SU/GP-B P0679 Rev- AB

STANFORD UNIVERSITY
W.W. HANSEN EXPERIMENTAL PHYSICS LABORATORY
GRAVITY PROBE B, RELATIVITY GYROSCOPE EXPERIMENT
STANFORD, CALIFORNIA 94305-4085

MEASUREMENT OF GMA SOLENOID VALVES FOR READJUSTMENT

GPB ENGINEERING PROCEDURE

9 May, 2000

AS-BUILT

TABLE OF CONTENTS

1. GENERAL DESCRIPTION

This procedure describes the measurements that will be taken on the flight solenoid valves (26211-101) in order to properly adjust them. These measurements will determine the gap between the solenoid rod and the spool pin, as well as the length of travel of the solenoid itself. They will also determine shims necessary to properly set the latching mechanism. These measurements will be taken twice to ensure accuracy, and repeated as necessary in cases of a discrepancy.

2. TEST INFORMATION

- Proper care should be taken in handling components, and their cleanliness must be preserved.
- Temperature: Room temperature
- Humidity: not critical

2.2 Cleanliness

2.2.1 Normal lab environment when components are double bagged.

2.2.2 Class 1000 Clean room when valves are open to atmosphere (use clean hood when possible)

2.3 ESD precautions

2.3.1 None required.

ONR representative, and QA to be notified prior to beginning this procedure

2.4 Personnel, QA, and Documentation

2.4.1 Personnel Integration and Test Director

The Integration and Test Director (ITD) shall be Gideon Asher or an alternate that he shall designate. The ITD has overall responsibility for the implementation of this procedure and shall sign off the completed procedure and relevant sections within it. The GMA REE shall also sign off the completed "As-Built" procedure.

Integration Engineers and other personnel. All engineers and technicians participating in this procedure shall work under the direction of the ITD who shall determine personnel that are qualified to participate in this procedure. Participants in this procedure are to be R. Stephenson and Gideon Asher.

The test shall be conducted on a formal basis to approved and released procedures. The QA program office shall be notified of the start of this procedure. A Quality Assurance Representative, designated by D. Ross shall be present during the procedure (if deemed necessary) and shall review any discrepancies noted and approve their disposition. Upon completion of this procedure, the QA Manager, D. Ross or her designate, shall certify their concurrence that the effort was performed and accomplished in accordance with the prescribed instructions by signing and dating in the designated place(s) in this document. Discrepancies will be recorded in a D-log or as a DR per Quality Plan P0108. If a re-test of any or all of the hardware is necessary, the ITD will determine the appropriate changes in the procedure, with the QA Manager's approval.

2.5 Red-line Authority

Authority to red-line (make minor changes during execution) this procedure is given solely to the ITD or his designate, or the GMA Manager, and shall be approved by QA. Additionally, approval by the Hardware Manager shall be required, if in the judgment of the ITD or QA Representative, experiment functionality may be affected.

To conveniently record data directly into the procedure thus generating the "as-built" document, the procedure will be handled, if possible, in a paperless fashion until completed. A Laptop computer containing an electronic version of this procedure will be operated by the ITD or QA Representative and data shall be recorded by typing directly into the electronic file. Alternatively, an "As-Built" may be created after-the-fact from hand written notes in the approved procedure.

Following completion of the procedure and the creation of an edited electronic copy, a hard copy of the "As-Built" procedure shall be printed and ***signed off by all the designated parties.*** It shall then be filed, including an electronic copy into the data base.

The electronic editing of this document shall be as follows:

Data will be inserted into the document using normal font, i.e. non-bold, non-italic

- "Signatures" shall be designated by **BLACK CAPITAL BOLD LETTERS**.
- "Redlines" shall be in ***RED BOLD ITALICS*** to make them distinguishable in computer and on the hard copy printout.
- If available, digital pictures shall be inserted into the document where appropriate.

