2.0.9 Acceptance Criteria

The acceptance criteria for seismic testing is the lack of visible signs of overstress in the unit being tested. This means lack of any visible difference in equipment or performance detrimental to proper operation compared to the unit prior to the seismic test, which would encompass cracks, bent shafting, or other permanent deformation that could be noted by eye.

2.0.10 Switch Chatter Analysis

Relating to the switches in the Limitorque Valve Actuator, engineering evaluation of the limit switch construction shows the limit switches would not chatter at low frequencies within the qualified acceleration levels. The primary cause of malfunction of the limit switch would be caused by the fingers physically being lifted from the rotors (contact chatter) by inertia during seismic excitation. The contact fingers are light, weighing approximately .011 pounds each and are preloaded by a spring that provides approximately .32 pounds load. Accounting for the location of the cg of the finger in relation to the center of the spring, it would require an acceleration loading of 22 g's before the fingers could possibly leave the limit switch rotor, regardless of frequency. The torque switch would also require accelerations in this range before the contacts would break contact.

2.0.11 Motor Insulation Class

Limitorque Valve Actuators are supplied with class B insulation motors for normal outside containment service and with class RH insulation motors for inside containment service. Seismically, the weight difference in the two insulation systems are negligible with the result that seismic tests conducted on units with either insulation system in the motor would also qualify the Actuator with the other insulation system. The motor leads, although differing in diameter and appearance, also would not be effected, since they pass through an internal conduit in the motor mounting flange and then connected in the limit switch compartment. The length of unsupported motor leads is small (inches) thereby minimizing undue loads on either the wire or end connection points during seismic excitation.

2.0.12 Seismic Qualification Definition

The seismic tests we have conducted qualify our units seismically to g levels indicated when the seismic excitation is imparted to the mounting flange of our unit.

3.0 IDENTIFICATION OF TESTED VALVE ACTUATORS

The Valve Actuators as tested are identified in each individual seismic report. The reports are as listed in the Table of Contents and are included in the Appendix.

4.0 TYPE TEST PROCEDURE

The test procedure used is as marked on the cover page of each test report. Prior to conducting the seismic test, the unit is mounted on a test stand and the torque switch calibrated to develop the rated unit torque and thrust for SMC, SMB and SB units and the rated unit torque for SMB/HBC assemblies.

4.1 Standard Seismic Test Procedure

4.1.1 Mount the Limitorque Valve Actuator or Limitorque Valve Actuator/ secondary reducer combination actuator assembly with fixture capable of simulating seating torque and/or thrust (as appropriate to unit tested) to the shaker table with the axis of the output drive sleeve mounted vertically.

4.1.2 Connect the limit switches and torque switch into the control circuit for operation per wiring diagram 19-499-0022-4. Connect limit switch contacts 11 and 15 (which is set to be normally closed during mid stroke) and the open torque switch to electronic chatter circuits per MIL-STD-202D or equivalent with 2 millisecond break time detection (prior to 1978, a sensitive relay with 7 to 8 milisecond dropout time, as shown on wiring diagram 19-499-0022-4, was used to detect contact chatter).

4.1.3 At minimum, install (3) accelerometers on the motor (for SMB and SB units) and on the motor and SMB mounting flange (for SMB/HBC assemblies) to measure accelerations in each of the three axis (one vertical and two horizontal). Install (3) matching accelerometers on the shaker table.

4.1.4 Scan in each of the three axis at a minimum of .2g from 1 to 33 Hz at a sweep rate not exceeding 2 octaves per minute (prior to 1976, due to the "shaker table" used, the resonance scan was made at a minimum acceleration of .1g (not exceeding 1g) from 5 to 33 Hz, dwelling at each integer frequency for 6 seconds).

Record the accelerometer readings in each of the three axis, both on the Limitorque Valve Actuator and shaker table - - - V (vertical), H1 (horizontal parallel to motor axis) and H2 (horizontal perpendicular to motor axis) for determination of cross coupling.

Note resonant frequency in axis being scanned. (Resonance is defined as a minimum acceleration multiplication factor of 2 and/or a 90^{o} phase shift of response accelerometers.)

