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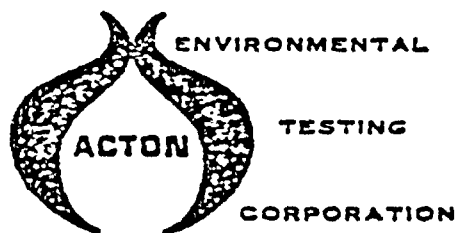
Test Report No. 14331-3

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REVISION 1 - 3/13/79

## Report of Test on

SEISMIC VIBRATION TESTING OF  
ONE (1) LIMITORQUE SMB-000/HOBC ACTUATOR  
WITH SEISMIC ADAPTOR  
FOR LIMITORQUE CORPORATION  
UNDER PURCHASE ORDER NO. TL-413



Date January 31, 1979

	Prepared	Checked	Approved
By	B. Esposito	M. Casaubon	M. L. Tolf
Signed	<i>Bruce Esposito</i>	<i>M. Casaubon</i>	<i>M. L. Tolf</i>
Date	<i>Jan 31, 1979</i>	<i>1-31-79</i>	<i>1/31/79</i>

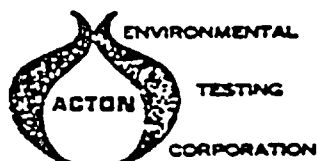
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# REVISION RECORD

DATE	REVISION NUMBER	PAGE NUMBER	PARAGRAPH NUMBER	CHANGES OR ADDITIONS	APPROVED BY
1/31/79	0	-----FIRST ISSUE-----			
3/13/79	1	2	1.0	Changed <u>Adaptor</u> to <u>Bracket</u>	<i>Carrie Espino 3/13/79</i> <i>Revised per 3/6/79 Demetrious Letter</i>
				Added last sentence	
			3.2	Changed <u>above</u> to <u>below</u>	
		4	3.4	Change <u>440</u> to <u>460</u>	
				Added last column to table	
			Footnote	Typographical correction	
				Added second foot- note	
		5	3.5	Added last column to table.	
			Footnote	Typographical cor- rections	
				Added second foot- note	
		6	Footnote 4.2(48)	Added footnote	
				Changed <u>valve</u> to <u>actuator</u>	
				Added last sentence	
			4.2(7B)	Changed <u>valve</u> to <u>actuator</u>	
		7	4.2(12B)	Reworded next to last last sentence.	
				Added last sentence	
			4.3(13B)	Added word "cover"	



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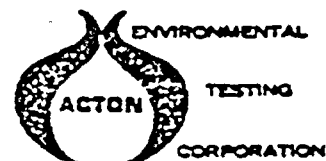
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## Administrative Data

- 1.0 Purpose of Test: To subject one (1) actuator to seismic vibration testing.
- 2.0 Manufacturer: Limitorque Corporation  
Lynchburg, Virginia
- 3.0 Manufacturer's Type or Model No: SMB-000/HOBC
- 4.0 Drawing, Specification or Exhibit: Limitorque P. O. No. TL-413
- 5.0 Quantity of Items Tested: One (1)
- 6.0 Security Classification of Items: Unclassified
- 7.0 Date Test Completed: September 11, 1978
- 8.0 Test Conducted By: C. Pilotte
- 9.0 Disposition of Specimens: Returned to Limitorque Corporation.
- 10.0 Abstract: Refer to result section herein.

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## 1.0 TEST ITEM

One (1) Limitorque SMB-000/HOBC Actuator with a Seismic Bracket was submitted by Limitorque Corporation for seismic vibration testing at Acton Environmental Testing Corporation (AETC).

Note: Actuator was also subjected to additional seismic excitation as documented in Acton Report #14331-2.

## 2.0 TEST REQUIREMENTS

The purpose of this test was to subject the actuator specified in section 1.0 above to the seismic vibration test specified in section 3.0 below to determine its ability to withstand such vibration without evidence of mechanical damage, deterioration, loss of its ability to operate properly, or contact chatter in excess of one (1) millisecond.

