The outlet should be capable of supplying 15 amps.

- Plug the power cord #2 into a 220 volt three phase AC grounded outlet. The outlet should be capable of supplying 30 amps.

- Turn switches M1 and M3 OFF and V1, V2, and V3 to ON.

- Insure STOP switch is in ON position (out/released).

- Set cyclic controller switch to NORMAL.

- Press START button to energize the stand.

- Make sure the O-rings at the A and B ports of the lock valve are properly installed. Mount the lock valve assembly to the hydraulic manifold so that the port identification markings are up-side-down.

Test Procedure

1) Rotate knobs at base of 200 and 600 PSI gages fully clockwise.

2) Connect Line 1 to port P1, line 2 to port P2, line A to port A, and line B to port B.

3) Turn on primary pump by setting switch M3 to ON and adjust throttle valve VT1 to obtain pressure of 1250 PSI. Adjust throttle valve VT2 if required to obtain required pressure.

4) Set cyclic controller power switch to ON.

5) Press START on controller to start test. After controller stops, record results and reset controller if counter reads 18000 or HP1 or HP2 status lights are on. If LP status light is on, do not reset counter and correct servo valve failure and continue test..

6) Turn off pump by setting switch M3 to OFF.

7) Connect line 1 to port M1 and line 2 to port M2 and repeat steps 3 to 5.

8) Test completed.

NOTE: HP1 and HP2 indicator lights ON indicate Lock Valve failure to shift spool. LP indicator light ON indicates stand sevo valve failure.

ENDURANCE TEST DATA SHEET

MANUFACTURER:_____

SN:_____

DATE TEST STARTED:_____

TIME TEST STARTED:_____

DATE TEST ENDED:_____

TIME TEST ENDED:_____

CYCLE COUNTER READING AT START:_____

CYCLE COUNTER READING AT END:_____

INDICATOR STATUS AT END OF TEST

INDICATOR	LIGHT ON?	
LP	Y	N
HP1	Y	N
HP2	Y	N

APPENDIX E - WEAPON ELEVATION RATE/HOLD TEST

GENERAL PREPARATION

1. An M109A6 will be used to test the lock valve's on-vehicle performance.

2. Prior to installing the valve, ensure that the gun is in travel lock and the hydraulic system is properly discharged (para. 18-1 a. from TM 9-2350-314-20-2-2).

3. Remove the presently installed lock valve, and replace it with the test lock valve (para. 10-8 b. and c. from TM 9-2350-314-34-2.). The removed lock valve should be properly plugged and placed into protective packaging to ensure the valve is not contaminated.

4. Prior to the initiation of testing, ensure that the equilibration/elevation system is properly charged (para 28-10 of TM 9-2350-314-20-2-2), bled, and equilibrated (para. 18-1 e. and f. of TM 9-2350-314-20-2-2).

5. The ability to retain a set elevation over a period of time shall be verified. Elevate the gun tube to 700 mils and verify using a gunner's quadrant. Record the time and elevation. Allow the vehicle to remain undisturbed for one hour. Then use the gunner's quadrant to determine the elevation. Record the time and elevation. Determine the differences between the times and elevations. For a minimum time difference of one hour there is a maximum allowable elevation difference of 1.5 mils. The fluid temperature must remain at 75 +/- 5 degrees F during the test.

6. The gun tube cycle time between 0 mils and max. elevation shall be verified. Turn the hydraulics on and set the gun tube elevation at 0 mil. Use the COS control handle to raise the gun tube to max. elevation at full speed. Measure and record the amount of time expended to complete this operation. Starting with the gun tube at max. elevation, use the COS handle to lower the gun tube to 0 mils at full speed. Measure and record the time expended to complete this operation. In both cases (elevation and depression) the expended time shall not exceed 11 seconds. The ambient temperature must be 70 +/- 15 degrees F and the fluid temperature must be 90 +/- 30 degrees F. Repeat this procedure twice.

7. The gun elevation rate in mils per sec shall be measured for varying degrees of gun control handle actuation. Bring the gun tube to the lower stop and with the hydraulics off, pull the COS control handle 7.5 degrees off the centered position. Turn the hydraulic on and allow the gun to elevate to the upper stop. Use the vehicle's elevation tachometer to determine the elevation rate while simultaneously using the DRU to determine the elevation. This data will be used to create plots of elevation velocity verses time for the ranges of 0-300 mils, 500-800 mils, and 1000-1300 mils. This shall be repeated with the control handle at 10, 15, 20, 25, and 30 degrees off neutral position. For each curve, there shall be no oscillation greater than +/- 5% about the curveÕs mean value. The velocity at 533 mils for each control handle position shall be used to create a second plot of velocity verses handle position. This curve shall have no inflection points.