4.1.5 Prepare to conduct dwell tests in each of the three axis on the basis of 6g in each of the axis (on basis of 3g if seismic bracket is not included on SMB/HBC assemblies and 6g if seismic bracket is included).

Conduct dwell test in vertical axis V at resonant frequency determined in Step 4.1.4 or dwell at 33 Hz if resonant frequencies not evident. Determine required test dwell g level as follows:

4.1.5.1 At dwell frequency, note cross coupling on V axis. (This would be the difference between the accelerometer readings on the Limitorque Valve Actuator and the shaker table to eliminate effects of table "cross coupling")

4.1.5.2 If any cross coupling noted, calculate acceleration adder to V axis as follows:

H1 axis & H2 axis

$$\text{V Adder} = \frac{(\text{test g level}) \times (\text{cross couple g level})}{(\text{g level of scan})}$$

4.1.5.3 Add the calculated values of the V adder of both H1 and H2 axis determined in 4.1.5.2 to 6g (3g in case of SMB/HBC assembly without seismic support) establishing the acceleration level for the seismic dwell test.

4.1.5.4 Conduct (5) dwell tests each of 30 second duration at one half g level determined in 4.1.5.3. Operate unit through full open and close cycle during each dwell. Note results.

4.1.5.5 Conduct (1) dwell test of 30 second duration at full g level determined in 4.1.5.3. Operate unit through full open and close cycle during the dwell and note results.

4.1.6 Conduct dwell test in horizontal axis H1 at resonant frequency determined in Step 4.1.4 (dwell at 33 Hz if resonant frequency not evident).

4.1.6.1 Determine dwell g level as indicated in 4.1.5.1, 4.1.5.2 and 4.1.5.3 except interchange V axis and H1 axis.

4.1.6.2 Conduct dwell tests as indicated in 4.1.5.4 and 4.1.5.5.

4.1.7 Conduct dwell test in horizontal axis H2 at resonant frequency determined in Step 4.1.4 (dwell at 33 Hz if resonant frequencies not evident).

4.1.7.1 Determine dwell g level as indicated in 4.1.5.1, 4.1.5.2 and 4.1.5.3 except interchange V axis and H2 axis.

4.1.7.2 Conduct dwell tests as indicated in 4.1.5.4 and 4.1.5.5.

4.1.8 After completion of above tests, operate unit through full open and close cycle and note results.

4.1.9 Before removing from shaker table, visually inspect for any signs of overstress comparing to the unit before the test. This would encompass such areas as cracks, bent shafting or other permanent deformation. Note observations.

4.2 Fragility Test Procedure

4.2.1 Mount the Limitorque Valve Actuator or the SMB/HBC assembly on fixture capable of simulating seating torque and/or thrust (as appropriate to unit tested) to the shaker table with the axis of the output mounted vertically.

4.2.2 Connect the limit switches and torque switch into the control circuit for operation per wiring diagram 19-499-0022-4. Connect limit switch contacts 11 and 15 (which is set to be normally closed during mid stroke) and the open torque switch to electronic chatter circuits per MIL-STD-202D or equivalent with 2 millisecond break time detection (prior to 1978, a sensitive relay with 7 to 8 millisecond dropout time, as shown on wiring diagram 19-499-0022-4, was used to detect contact chatter).

4.2.3 At minimum, install (3) accelerometers on the motor (for SMB and SB units) and on the motor and SMB mounting flange (for SMB/HBC assemblies) to measure accelerations in each of the three axis (one vertical and two horizontal). Install (3) matching accelerometers on the shaker table.

4.2.4 Scan in each of the 3 axis at a minimum of .2g from 1 to 33 Hz at a sweep rate not exceeding 2 octaves per minute (prior to 1976, due to the shaker table used, the resonance scan was made at a minimum acceleration of .1g varying to 1g at a frequency span of 5 to 33 Hz, dwelling at each integer frequency for 6 seconds).