## 3.0 TEST PROCEDURES

This test was performed under the direction of Mr. Paul Young of Limitorque Corporation.

### 3.1 Test Mounting

The actuator was bolted to a test fixture supplied by Limitorque. The test fixture was then securely attached to the single-axis table of the AETC seismic test facility.

### 3.2 Test Conditions

All tests were performed at room temperature and pressure.

During the resonance survey specified in section 3.4 below, the actuator was not operated.

During the sinusoidal dwell test specified in section 3.5 below, the actuator was cycled open and closed at least once per dwell. 460 VAC 3Ø power was supplied to the actuator.

### 3.3 Test Monitoring

The actuator was visually monitored for any evidence of

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mechanical damage, deterioration or loss of its ability to operate properly.

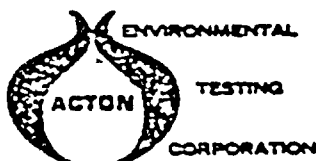
The actuator was monitored with triaxial groups of accelerometers by AETC personnel to determine its mechanical response during the resonance survey and sinusoidal dwell test specified in sections 3.4 and 3.5 below. Data from these accelerometers through appropriate signal conditioning was recorded on visicorder recording paper included with this report. The eighteen (18) monitoring accelerometers and one (1) control accelerometer were mounted as follows:

ACCELEROMETER NO.	AXIS SENSING ORIENTATION*	LOCATION
1	H <sub>1</sub>	Triaxial on end of motor
2	H <sub>2</sub>	
3	V	
4	H <sub>1</sub>	Triaxial on SMB-000 Housing at mounting flange
5	H <sub>2</sub>	
6	V	
7	H <sub>1</sub>	Triaxial on HOBC mounting adaptor
8	H <sub>2</sub>	
9	V	
10	H <sub>1</sub>	Triaxial on base of test fixture, control is #12
11	H <sub>2</sub>	
12	V	
13	H <sub>1</sub>	Triaxial on top corner of actuator housing
14	H <sub>2</sub>	
15	V	
16	H <sub>1</sub>	Triaxial on gear frame of geared switch
17	H <sub>2</sub>	
18	V	

\*  
H<sub>1</sub> is the horizontal axis parallel to the motor axis.  
H<sub>2</sub> is the horizontal axis perpendicular to the motor axis  
V<sup>2</sup> is the vertical axis

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One (1) normally closed (N/C) set of contacts of the limit switch and one (1) N/C set of contacts of the torque switch were monitored for contact chatter in excess of one (1) millisecond.

### 3.4 Resonance Survey

The resonance survey consisted of a sinusoidal input with peak horizontal or vertical accelerations of 0.5g. The resonance survey was conducted at a sweep rate of 6 seconds/Hz (1 octave/minute for Tests 5B, 6B & 8B). The resonance surveys were performed as follows:

TEST NO.	AXIS OF EXCITATION*	FREQUENCY RANGE (Hz)	TEST TABLE**
1B	V	1-60-1	1
2B	H <sub>1</sub>	1-50-1	1
3B	H <sub>2</sub>	1-50-1	1
5B	V	5-36	2
6B	H <sub>1</sub>	5-36	2
8B	H <sub>2</sub>	5-36	2

### 3.5 Sinusoidal Dwell Test

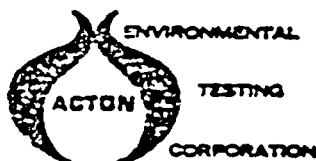
The sinusoidal dwell test consisted of a continuous steady state sinusoidal input. The sinusoidal dwell test was to be performed at the resonant frequencies found during the resonance survey (only those below 33 Hz) specified in section 3.4 above. If no resonances were detected, then testing was to be performed at 33 Hz.

Each input at each test level was for a duration of thirty (30) seconds. The input was applied as follows:

- \*  
H<sub>1</sub> is the horizontal axis parallel to the motor axis  
H<sub>2</sub> is the horizontal axis perpendicular to the motor axis  
V is the vertical axis.

