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NAVAIR 17-20SV-15

SV-15

TECHNICAL MANUAL

INSTRUMENT CALIBRATION PROCEDURE

**VIBRATION METER
WITH
VIBRATION PICKUP**

INTERNATIONAL RESEARCH AND
DEVELOPMENT CORP. 306 AND
IRD MECHANALYSIS INC.
306 AND 309 WITH THE 544 PICKUP AND
IRD MECHANALYSIS INC. 870 WITH THE 544 PICKUP
OR 970 ACCELEROMETER



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Page No.	Change No. *	Change Date	Page No.	Change No. *	Change Date
Title	0				
A	0				
i	0				
1 to 13	0				
14 (blank)	0				
15	0				
16 (blank)	0				
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18 (blank)	0				
19	0				
20 (blank)	0				
21	0				

* Zero in this column indicates an original page.

TABLE OF CONTENTS

Section	Page
1 Introduction and Description	1
2 Equipment Requirements	2
3 Preliminary Operations	3
4 Calibration Process	4
4.1 Displacement Tests	4
4.2 Velocity Tests (Recent Model 306 TI's)	7
4.3 Velocity Tests (Model 309 TI's)	7
4.4 Displacement Amplitude Test (Model 870 with 544 Vibration Pickup)	8
4.5 Velocity Tests (Model 870 with 970 Accelerometer)	9
Worksheet 1	11
Worksheet 2	12
Navy Calibration Checklist	13

ILLUSTRATIONS

Figure	Page
1 Test Configuration	4

TABLES

Table	Page
1 Calibration Description	1

SECTION 1

INTRODUCTION AND DESCRIPTION

1.1 This procedure describes the calibration of the International Research and Development Corp. and IRD Mechanalysis Inc. 306 Vibration Meter with the 544 Vibration Pickup, IRD Mechanalysis Inc. 309 Vibration Meter with the 544 Vibration Pickup, and the IRD Mechanalysis Inc. 870 Vibration Analyzer with the 544 Vibration Pickup or 970 Accelerometer. The instrument being calibrated is referred to herein as the TI (Test Instrument).

1.2 All comments concerning this procedure should be directed to Navy Measurement Science Directorate, Naval Warfare Assessment Division, P.O. Box 5000, Corona, CA 91718-5000.

1.3 This procedure includes tests of essential performance parameters only. Any malfunction noticed during calibration, whether specifically tested for or not, should be corrected.

NOTE

The original International Research and Development Corp. Model 306 Vibration Meter is a single scale, four range switch selectable meter designed for making displacement measurements in mils only. The most recent Model 306 manufactured under the IRD Mechanalysis Inc. name has an amplitude meter with two meter scales and seven ranges of Displacement of Velocity.

Table 1. Calibration Description

TI Characteristics	Performance Specifications	Test Method
International Research and Development Corp. Model 306		
Displacement	Ranges: 0 to 0.1, 0 to 1, 0 to 10, and 0 to 100 milli-inches peak to peak Tolerance: $\pm 10\%$ over the frequency range of 10 to 2000 Hz IRD Mechanalysis Inc. Model 306	The TI indication is compared to the corrected standard indication.
Displacement	Ranges: 0 to 0.1, 0 to 0.3, 0 to 1, 0 to 3, 0 to 10, 0 to 30, and 0 to 100 milli-inches peak to peak or 0 to 3000 microns peak to peak Tolerance: $\pm 11\%$ over the frequency range of 12 to 1000 Hz	The TI indication is compared to the corrected standard indication.
Velocity	Ranges: 0 to 0.1, 0 to 0.3, 0 to 1, 0 to 3, 0 to 10, 0 to 30, and 0 to 100 inches per second or 0 to 3000 mm per second Tolerance: $\pm 11\%$ over the frequency range of 12 to 1000 Hz	The TI indication is compared to the corrected standard indication.