Record the accelerometer readings in each of the three axis, both on the Limitorque Valve Actuator and shaker table - - - V (vertical), H1 (horizontal parallel to motor axis) and H2 (horizontal perpendicular to motor axis) for indication of cross coupling, if any.

Note resonant frequency in axis being scanned. (Resonance is defined as a minimum acceleration multiplier factor of 2 and/or a 90^0 phase shift of response accelerometers).

4.2.5 When testing an SMB/HBC assembly (motor actuator mounted on a secondary reducer), start dwells at a 3g level and when SMB (motor actuator) at a 6g level. Note: If the SMB/HBC assembly includes a seismic bracket start dwells at a 6g acceleration level. Continue testing in this axis at each integer g level until unit failure occurs or until the capacity of the shaker table is reached.

4.2.6 Conduct dwell tests at resonant frequency determined in step 3.2.4 or at 33 Hz if resonant frequencies not evident in each of the three axis with each dwell being of 30 second duration. During each dwell, run unit through full close and open stroke and note results. Also record the accelerometer readings on each axis.

4.2.7 Before removing from shaker table, visually inspect for any signs of overstress comparing to the unit before the test. This would encompass such areas as cracks, bent shafting or other permanent deformation. Note observations.

4.2.8 Should any damage have been incurred, repair if possible and subject the actuator to dwells in the second axis per step 4.2.6 and inspect per 4.2.7. Repeat the dwells and inspection in the third axis.

4.2.9 Should the unit have failed during the fragility testing, provide detailed report of failure plus record any observations made during the test at time of failure. In event of failure before fragility test completed in all three axis, replace failed component and complete the test.

5.0 CONCLUSION

5.0.1 Linear Actuators

The units tested consisted of units with the most adverse weight distribution, enveloping the entire generic family of Actuators, SMB/SB/SBD/SMC-04/SMB-HBC/SMC-HBC assemblies. The Limitorque Valve Actuators performed all functions at seismic dwells and tripped at the preset torque switch setting (the resulting load approximating the unit rating) with no indication of malfunction. Further, the chatter circuit connected to limit switch contacts did not de-energize even during dwells up to 8g acceleration. Therefore, the generic line of Limitorque Valve Actuators, type SMB/SB/SBD/SMC-04 is considered qualified per IEEE 344-1975 up to levels of 6g acceleration in any of the three axis.

5.0.2 Rotary Actuators

The SMB Limitorque Valve Actuators mounted on HBC secondary reducers were chosen and performed during the seismic test in the same manner stipulated in paragraph 5.0.1 above. The SMC type actuator, being lighter than the SMB, would be enveloped by above tests. The SMB/HBC or SMC/HBC assemblies, without spur gear attachments, are considered qualified per IEEE 344-1975 up to levels of 3g acceleration without seismic bracket and up to 6g acceleration with the seismic bracket in any of the three orthogonal axis.

APPENDIX 1

AERO NAV REPORT 5771

SMB-000-5

PROCEDURE 4.1

AERO NAV
LABORATORIES, INC.

14-29 112TH STREET • COLLEGE POINT, N.Y. 11356 • (212) 939-4422

(UNCLASSIFIED)

REPORT OF SEISMIC TEST ON SMB-000-5 MOTOR ACTUATOR FOR LIMITORQUE CORPORATION KING OF PRUSSIA, PENNSYLVANIA

TESTED BY		ETL REPORT	5771
CHECKED BY		AERO NAV SALES ORDER	708-421
APPROVED BY		CUSTOMER P.O.	383964-1
DATE	17 October 1975		
GOVERNMENT QAR	NONE		