3. DOCUMENTS AND EQUIPMENT

3.1 Applicable Documents

Document number	Rev	Description
25110	B	GMA Assembly
25111	A	Caging Component Assembly
25112	B	Spinup Component Assembly
25113	C	Regulator Component Assembly
26211-101	A	Solenoid Valve Assembly

3.2 Test Equipment

Equipment	Model and Serial Number	Calibration
Height Gage	Brown and Sharpe Digit Hite Plus S/N 101842	3/24/01
Depth Gage		
Granite Block	Rahn S/N G-1210	2/14/03
Solenoid Measurement Fixture	N/A	N/A
Latch Measurement Pins	N/A	N/A
Solenoid Measurement Plug	N/A	Depth = 1.3460
Solenoid Control Box	N/A	P0612

4 MEASUREMENT OF SOLENDOID VALVES

Started on: 5/9/00 at 14:45

4.1 Disassembly of Caging and Regulator Modules

4.1.1 Assume that the GMA is installed on the shipping plate, which is fastened to the Rotating Fixture. All work is presumed to be undertaken in the class 1000 Clean Room.

4.1.2 Remove four (4) screws that fasten the solenoid to the valve body. Place screws in serially labeled container. At all times, keep parts from individual solenoids separated into kits.

4.1.3 Place the solenoid in a plastic bag, and store in a plastic container for the time being.

4.1.4 Place the shims and washers from the solenoid valve assembly into the previously mentioned labeled container.

4.1.5 Repeat steps 4.1.2 through 4.1.4 for all solenoids on the Regulator and Caging assemblies.

4.2 Measurement of Solenoid Travel and Shim Placement

4.2.1 Remove solenoid from plastic storage container, and install on Solenoid Measurement Fixture without any washers, springs, or shims.

4.2.2 Use the Solenoid Control Box to make sure the solenoid is closed.

4.2.3 On calibrated granite block, use the height gage and the Latch Measurement pins to measure the depth of the latching mechanism surface (where the shims would rest) to the base of the solenoid. ***Use the average of the four pins, see appendix A.*** **RICK STEPHENSON, RUSS LEESE, 5/9/00**

4.2.4 Remove the solenoid from the Solenoid Measurement Fixture.

4.2.5 Reinstall the solenoid on Solenoid Measurement Fixture using the washer, wave spring, and shims that were installed on with the solenoid originally (from the serially labeled containers).

4.2.6 On granite block, use the height gage, the Solenoid Measurement plug, and the solenoid control box to measure the open and closed positions of the solenoid rod and record this value in Table A.

4.2.7 Measure the position of the underside of the top plate of the Solenoid Measurement Fixture and record this value in Table A. This number, subtracted from the closed position of the rod (which has first had the height of the Solenoid Measurement Plug subtracted) will give the height of the rod from the solenoid base.

4.2.8 Remove the solenoid from the Solenoid Measurement Fixture and store it and the washer/spring/shims in their proper places.

4.2.9 Repeat steps 4.2.1 through 4.2.7 for all GMA Solenoids.

4.2.10 Repeat all measurements and record in Table B. ***All measurements will not be repeated due to the excessive time this would take. Five solenoids were randomly selected, and the measurements repeated (Recorded in table 1). All anomalous measurements were thoroughly investigated in the second run (recorded in table 2). These measures should prevent errors.*** **RICK STEPHENSON, RUSS LEESE, 5/9/00**

4.3 Measurement of spool pin height

4.3.1 On a solenoid body already installed on the shipping plate and assembled, use a depth gage to measure the distance from the top of the circular ridge on the solenoid body to the ledge on which the solenoid rests. Record this datum in Table A. This measurement will be used along with the latching surface depth to determine proper shim use.

4.3.2 Measure the height from the top of the circular ridge on the solenoid body to the spool pin using the depth gage. Record this datum in Table A.

4.3.3 Repeat steps 4.3.1 through 4.3.2 for all solenoid bodies of the Caging and Regulator Modules. The Spinup Module will not be tested at this time. The Spinup module dimensions will be verified later, during assembly.

4.3.4 Repeat all measurements and Record in Table B. ***All measurements will not be repeated due to the excessive time this would take. Five solenoids were randomly selected, and the measurements repeated (Recorded in table 1). All anomalous measurements were thoroughly investigated in the second run (recorded in table 2). These measures should prevent errors.*** **RICK STEPHENSON, RUSS LEESE, 5/12/00**

5 TABLES

5.1 Table 1, First Run Raw Data

Note	Solenoid	# of shims	Base Height	Rod Closed	Rod Open	Latching Surface	Ridge to base	Ridge to pin
**	A	2	1.1869	2.4846	2.5198	0.9895	0.1425	0.1052
	A	X	X	X	X	X	0.1428	0.106
**	B	2	5.3644	6.6637	6.6987	3.4742	0.1418	0.1046
	C	2	2.2144	3.52	3.5564	2.0058	0.1424	0.1058
**	D	2	1.7731	3.078	3.1135	1.5639	X	X
	E	2	1.7737	3.0772	3.1132	1.5747	X	X