- \*\*  
1 Single Axis Hydraulic  
2 Ling A-249 Magnetic

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TEST NO.	AXIS OF EXCITATION*	TEST LEVEL (G)	TEST FREQ. (Hz)	TEST TABLE**
4B	V	3,4,5,6	33	1
7B	H <sub>1</sub>	3,4,5,6	33	1
9B	H <sub>2</sub>	3,4,5,6	33	1
10B	V	7,8,9,10,11,12	33	2
11B	H <sub>1</sub>	7,8,9,10,11,12	33	2
12B	H <sub>2</sub>	7,8,9	33	2

### 3.6 Sine Cycling Test

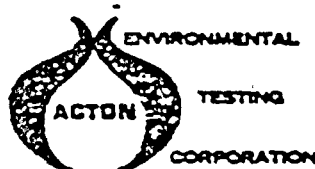
The sine cycling test consisted of a sinusoidal input cycling from 10 to 100 Hz and back to 10 Hz, at a sweep rate of two (2) octaves/minute. The sine cycling test was performed for a period of ninety (90) minutes/axis. The vertical or horizontal input was 0.025" DA from 10-24 Hz and 0.75g peak from 24-100 Hz. The input was applied as follows:

TEST NO.	AXIS OF EXCITATION*
13B	H <sub>2</sub>
14B	H <sub>1</sub>
15B	V

- \*  
H<sub>1</sub> is the horizontal axis parallel to the motor axis  
H<sub>2</sub> is the horizontal axis perpendicular to the motor axis  
V is the vertical axis

- \*\*  
1 Single Axis Hydraulic  
2 Ling A-249 Magnetic

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#### 4.0 TEST RESULTS

##### 4.1 Resonance Survey Test Results

TEST 1B - Resonance was detected on the motor end cap at 104\* Hz.

TEST 2B - Resonance was detected at 70\* Hz on motor end cap SMB-000 actuator housing and SMB-000 housing at mounting flange.

TEST 3B - Resonance was detected at 46 Hz on gear frame of gear limit switch at 74\* Hz at motor end cap and actuator housing.

TEST 5B - No resonances were detected.

TEST 6B - No resonances were detected.

TEST 8B - No resonances were detected.

##### 4.2 Sinusoidal Dwell Test Results

TEST 4B - The actuator operated correctly. The torque switch chattered at each test level. Torque switch was defective before testing.

Between TEST 6B and 7B, the housing of the limit gear switch was found to be loose and was retightened.

TEST 7B - The actuator was operated at each level and the torque switch chattered at each test level. At the 6g level, a shift in response was detected at the motor end housing and actuator housing. The mounting bolts between the motor and actuator were found to be loose and it seemed as if local yielding had occurred. The bolts were removed. The holes in the actuator were recapped and new bolts were installed.

TEST 9B - The actuator was operated at each level. The torque switch chattered at 4g's, 5g's and 6g's. When trying to remove the unit from the test fixture, the bolt threads holding the test item to the fixture were found to have yielded. The bolts were removed and replaced with new ones.

\*  
Harmonics not within frequency range of interest.

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TEST 10B - The actuator was operated at each test level. The torque switch chattered at 7g's, 8g's, 9g's, 10g's, 11g's and 12g's.

TEST 11B - The actuator was operated at each test level. The torque switch chattered at 7g's, 8g's, 9g's, 10g's, 11g's and 12g's. Following completion of the 12g run, the coupling adaptor was found to be fractured in the same manner that previous couplings had fractured.

The coupling adaptor was replaced.

TEST 12B - The actuator was operated at each test level. After first attempt at 9g's, one of the finger basis of the gear limit switch fractured shorting input power. The finger base was replaced and the test continued. This necessitated moving accelerometers 17, 18 and 19 from the previous location to the thin metallic gear limit frame cover. The actuator was operated manually by the representative from Limitorque after testing in each axis was completed.

#### 4.3 Sine cycling Test Results

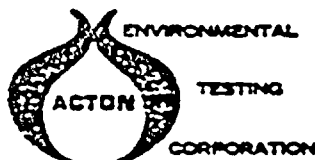
TEST 13B - The actuator was cycled every 15 minutes and resonances were found as follows: Resonances were detected on the gear frame cover of the gear limit switch between 48 and 90 Hz. The SMB-000 housing at the mounting flange and the motor end cap and actuator housing resonated at 75 Hz. No chatter occurred during the cycling.