ADMINISTRATIVE DATA

DATE
17 October 1975

PURPOSE OF TEST:	To determine the effects of Seismic Vibration on the physical and operational characteristics of the submitted specimen.
MANUFACTURER:	LIMITORQUE CORPORATION 181 S. Gulph Road King of Prussia, Pennsylvania 19406
MANUFACTURER TYPE AND SERIAL NUMBER:	Limitorque SMB000 Valve Actuator with reliance 5 ft-lbs. Motor Limit Switch 2 train - 4 gear MDPI, Position Indicator, and Remote Position Indicator. See paragraph 2.0 for name plate data.
DRAWINGS SPECIFICATIONS OR EXHIBIT:	Tested in accordance with detailed instructions of client and Limitorque Test Procedure (O/N 383964)
QUANTITY OF ITEMS TESTED:	One (1) only
EQUIPMENT:	Unclassified
REPORT:	Unclassified
DATE TEST COMPLETED:	30 April 1975
TEST CONDUCTED BY:	AERO NAV LABORATORIES, INC. 14-29 112th STREET COLLEGE POINT, NEW YORK 11356
DISPOSITION OF SPECIMEN:	Returned to client
ABSTRACT:	It is the function of the Aero Nav Laboratories, Inc., as an impartial testing agency in performing this test, to subject the specimen to seismic vibration of magnitude and direction as specified in the detailed specifications.

ETL 5771
S.O. 708-421

FACTUAL DATA

1.0 DESCRIPTION OF TEST APPARATUS:

1.1 Vibration Machine and Control System, Type RVH-72-5000, Serial No. 51402, manufactured by L.A.B. Corporation.
Calibration Due: 28 March 1976.

1.2 Accelerometers, Model 2213E, Serial Nos. CP36, CP37, CP48, LA57 and CP43, manufactured by Endevco Corporation.
Calibration Due: 18 January 1976.

1.3 Amplifier, Model 2616, Serial No. CA13, manufactured by Endevco Corporation.
Calibration Due: 18 January 1976.

1.4 Power Supply, Model 2622, Serial No. CA24, manufactured by Endevco Corporation.
Calibration Due: 18 January 1976.

1.5 Band Pass Filter, Model No. 330M, Serial No. 2116, manufactured by Krohn-Hite Corporation.
Calibration Due: 26 February 1976.

1.6 True R.M.S. VTVM, Model 320A, Serial No. 8622, manufactured by Ballantine Labs.
Calibration Due: 3 March 1976.

2.0 NAME PLATE DATA:

2.1 Actuator:

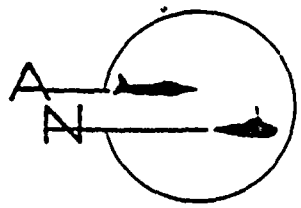
Limitorque Corporation, King of Prussia, Pa.
Type SMB Size 000
Order #383964A, Serial #195864, Valve K-1394.

2.2 Motor

Mfr. Reliance
Frame K48
Type P
Ins. Class B
I.D. # 447021-D2
Hp 0.33
Speed 1700 rpm
Voltage 230/460 V
Phase 3Ø
Amp. 1.91/.95A
Freq. 60 Hz
Ambient 40°C
Duty 15 min
Start Torque 5 lbs/ft.

ETL 5771

S.O. 708-421



3.0 METHOD OF TEST:

The submitted specimen mounted on a baseplate fixture supplied by Limitorque Corporation was affixed to the table of the seismic simulator in such a manner that the axis of the stem nut was vertical. Four (4) accelerometers were used to monitor resonant conditions of the actuator.

During the test the actuator was electrically connected to a control console supplied by Limitorque.

3.1 Resonant Frequency Search:

The specimen was subjected to a resonant frequency search from 5 to 33 Hz. The applied excitation levels were in accordance with Table I. The frequency range was increased in discrete steps of 1 Hz and vibration was maintained at each frequency for a period of not less than six (6) seconds.

The above test was performed in each of the three (3) mutually perpendicular axis.

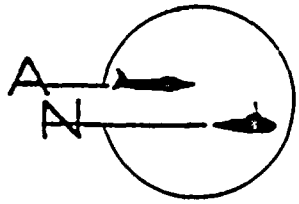
Table I - Amplitudes of Vibration

Frequency (Hz)	Acceleration (G peak)
5 to 33	0.1 to .76

3.2 Seismic Dwell Test:

Upon completion of the resonant frequency search in all axes, the specimen was subjected to a seismic dwell test at each of the resonant frequencies noted during the resonant frequency search. If no resonant frequencies were noted the seismic dwell test was performed at 33 Hz. Five (5) thirty (30) second dwells were performed at 1/2 g levels, and one (1) thirty (30) second dwell was performed at full g level.