	F	2	1.1869	2.5021	2.5375	0.9809	0.143	0.107
**	G	3	1.7739	3.0872	3.1217	1.565	X	X
	G	2	1.7739	3.0873	3.1217	X	X	X
	H	2	1.7732	3.0742	3.1103	1.5716	X	X
	J	2	1.1869	2.4857	2.5216	0.9874	0.1422	0.1059
	K	2	1.7736	3.0797	3.1154	1.5667	X	X
	L	2	1.1172	2.4146	2.4492	0.9164	0.1419	0.1058
	M	2	2.2144	3.5122	3.5478	2.0033	0.1428	0.107
	N	2	1.1869	2.4876	2.5217	0.9755	0.1426	0.1066
	P	2	2.2144	3.5176	3.5523	2.0115	0.1433	0.1059
	Q	2	2.2143	3.5206	3.556	2.0032	0.1434	0.1061
	R	2	1.7736	3.0809	3.1165	1.5624	X	X
	R	2	1.7738	3.0809	3.1162	X	X	X
	S	2	2.2141	3.5146	3.5512	2.0085	0.1429	0.1039
	S	X	X	X	X	X	0.143	0.1068
	T	2	1.1869	2.4856	2.5218	0.9806	0.1431	0.107
	U	2	1.7739	3.0791	3.115	1.5661	X	X
	U	2	1.7738	3.0788	3.1146	X	X	X
	V	2	1.1869	2.4866	2.5231	0.9727	0.1433	0.1068
	W	2	1.7738	3.0765	3.1119	1.5753	X	X
***	X	2	1.7738	3.08	3.1135	1.5437	X	X
	Y	2	1.7736	3.0797	3.1148	1.5678	X	X
	Z	2	2.2142	3.5231	3.559	2.008	0.143	0.1059
	A1	2	1.7738	3.0737	3.1088	1.5646	X	X
	A2	2	1.1869	2.4973	2.5326	0.9834	0.143	0.107
	A2	X	X	X	X	X	0.1431	0.1075
	A3	2	1.7737	3.0824	3.1186	1.5658	X	X
	A4	2	1.7738	3.0836	3.1187	1.5702	X	X
	A4	2	1.7739	3.0838	3.1191	X	X	X
**	A5	2	1.1868	2.4864	2.5212	0.9842	0.1426	0.1048
	A5	X	X	X	X	X	0.1428	0.1051
	A6	2	2.2141	3.5237	3.5592	1.9822	0.142	0.1061

	A6	X	X	X	X	X	0.143	0.1057
	A7	2	1.7737	3.0749	3.11	1.5666	X	X
	A8	2	1.1172	2.423	2.4574	0.9117	0.142	0.1057
	A9	2	1.1171	2.4326	2.4695	0.9103	X	X
	A10	2	1.1873	2.498	2.5334	0.9769	X	X
	A11	2	1.7736	3.0769	3.112	1.5625	X	X
	A11	2	1.7739	3.0767	3.1124	X	X	X

** Solenoid did not close well. May need shim adjustments. ***After further testing, it was determined that this was not a problem. With less force than the poppet spring provides, the solenoids closed easily.*** **RICK STEPHENSON, RUSS LEESE, 5/18 /00**

*** Solenoid worked well after removal of two shims.

5.2 Table 2, Second Run Raw Data

Solenoid	# of shims	Base Height	Rod Closed	Rod Open	Latching Surface	Ridge to base	Ridge to pin
A	X	3.9970	X	X	3.8024	.1423	X
B	X	3.9972	X	X	3.7648	.1430	X
D	X	3.997	X	X	3.7870	X	X
G	3	3.9971	5.3092	5.3435	3.7878	X	X
X	X	3.9972	X	X	3.7939	X	X
A5	X	3.9970	X	X	3.7949	.1435	X
A6	2	3.9971	5.3051	5.3415	3.7907	.1434	.1050
F	2	3.9971	5.3109	5.3466	X	.1429	.1040
A2	2	3.9971	5.3069	5.3424	X	.1430	.1034
Z	2	3.9970	5.3046	5.3404	X	.1424	.1050
Q	2	3.9972	5.3036	5.3392	X	.1430	.1050
R	2	3.9972	5.3031	5.3382	X	X	X
A3	2	3.9973	5.3043	5.3410	X	X	X
A4	2	3.9971	5.3056	5.3409	X	.1421	X
A9	2	3.9972	5.3120	5.3488	X	X	X
A10	2	3.9972	5.3061	5.3418	X	X	X