TEST 14B - Resonance was detected at 65 Hz of the motor end cap, actuator housing and SMB-000 housing at the mounting flange. Handwheel recorded at 65 Hz. No switch chatter occurred during the cycling.

TEST 15B - No resonance below 100 Hz was detected. No switch chatter occurred. The actuator was operated manually by the representative from Limitorque after testing in each axis was completed.

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# TEST EQUIPMENT LIST

NAME	MFG	MODEL	SER. NO.	RANGE	ACCURACY	INV. #	CAL. FREQ.
Exciter Amplifier	Ling	A249	70	30,000# force 1" P/P disp.	+5%		
	Ling	PP120/150	56	5 - 5 KHz	+2%	PE317	1 month.
Hydraulic Actuator	MTS	204.63S		DC - 300 Hz, 25K force lbs.	+2% F		
Controller	MTS	443.115		25" DA max.	+5% A		
				DC - 2000 Hz	+1%	PE367	6 months
Chatter Monitor	Matrix	202D	310	Detection: 10 & 100 usec	+2%	PE370	6 months
Power Supply Rack	PCB	483A	299	22 VDC 12 MADC			
				12 channel	N/A	PE379	6 months
Power Supply & Amplifier	PCB	483M23	289	12 channel X1 & X5 gain filter			
				freq. 50 Hz	N/A	PE385	6 months
Power Supply	PCB	483A02	361	+22VDC current 4 MA			
				6 channel	N/A	PE397	6 months
Visicorder	Honeywell	906B	8687	DC-2 KHz 12 channel	+1db	RE301	3 months
Visicorder	Honeywell	906	9-5235	DC-2 KHz 12 channel	+1db	RE332	3 months
Visicorder	Honeywell	1508	161715R	12 channel-metric	+1db	RE347	3 months
Timer Seconds	SE	S60		0-60 seconds 1-rpm	+0.1sec	FM311	6 months
Strobosc	GRC	1531A	185	0-25K rpm	+1%	PP322	6 months
Sweep Oscillator	SDY	SD-104-5	21A	0.005 Hz -50 KHz	+1%	SG315	6 months
Scope, Storage	Tektronix	564-	11582	DC to 10 MHz	+3%	OS309	3 months
Power Supply	Trygon	HR60-5A	27979	60 volts 5 amps	.01%	PD328	6 months
Power Supply	Bubr	506/16	322	+15 VDC, 1" ADC	0.5%	PD372	6 months
Decade Ampl.	Glen	F408	624	3 to 100 KHz 40db/x100	+1%	AM315	6 months





# TEST EQUIPMENT LIST

NAME	MFGR.	MODEL	SER. NO.	RANGE	ACCURACY	INV. #	CAL. FREQ.
Accelerometer	PCB	302A	667	0.25 Hz - 5 KHz	+5%	AC376	3 months
"	"	"	668	"	"	AC377	" "
"	"	"	671	"	"	AC380	" "
"	"	"	673	"	"	AC382	" "
"	"	"	2845	1 Hz - 5 KHz	"	AC383	" "
"	"	"	694	0.25 Hz - 5 KHz	"	AC384	" "
"	"	"	696	"	"	AC386	" "
"	"	"	697	"	"	AC387	" "
"	"	"	2851	1 Hz - 5 KHz	"	AC392	" "
"	"	"	2852	"	"	AC394	" "
"	BK	4344	447575	0.25 - 5 KHz	"	AC395	" "
"	"	302A	2856	1 Hz - 5 KHz	"	AC414	" "
"	"	"	1772	"	"	AC415	" "
"	"	"	1774	"	"	AC417	" "
"	"	"	1780	"	"	AC423	" "
"	"	"	1781	"	"	AC424	" "
"	"	"	1805	"	"	AC425	" "
"	"	"	1811	"	"	AC429	" "

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