The full g level was based on 6 g's in the plane of excitation and 3.2 g's in the other two planes times a cross coupling ratio: calculated from data obtained during the freequency scans in each axis.



3.0 METHOD OF TEST (continued):

3.2 Seismic Dwell Test (continued):

Calculation of g level for Dwell in the V Axis:

$$\text{V Axis Dwell Level} = 6.0g + 3.2g \frac{\text{V cross coupling during } H_1 \text{ scan}}{\text{g level (at dwell freq.) of } H_1 \text{ scan}} + 3.2g \frac{\text{V cross coupling during } H_1 \text{ scan}}{\text{g level of } H_2 \text{ (at dwell freq.)}}$$

Calculation of g level for Dwell in the H_1 Axis:

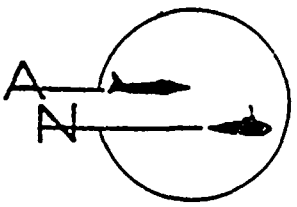
$$H_1 \text{ Axis Dwell Level} = 6.0g + 3.2g \frac{H_1 \text{ cross coupling during V scan}}{\text{g level of V (at dwell freq.)}} + 3.2g \frac{H_1 \text{ cross coupling during } H_2 \text{ scan}}{\text{g level of } H_2 \text{ (at dwell freq.)}}$$

Calculation of g level for dwell in the 1/2 Axis:

$$H_2 \text{ Axis Dwell Level} = 6.0 + 3.2g \frac{H_2 \text{ cross coupling during V scan}}{\text{g level of V (at dwell freq.)}} + 3.2g \frac{H_2 \text{ cross coupling during the } H_1 \text{ scan}}{\text{g level of } H_1 \text{ (at dwell freq.)}}$$

During the dwell tests the actuator was operated through open and close strokes using the gear limit switch for open position and the torque switch for close position (torque seated *). Indicating lights were provided for monitoring all rotors.

* The torque switch was precalibrated and set by Limitorque Test Lab for the rating of the unit.



4.0 RESULTS OF TEST:

The following observations were noted and recorded during the above detailed test procedure:

4.1 Vertical Axis: (along the Actuator Stem)

Accelerometer Locations and Orientation:

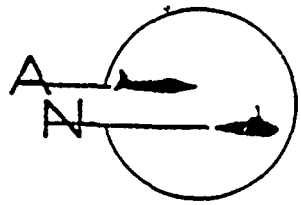
Input - On baseplate - vertical

Outputs A - Top flange of Actuator (vertical)

B - Top of Actuator F-B (H_1)

C - Top of Actuator S-S (H_2)

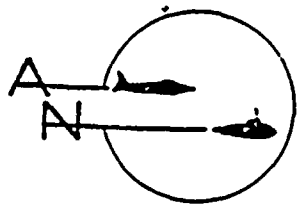
D - On end of Motor (vertical)



4.0 RESULTS OF TEST (continued):

4.1.1 Resonant Frequency Search:

Frequency (Hz)	Input (G's)	A (V)	B (H_1)	C (H_2)	D (Motor V)
5	0.035	0.040	0.013	0.010	0.040
6	0.046	0.050	0.012	0.012	0.055
7	0.060	0.065	0.012	0.012	0.075
8	0.075	0.080	0.012	0.012	0.090
9	0.090	0.100	0.012	0.015	0.120
10	0.120	0.120	0.015	0.015	0.150
11	0.130	0.140	0.015	0.020	0.160
12	0.160	0.170	0.014	0.020	0.200
13	0.190	0.200	0.015	0.020	0.230
14	0.230	0.240	0.015	0.020	0.250
15	0.260	0.270	0.015	0.020	0.300
16	0.300	0.310	0.025	0.020	0.330
17	0.330	0.350	0.015	0.020	0.370
18	0.370	0.390	0.015	0.020	0.420
19	0.420	0.430	0.015	0.020	0.460
20	0.450	0.480	0.015	0.020	0.520
21	0.530	0.550	0.015	0.020	0.600
22	0.580	0.600	0.017	0.030	0.660
23	0.630	0.660	0.018	0.030	0.720
24	0.690	0.720	0.020	0.030	0.770
25	0.750	0.780	0.020	0.035	0.850
26	0.800	0.850	0.025	0.040	0.950
27	0.880	0.930	0.025	0.040	1.000
28	0.950	1.000	0.025	0.045	1.100
29	1.000	1.100	0.025	0.050	1.200
30	1.100	1.150	0.025	0.050	1.300
31	1.200	1.250	0.025	0.055	1.400
32	1.250	1.350	0.025	0.060	1.500
33	1.400	1.450	0.025	0.070	1.600