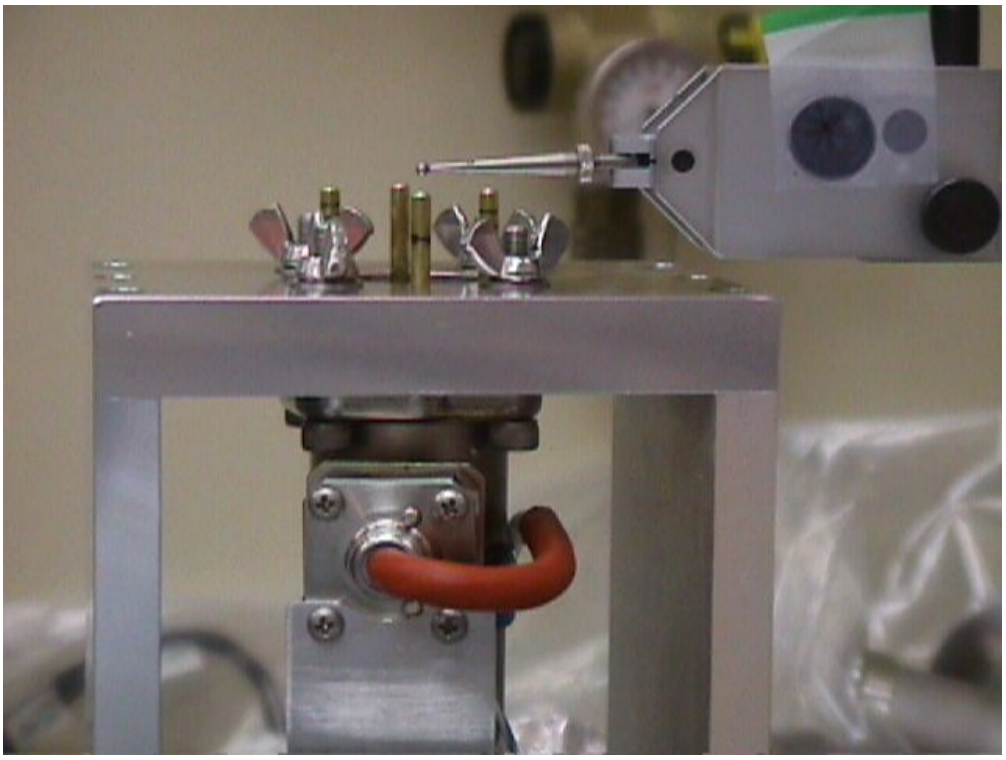
5.3 Table 3, Results

							Second run			
Solenoid	# of shims	Travel	Shim Gap	Estimated Shim Gap	Total Gap	Estimated gap	Shim Gap	Estimated Shim Gap	Total Gap	Estimated gap
A	2	0.0352	0.0549		0.0110		0.0523			
A	X									
B	2	0.035	0.0797		0.0095		0.0518			
C	2	0.0364	0.0662		0.0038					
D	2	0.0355		0.0665		0.0044		0.0673		
E	2	0.036		0.0563		0.0058				
F	2	0.0354	0.063		-0.0052					
G	3	0.0345		0.0662		-0.0040		0.0666	-0.0067	
G	2	0.0344				-0.0041				
H	2	0.0361		0.0589		0.0083				
J	2	0.0359	0.0573		0.0109					
K	2	0.0357		0.0642		0.0032				
L	2	0.0346	0.0589		0.0125					
M	2	0.0356	0.0683		0.0124					
N	2	0.0341	0.0688		0.0093					
P	2	0.0347	0.0596		0.0054					
Q	2	0.0354	0.0677		0.0024				0.0016	
R	2	0.0356		0.0685		0.0020				0.0034
R	2	0.0353				0.0022				
S	2	0.0366	0.0627		0.0065					
S	X	X								
T	2	0.0362	0.0632		0.0112					
U	2	0.0359		0.0651		0.0041				
U	2	0.0358				0.0043				
V	2	0.0365	0.0709		0.0098					
W	2	0.0354		0.0558		0.0066				
X	2	0.0335		0.0874		0.0031		0.0606		