TI Characteristics	Performance Specifications	Test Method
Velocity	IRD Mechanalysis Inc. Model 309 Ranges: 0 to 0.1, 0 to 0.3, 0 to 1, 0 to 3, 0 to 10, 0 to 30, and 0 to 100 inches per second or 0 to 3000 mm per second Tolerance: $\pm 11\%$ over the frequency range of 12 to 1000 Hz	The TI indication is compared to the corrected standard indication.
Displacement	IRD Mechanalysis Inc. Model 870 with 544 Vibration Pickup: Ranges: 0 to 1, 0 to 2.5, 0 to 5, 0 to 10, 0 to 25, and 0 to 50 mils peak to peak or 0 to 1000 microns peak to peak Tolerance: $\pm 11\%$ over the frequency range of 12 to 1000 Hz	The TI indication is compared to the corrected standard indication.
Velocity	with 970 Accelerometer: Ranges: 0 to 0.1, 0 to 0.25, 0 to 0.5, 0 to 1.0, 0 to 2.5, and 0 to 5.0 inches per second or 0 to 100 mm per second Tolerance: $\pm 8\%$ over the frequency range of 8 to 2000 Hz	The TI indication is compared to the corrected standard indication.

SECTION 2

EQUIPMENT REQUIREMENTS

NOTE

Minimum use specifications are the principal parameters required for performance of the calibration, and are included to assist in the selection of alternate equipment, which may be used at the discretion of the using laboratory. Satisfactory performance of alternate items shall be verified prior to use. All applicable equipment must bear evidence of current calibration.

The instruments utilized in this procedure were selected from those known to be available at Navy calibration facilities, and the listing by make or model number carries no implication of preference, recommendation, or approval for use by other agencies. It is recognized that equivalent equipment produced by other manufacturers may be capable of equally satisfactory performance in this procedure.

Item	Minimum Use Specifications	Calibration Equipment
2.1 Standard accelerometer	Range: 10 to 2000 Hz "G" Range: 0.5 to 41.0 with report of calibration	Kistler Instrument Co. 808 K1
2.2 Charge amplifier	To amplify output of accelerometer Uncertainty: $\pm 5\%$	Kistler Instrument Co. 561T
2.3 True RMS voltmeter (EVM)	Range: 5 to 450 mV Uncertainty: $\pm 1\%$	Hewlett-Packard 3403C
2.4 Vibration calibration (shaker)	Range: 0.5 to 41.0 G's	Unholtz-Dickie 330B
2.5 Power amplifier	Part of item 2.4	Unholtz-Dickie TA-100
2.6 Oscillator	Frequency range: 10 to 2000 Hz To supply input to item 2.5	Waveforms Inc. 401H-1/2R

SECTION 3

PRELIMINARY OPERATIONS

3.1 Verify that all power switches are off, and set all equipment controls as necessary to avoid damage to the equipment and so that dangerous voltages will not be present on output terminals when the power switches are turned on.

3.2 Connect the equipment to the appropriate power source.

3.3 Check that the TI is clean and there is no visible damage.

3.4 Check the TI meter for mechanical zero, if applicable, and adjust if required.

3.5 Turn all power switches on and allow a sufficient warm-up time for the equipment (the TI requires 5 minutes warm-up time); on model 870, ensure that a full screen of vertical lines is displayed on the LCD for approximately three seconds.

3.6 On model 870, ensure that the TI batteries are fully charged (8 hrs or greater).

3.7 On the original model TI's (models 306 and 309 only), set the Range switch to the CAL position and adjust the TI BAL-CAL Control for a TI meter indication of exactly 1.0. On the recent model 306 TI's and model 309 TI's, set the Range switch to TEST and verify that the AMPLITUDE meter indicates 0.9 or more.

3.8 Remove the Probe from the TI Vibration pickup.

SECTION 4
 CALIBRATION PROCESS

NOTE

Unless otherwise specified, verify the results of each test and take corrective action whenever the test requirement is not met, before proceeding.

If the TI is the original model 306 with the single meter scale, perform subsection 4.1.1. only.