4.0 RESULTS OF TEST (continued):

4.2 Horizontal Axis (H_1) (Along the Motor Axis):

Accelerometer Locations and Orientation:

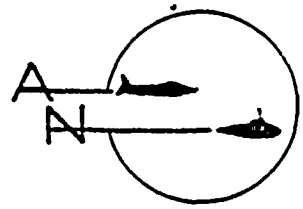
Input - On baseplate in direction of vibration (H_1)

Outputs A - Top of Actuator (H_2)

B - End of Motor (H_2)

C - Top of Actuator (H_1)

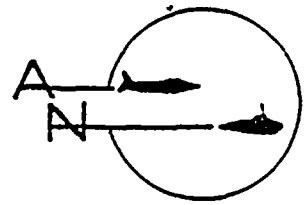
D - Top of Actuator (Vertical)



4.0 RESULTS OF TEST (continued):

4.2.1 Resonant Frequency Search:

Frequency (Hz)	Input (G's)	A (H_2)	B(Motor H_2)	C (H_1)	D (V)
5	0.030	0.010	0.010	0.030	0.010
6	0.040	0.010	0.010	0.040	0.015
7	0.055	0.010	0.010	0.055	0.015
8	0.068	0.010	0.010	0.073	0.015
9	0.090	0.010	0.010	0.085	0.010
10	0.100	0.010	0.010	0.100	0.010
11	0.120	0.010	0.010	0.130	0.015
12	0.150	0.010	0.010	0.150	0.015
13	0.170	0.010	0.010	0.170	0.015
14	0.210	0.010	0.010	0.220	0.015
15	0.230	0.010	0.010	0.220	0.020
16	0.280	0.012	0.010	0.250	0.020
17	0.280	0.015	0.010	0.280	0.020
18	0.310	0.016	0.010	0.330	0.020
19	0.350	0.016	0.010	0.340	0.020
20	0.370	0.017	0.010	0.370	0.025
21	0.400	0.016	0.010	0.400	0.025
22	0.430	0.017	0.010	0.440	0.025
23	0.460	0.018	0.010	0.470	0.025
24	0.500	0.020	0.013	0.510	0.040
25	0.540	0.020	0.013	0.540	0.035
26	0.560	0.020	0.013	0.560	0.040
27	0.590	0.020	0.015	0.600	0.046
28	0.630	0.020	0.020	0.630	0.045
29	0.660	0.024	0.016	0.670	0.045
30	0.690	0.025	0.015	0.700	0.045
31	0.720	0.025	0.020	0.730	0.050
32	0.750	0.027	0.025	0.760	0.045
33	0.760	0.030	0.025	0.800	0.050



4.0 RESULTS OF TEST (continued):

4.3 Horizontal Axis (H_2) (Perpendicular to Motor Axis):

Accelerometer Locations and Orientation:

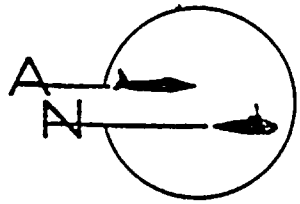
Input - On baseplate - Horizontal in direction of vibration.