Y	2	0.0351		0.0631		0.0032				
Z	2	0.0359	0.0632		0.0000				0.0010	
A1	2	0.0351		0.0665		0.0094				
A2	2	0.0353	0.0605		-0.0004				-0.0034	
A2	X	X								
A3	2	0.0362		0.0652		0.0006				0.0023
A4	2	0.0351		0.0609		-0.0005				0.0008
A4	2	0.0353				-0.0006				
A5	2	0.0348	0.06		0.0086		0.0586			
A5	X									
A6	2	0.0355	0.0899		0.0005		0.0630		-0.0004	
A6	X	X								
A7	2	0.0351		0.0644		0.0081				
A8	2	0.0344	0.0635		0.0039					
A9	2	0.0369		0.0641		-0.0062				-0.0055
A10	2	0.0354		0.0677		-0.0014				0.0004
A11	2	0.0351		0.0684		0.0060				
A11	2	0.0357								
	average Pin depth			0.0367						
	average Ridge Height			0.1427						
	average shim gap:			0.0653	average gap:	0.00427				
Number of Valves that need poppets replaced: 18										

Accuracy = ± .002

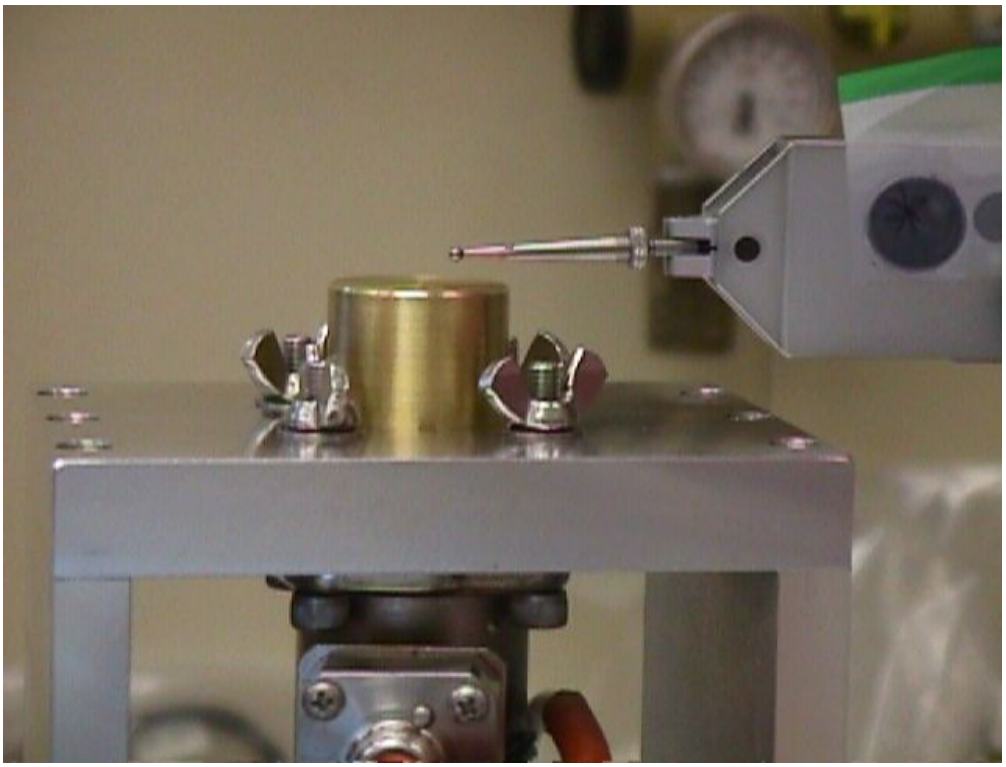
6 PHOTOS



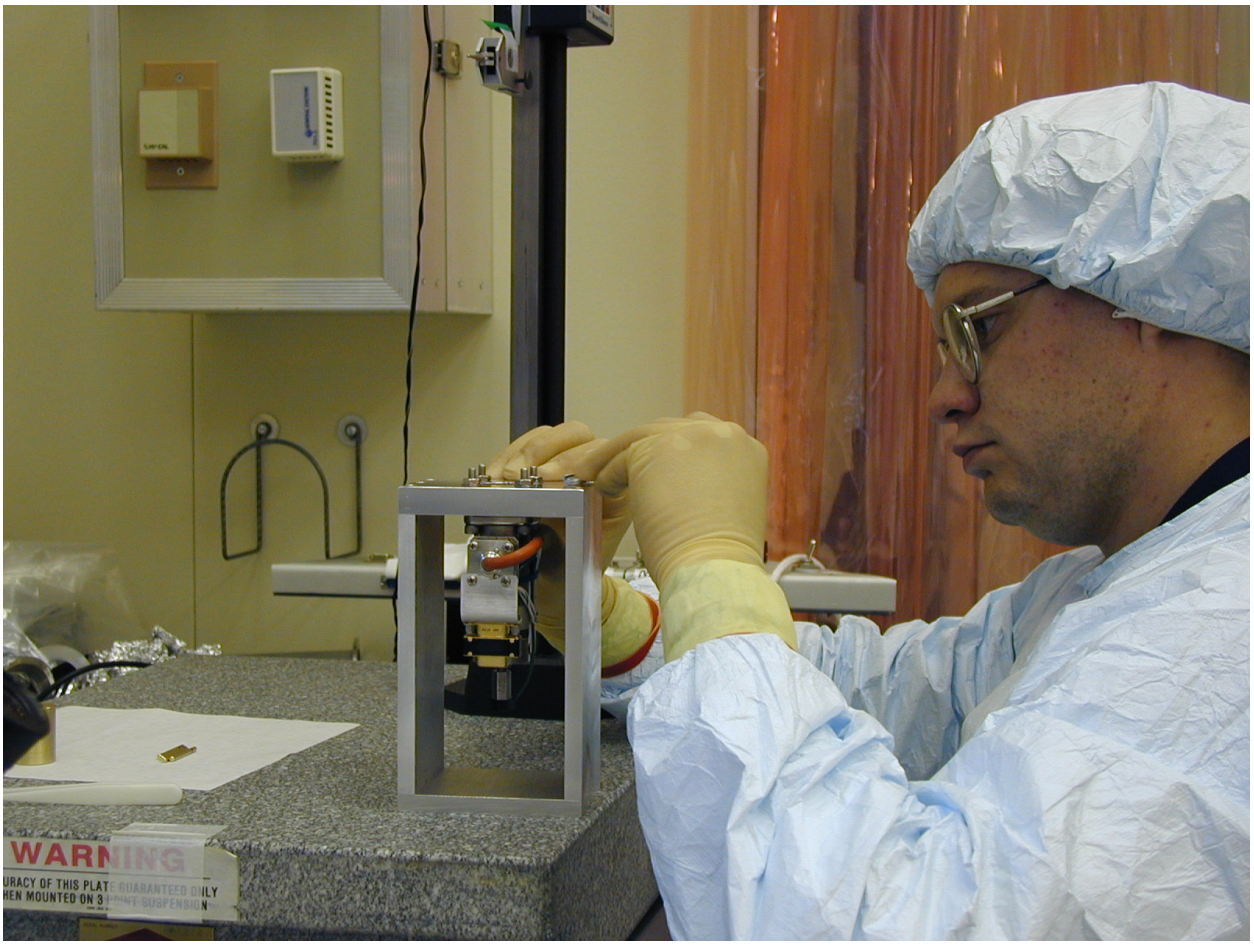
Two Views of Height gage and solenoid in fixture

Measuring Latching mechanism with pins.

Measuring Solenoid rod with large plug.



Installing the Solenoid on the fixture.



7 PROCEDURE COMPLETION

The results obtained in the performance of this procedure are acceptable:

_____ date: _____
R. Stephenson, GMA Engineer

Discrepancies if any:

Approved: _____ date: _____
G. Asher, GMA REE

Approved: _____ date: _____
R. Leese, QA Representative

Approved: _____ date: _____
D.Ross, S.E.M

8 DATA BASE ENTRY

The following data shall be entered into the GP-B Data Base:

- Name, number and revision of this procedure
- Date of successful completion of procedure.