If the TI is the more recent model 306 with two meter scales, perform subsections 4.1.2 and 4.2.

If the TI is the model 309 with two meter scales and a filter switch, perform subsection 4.3 only.

If the TI is the model 870 with 544 vibration pickup, perform subsection 4.4 only.

If the TI is the model 870 with 970 accelerometer, perform subsection 4.5 only.

4.1 DISPLACEMENT TESTS

4.1.1 Original Model 306 Displacement Test

4.1.1.1 Connect the equipment as shown in Figure 1.

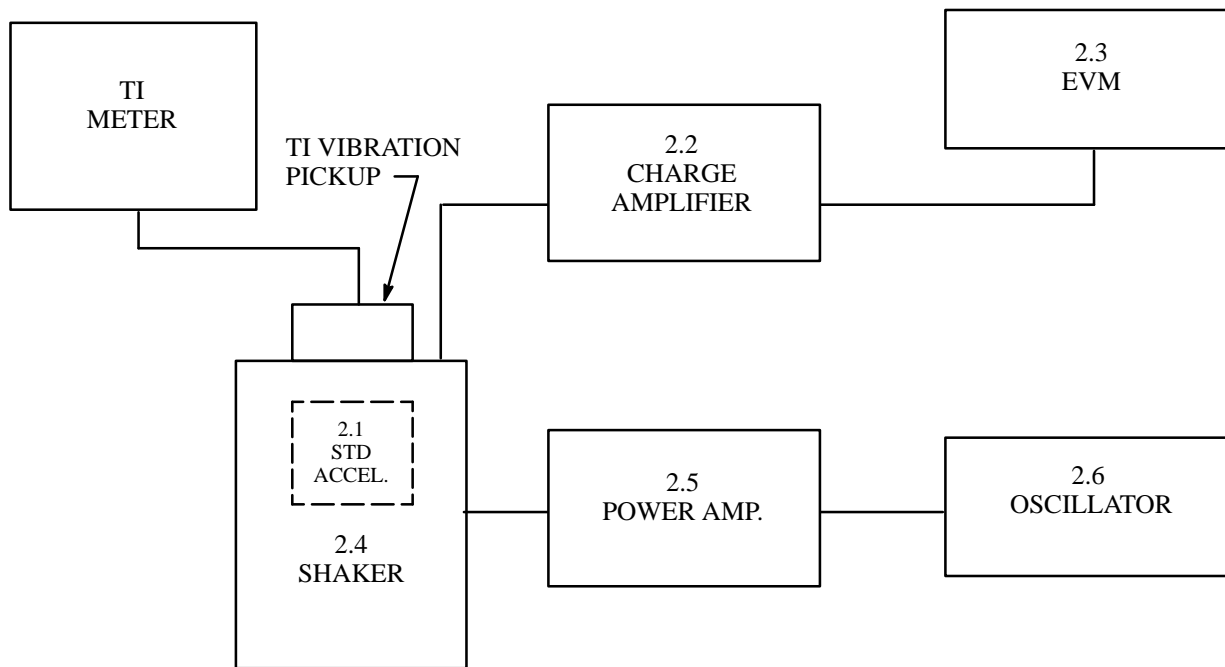


Figure 1. Test Configuration

4.1.1.2 Mount the TI Vibration Pickup to the shaker armature using a 1/4" – 28 threaded stud in place of the TI probe.

4.1.1.3 At each calibration point, record the standard accelerometer (item 2.1) sensitivity from the Report of Calibration in column 3 Table 1.

NOTE

Accelerometer sensitivity recorded must be mV/g rms. To obtain rms, multiply peak value by 0.707.

4.1.1.4 At each calibration point, multiply the shaker "G" level (column 2) by the standard accelerometer sensitivity (column 3) and record as the standard accelerometer mV output (column 4) of Table 1.