Outputs A - Top of Acutator F-B (H_2)

B - End of Motor F-B (H_2)

C - Top of Actuator S-S (H_1)

D - Top of Actuator (vertical)



4.0 RESULTS OF TEST (continued):

4.3.1 Resonant Frequency Search:

Frequency (Hz)	Input (G's)	A (H_2)	B (Motor H_2)	C (H_1)	D (V)
5	0.030	0.030	0.030	0.030	0.010
6	0.041	0.050	0.050	0.030	0.010
7	0.050	0.060	0.060	0.030	0.010
8	0.070	0.090	0.080	0.040	0.010
9	0.090	0.110	0.090	0.010	0.010
10	0.110	0.130	0.120	0.030	0.020
11	0.140	0.160	0.150	0.030	0.020
12	0.160	0.180	0.180	0.050	0.030
13	0.190	0.210	0.200	0.040	0.030
14	0.220	0.250	0.240	0.030	0.040
15	0.250	0.290	0.290	0.020	0.030
16	0.300	0.330	0.300	0.040	0.040
17	0.330	0.360	0.340	0.040	0.040
18	0.360	0.400	0.370	0.040	0.060
19	0.400	0.460	0.420	0.030	0.070
20	0.460	0.510	0.470	0.030	0.080
21	0.500	0.560	0.530	0.030	0.080
22	0.550	0.620	0.570	0.040	0.100
23	0.600	0.680	0.620	0.040	0.111
24	0.650	0.730	0.700	0.040	0.130
25	0.710	0.790	0.740	0.040	0.140
26	0.780	0.850	0.800	0.040	0.150
27	0.830	0.910	0.900	0.030	0.160
28	0.900	1.000	0.950	0.030	0.170
29	0.980	1.000	1.000	0.030	0.190
30	1.050	1.100	1.050	0.040	0.200
31	1.100	1.200	1.150	0.040	0.210
32	1.200	1.300	1.300	0.030	0.240
33	1.300	1.500	1.400	0.030	0.250

FACTUAL DATA

4.0 RESULTS OF TEST (continued):

4.3.2 Calculation of g Levels for Dwell:

$$\text{V Axis Dwell Level at 33 Hz} = 6.0 + 3.2\,\frac{.050}{.800} + 3.2\,\frac{.25}{1.5}$$

$$= 6.0 + .200 + 5.33$$

$$= \underline{6.733 \text{ g's}}$$

$$\text{H}_1 \text{ Axis Dwell Level at 33 Hz} = 6.0 + 3.2\,\frac{.025}{1.45} + 3.2\,\frac{.03}{1.5}$$

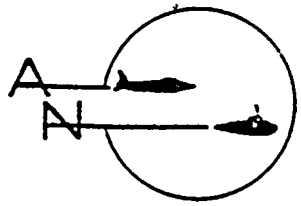
$$= 6.0 + .055 + .064$$

$$= \underline{6.119 \text{ g's}}$$

$$\text{H}_2 \text{ Axis Dwell Level at 33 Hz} = 6.0 + 3.2\,\frac{.070}{1.45} + 3.2\,\frac{.030}{.800}$$

$$= 6.0 + .154 + .12$$

$$= \underline{6.274 \text{ g's}}$$



4.0 RESULTS OF TEST (continued):

4.4 Seismic Dwell Test:

4.4.1 Vertical Axis (along the actuator stem):

The Seismic Dwell tests were performed at 33 Hz for a duration of 30 seconds for each run.

Five runs were performed at an input of 3.05g's and one run was performed at an input of 6.1g's.

During each of the dwells the actuator was operated to close seat to open.

There was no evidence of external physical damage as a result of the stress of this test.

4.4.2 Horizontal Axis (H_1) (Along the Motor Axis):

The Seismic Dwell tests were performed at 33 Hz for a duration of 30 seconds for each run.

Five runs were performed at an input of 3.05g's and one run was performed at an input of 6.1 g's.

During each of the dwells the actuator was operated open to close seat to open.

Actuator MDPI housing was found to be loose. Hardware was tightened and testing was continued.