8. The gun elevation rate in mils per sec shall be measured for a constant manual elevation hand pump rotation. Remove the manual elevation pump handle assembly (para. 10-14 a. TM 9-2350-314-34-2) and install a gear in its place. The gear should be mated with another gear that is mounted to an electric motor. The electric motor will be used to elevate the gun at a constant handle rotation. A plot of the elevation velocity verses time shall be created for motion between 400 and 700 mils. The curve shall fall within +/- 5% of the mean curve.

9. The elevation/depression rate shall be measured for the full range of gun elevations. Using the COS control handle, the gun shall be elevated from the lower gun stop to the upper gun stop while the elevation rate is recorded. This shall be repeated while going

from max. elevation to max. depression. The minimum elevation/depression rate shall be no less than 130 mils/sec.

10. During conduct of the above test procedures, there is no allowable motion from the manual elevation hand crank during power elevation. (Motion would most likely occur when the gun is brought into either the upper or lower stop.)

11. This completes the on vehicle tests for the valve. The above procedure should now be duplicated for any additional valves. If there are no additional valves, then the howitzer should be returned to the original configuration.

On Vehicle Testing
Test Document Sheet

Manufacturer:_____ Sample #:_____
Test date:_____

Gun Droop

Start Time_____ Elevation_____
Finish Time_____ Elevation_____
Time Duration_____ Elevation Delta_____

Gun Cycle Time

Elevation time_____ Depression Time_____
Elevation time_____ Depression Time_____
Elevation time_____ Depression Time_____

Gun Velocity at 533 Mils

Off Center Position of Control Handle_____ Velocity_____
Off Center Position of Control Handle_____ Velocity_____
Off Center Position of Control Handle_____ Velocity_____
Off Center Position of Control Handle_____ Velocity_____
Off Center Position of Control Handle_____ Velocity_____
Off Center Position of Control Handle_____ Velocity_____

APPENDIX B

HYDRAULIC CONTAMINATION CONTROL PLAN

Appendix B:

Hydraulic Contamination Control Plan

AMSTA-AR-FSA-W 2 Mar 95

MEMORANDUM FOR RECORD

SUBJECT: Hydraulic Contamination Control

1. The purpose of this memo is to provide guidance material to be followed during the hydraulic testing of M109 lock valves. Adherence to the following instructions will assure that the requisite cleanliness level 200 of MIL-STD-1246 is met.

2. Instructions for lock valve testing include:

- Gross cleaning as specified in MIL-STD-1246B will be employed.
- The test area will be maintained in a visually clean state.
- Only clean lint free rags will be used on the test stand and components.
- The lock valve protective packaging will not be opened until the valve is required for testing. The packaging will be cleaned before movement to the test stand to remove dust and dirt. This will apply to any other hydraulic components needed for the test stand.
- All open ports and fittings will be plugged or capped immediately when not in use. Plugs or caps will only be removed immediately prior to connecting that particular port or fitting.
- Hydraulic components will not remain unattended or unprotected.
- Any components removed from the test stand will be properly capped or plugged and stored in protective packaging.
- Compressed air will not at any time be permitted to clean hydraulic components.
- Dry sweep will not be used in the hydraulic areas.
- All hand tools and equipment used will be kept clean through the testing process.

3. Prior to testing, the test stand shall have new filters installed and will be flushed using a dummy lock valve. A hydraulic fluid sample will be taken and analyzed to ensure compliance with level 200 of MIL-STD-1246. Only certified clean sample bottles will be allowed.

4. All testing will be performed using the facilities located at Picatinny Arsenal. Picatinny does not have access to a hydraulic fluid particle counter to analyze fluid samples during the qualification testing. For this reason, it is deemed necessary to document that adherence to the above guidelines while performing the actual test sequence will produce acceptable oil contamination levels. A control set of Kemp locking valves will be run through the full set of tests and a fluid sample will be taken during each distinct phase. The samples will be analyzed and favorable results will be considered basis for qualifying the stand and the above guidelines.

5. Oil samples will only be taken during the qualification testing if there is a valve failure. The sample will be taken as soon as possible after the failure, but under no circumstances will the hydraulic system be opened before a sample is taken.

6. POC for this matter is Paul Kida, x2733.

Paul R. Kida
GS-12 Mechanical Engineer

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