4.1.1.5 Adjust the oscillator frequency control to each of the frequencies listed in Table 2. At each frequency, set the TI RANGE to the applicable position and adjust the oscillator output amplitude control to obtain the desired mV output (calculated in step 4.1.1.4) on the EVM (item 2.3).

4.1.1.6 Verify that the DISPLACEMENT METER indications are within tolerance at each calibration point.

TABLE 2

1	2	3	4	5	6
Shaker OSC Frequency (Hz)	Shaker "G" Level	STD Accel Sensitivity (mV/g)	STD Accel mV Output (mV)	TI RANGE Setting (Mils)	TI Meter Indication (Mils)
15	1.150			100	90 to 110
50	10.23			100	72 to 88
100	10.23			100	18 to 22
200	20.45			10	9 to 11
200	10.23			10	4.5 to 5.5
400	8.181			10	0.9 to 1.1
500	6.391			1	0.45 to 0.55
1000	10.23			1	0.27 to 0.33
2000	20.45			.1	0.09 to 0.11

NOTE

A Mil equals 0.001 inch displacement of the TI vibration pickup.

4.1.1.7 If no other tests are to be performed on the original model TI's, set all power switches to off or standby and disconnect the TI.

4.1.1.8 On the original model TI's recheck the TI battery by setting the displacement switch to CAL and ensuring that the TI indication can be adjusted to 1.0 with the BAL-CAL control.

4.1.1.9 If all tests are satisfactory, affix "SPECIAL CALIBRATION" labels to the meter and pickup indicating that they are to be used only with the associated units with which they are calibrated.

4.1.2 Recent Model 306 Displacement Test

4.1.2.1 Connect the equipment as shown in Figure 1.

4.1.2.2 Mount the TI Vibration Pickup to the shaker armature using 1/4" -28 threaded stud in place of the TI probe.

4.1.2.3 Ensure SELECTOR switch is set to DISP - MILS.

4.1.2.4 At each calibration point, record the standard accelerometer (item 2.1) sensitivity from the Report of Calibration in column 3 of Table 2.

NOTE

Accelerometer sensitivity recorded must be mV/g rms. To obtain rms, multiply peak value by 0.707.

4.1.2.5 At each calibration point, multiply the shaker "G" level (column 2) by the standard accelerometer sensitivity (column 3) and record as the standard accelerometer mV output (column 4) of Table 2.

4.1.2.6 Adjust the oscillator frequency control to each of the frequencies listed in Table 3. At each frequency, set the TI RANGE to the applicable position and adjust the oscillator output amplitude control to obtain the desired mV output (calculated in step 4.1.2.5) on the EVM (item 2.3).

4.1.2.7 Verify that the TI AMPLITUDE METER indications are within tolerance at each calibration point.

TABLE 2

1 Shaker OSC Frequency (Hz)	2 Shaker "G" Level	3 STD Accel Sensitivity (mV/g)	4 STD Accel mV Output (mV)	5 TI RANGE Setting (Mils)	6 TI Meter Indication (Mils)
15	1.150			100	89 to 111
50	10.23			100	71.2 to 88.8
100	10.23			30	17.8 to 22.2
200	20.45			30	8.9 to 11.1
200	10.23			10	4.45 to 5.55
400	8.181			3	0.89 to 1.11
500	6.391			1	0.445 to 0.555
1000	10.23			.3	0.178 to 0.222
1000	5.113			.1	0.089 to 0.111

NOTE

A Mil equals 0.001 inch displacement of the TI vibration pickup.

4.2 VELOCITY TESTS (Recent Model 306 TI's)

4.2.1 Amplitude Linearity Tests

4.2.1.1 With the test configuration connected as shown in Figure 1, set the TI Function switch to VEL-INS/SEC and the Range switch to 1, adjust the oscillator frequency controls to each of the frequencies listed below. At each frequency, adjust the oscillator output amplitude to obtain each of the TI meter indications listed.