- Part numbers and serial numbers of Caging Units and their components

APPENDIX A, ACTUAL MEASURMENTS OF LATCH

SOLENOID	PIN 0	ACTUAL	PIN I	ACTUAL	PIN II	ACTUAL	PIN III	ACTUAL	AVERAGE
		1.369		1.37		1.3695		1.369	
A	2.3463	0.9773	2.3635	0.9935	2.3659	0.9964	2.3597	0.9907	0.9895
C	3.3755	2.0065	3.3744	2.0044	3.3728	2.0033	3.3781	2.0091	2.0058
D	2.9383	1.5693	2.9298	1.5598	2.9343	1.5648	2.9306	1.5616	1.5639
E	2.9463	1.5773	2.9428	1.5728	2.9461	1.5766	2.9412	1.5722	1.5747
F	2.3522	0.9832	2.3481	0.9781	2.3513	0.9818	2.3494	0.9804	0.9809
G	2.9371	1.5681	2.9317	1.5617	2.9353	1.5658	2.9335	1.5645	1.5650
H	2.9456	1.5766	2.9352	1.5652	2.9386	1.5691	2.9445	1.5755	1.5716
J	2.3596	0.9906	2.3531	0.9831	2.3581	0.9886	2.3562	0.9872	0.9874
K	2.9351	1.5661	2.9374	1.5674	2.9391	1.5696	2.9328	1.5638	1.5667
L	2.2864	0.9174	2.2855	0.9155	2.2837	0.9142	2.2876	0.9186	0.9164
M	3.3702	2.0012	3.3757	2.0057	3.3704	2.0009	3.3742	2.0052	2.0033
N	2.3431	0.9741	2.3477	0.9777	2.3435	0.974	2.3451	0.9761	0.9755
P	3.3791	2.0101	3.3828	2.0128	3.385	2.0155	3.3764	2.0074	2.0115
Q	3.3654	1.9964	3.3798	2.0098	3.3698	2.0003	3.3752	2.0062	2.0032
R	2.9313	1.5623	2.9317	1.5617	2.9297	1.5602	2.9343	1.5653	1.5624
S	3.3761	2.0071	3.3807	2.0107	3.3783	2.0088	3.3763	2.0073	2.0085
T	2.3469	0.9779	2.3535	0.9835	2.3482	0.9787	2.3511	0.9821	0.9806
U	2.9321	1.5631	2.9398	1.5698	2.9358	1.5663	2.9341	1.5651	1.5661
V	2.3445	0.9755	2.3391	0.9691	2.3426	0.9731	2.342	0.973	0.9727
W	2.946	1.577	2.948	1.578	2.9394	1.5699	2.9451	1.5761	1.5753
X	2.914	1.545	2.912	1.542	2.9128	1.5433	2.9133	1.5443	1.5437
Y	2.9354	1.5664	2.9395	1.5695	2.9361	1.5666	2.9377	1.5687	1.5678
Z	3.3762	2.0072	3.3773	2.0073	3.3777	2.0082	3.3781	2.0091	2.0080
A1	2.9379	1.5689	2.9298	1.5598	2.9403	1.5708	2.9278	1.5588	1.5646
A2	2.3484	0.9794	2.3563	0.9863	2.3482	0.9787	2.358	0.989	0.9834
A3	2.9338	1.5648	2.9357	1.5657	2.9403	1.5708	2.9308	1.5618	1.5658
A4	2.9497	1.5807	2.9326	1.5626	2.9383	1.5688	2.9376	1.5686	1.5702
A5	2.3521	0.9831	2.3555	0.9855	2.3563	0.9868	2.3505	0.9815	0.9842
A6	3.3485	1.9795	3.3544	1.9844	3.3517	1.9822	3.3517	1.9827	1.9822
A7	2.9396	1.5706	2.9329	1.5629	2.9371	1.5676	2.9343	1.5653	1.5666
A8	2.2764	0.9074	2.2851	0.9151	2.2794	0.9099	2.2832	0.9142	0.9117

A9	2.2798	0.9108	2.2802	0.9102	2.2757	0.9062	2.2831	0.9141	0.9103
A10	2.3472	0.9782	2.3442	0.9742	2.3453	0.9758	2.3483	0.9793	0.9769
A11	2.9287	1.5597	2.9359	1.5659	2.9294	1.5599	2.9334	1.5644	1.5625