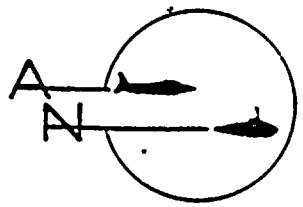
4.4.3 Horizontal Axis (H_2) (Perpendicular to Motor Axis):

The Seismic Dwell tests were performed at 33 Hz for a duration of 30 seconds for each run.

Five runs were performed at an input of 3.15g's and one run was performed at an input of 6.3g's.

During the dwells the actuator was operated open to close seat to open.

There was no evidence of external physical damage as a result of the stress of this test.



5.0 VISUAL POST TEST EXAMINATION:

Visual Post Test Examination revealed no evidence of any external physical damage as a result of the stress of this test.

6.0 RECOMMENDATIONS:

None, data merely submitted.

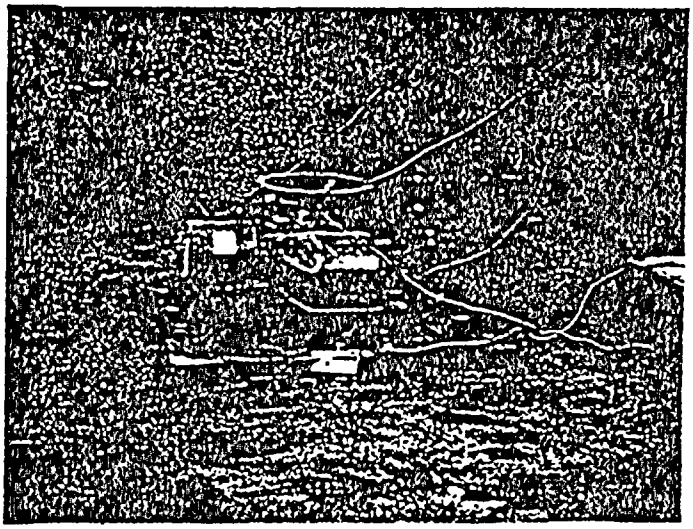
7.0 CONCLUSIONS:

Final evaluation of the submitted specimen for conformance to the requirements of the detailed specifications will be accomplished by Limitorque Corporation upon review of results reported herein and further examination as required.

LIMITORQUE CORPORATION

KING OF PRUSSIA, PENNSYLVANIA

SMB-000-5 MOTOR ACTUATOR



SEISMIC TEST SETUP

LIMITORQUE CORPORATION

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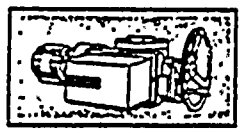

TEST REPORT 11/10/75

Subject: Job #383964 - Pre Seismic Torque Switch Calibration and Monitoring performed during Seismic Testing Unit SMB-000-5.

Reference: Limitorque PO #383964
Aero Nav Report #5771

Unit Identification & Description

SMB 000 with Reliance 5 ft.-lb. motor
2 train - 4 gear limit switch
MDPI with Reostat Remote position indicator

Unit serial number 195864
Motor I. D. number 447021-D2

Pre-Test Torque Switch Calibration

Procedure: Measured thrust output of SMB 000 using a 1 1/4 x 1/4 x 1/4 stem and a 10,000 lb. load cell.

Result: A desired thrust output of 7000 pounds was obtained at a torque switch setting of '3'.

Actual Value 7488 pounds (av. of 15 readings)

Approximate Torque

Torque = Thrust x Stem Factor

1 1/4 x 1/4 x 1/4 Stem S.F.= 0.0132

Torque = 7488 x 0.0132 = 98.8 ft.-#

Seismic Test Monitoring

Procedure: Both rotors were monitored by means of indicator lights.

The actuator was run from an open position (controlled by a limit switch) to a closed torqued out position (controlled by the torque switch) back to the open limit position during each of the dwells and at the end of the Seismic qualification.

The reostat was connected to a remote position indicator per standard Limitorque wiring diagram.

The valve position dial was monitored visually.

Result: The unit functioned properly performing all control functions and all indicating functions.

Conclusion: The actuator performed all functions and torqued-out at the pre-set load with no indication of malfunction. The unit is considered qualified per the IEEE 344 specification for Seismic levels of 6 g's.

Ad-5

Walt Sykes 11/10/75