Oscillator Frequency (Hz)	TI Range Switch VEL-IN/SEC	TI METER Indications AMPLITUDE
1000	1	1
1000	1	.5
1000	1	.2
500	1	.4
500	1	.6
200	1	.7
100	1	.8
50	1	1

4.2.1.2 Using Worksheet No. 1 and steps 4.2.1.3 through 4.2.1.6, record and calculate the data for each frequency listed in column (1).

4.2.1.3 At each calibration point, record the EVM (item 2.3) indication in column (4) and the standard accelerometer (item 2.1) sensitivity from the Report of Calibration in column (5).

4.2.1.4 Calculate the actual shaker output in G's by dividing column (4) by column (5). Record results on the worksheet in column (6).

4.2.1.5 Calculate the theoretical G level by the formula $G = \frac{VXF}{61.44}$

Where F is frequency and V is the TI indicated velocity in in/sec.

Record the results on Worksheet No. 1, column (3).

4.2.1.6 Verify that column (3) is within $\pm 11\%$ of column (6).

4.2.1.7 If no other tests are to be performed, set all power switches to off or standby and disconnect the TI.

4.2.2 Recheck the TI battery by setting the TI Range switch to TEST and ensuring that the TI indication is 0.9 or more.

4.2.3 If all tests are satisfactory, affix "SPECIAL CALIBRATION" labels to the meter and pickup indicating that they are to be used only with the associated units with which they are calibrated.

4.3 VELOCITY TESTS (Model 309 TI's)

4.3.1 Amplitude Linearity Tests

4.3.1.1 With the test configuration connected as shown in Figure 1, set the TI FILTER OUT-FILTER IN switch to FILTER OUT and the Range switch to 1, adjust the oscillator frequency controls to each of the frequencies listed below. At each frequency, adjust the oscillator output amplitude controls to obtain each of the TI meter indications listed.

Oscillator Frequency (Hz)	TI Range Switch VEL-IN/SEC	TI METER Indications AMPLITUDE
1000	1	1
1000	1	.5
1000	1	.2
500	1	.4
500	1	.6
200	1	.7
100	1	.8
50	1	1

4.3.1.2 Using Worksheet No. 1 and steps 4.3.1.3 through 4.3.1.6, record and calculate the data for each frequency listed in column (1).

4.3.1.3 At each calibration point, record the EVM (item 2.3) indication in column (4) and the standard accelerometer (item 2.1) sensitivity from the Report fo Calibration in column (5).

4.3.1.4 Calculate the actual shaker output in G's by dividing column (4) by column (5). Record results on the worksheet in column (6).

4.3.1.5 Calculate the theoretical G level by the formula $G = \frac{VXF}{61.44}$

Where F is frequency and V is the TI indicated velocity in in/sec.

Record the results on Worksheet No. 1, column (3).

4.3.1.6 Verify that column (3) is within $\pm 11\%$ (6).

4.3.1.7 If no other tests are to be performed, set all power switches to off or standby and disconnect the TI.

4.3.2 Recheck the TI battery by setting the TI Range switch to TEST and ensuring that the TI indication is 0.9 or more.

4.3.3 If all tests are satisfactory, affix "SPECIAL CALIBRATION" labels to the meter and pickup indicating that they are to be used only with the associated units with which they are calibrated.

4.4 DISPLACEMENT AMPLITUDE TEST (Model 870 with 544 Vibration Pickup)

4.4.1 Ensure the TI is set to AMPLITUDE VS FREQUENCY mode.

4.4.2 Connect the equipment as shown in Figure 1.

4.4.3 Mount the TI Vibration Pickup to the shaker armature using a 1/4" - 28 threaded stud in place of the TI probe.

4.4.4 At each calibration point, record the standard accelerometer (item 2.1) sensitivity from the Report of Calibration in column (3) in Table 4.

NOTE

Accelerometer sensitivity recorded must be in mV/g rms. To obtain rms, multiply peak value by 0.707.

4.4.5 At each calibration point, multiply the shaker “G” level in column (2) by the standard accelerometer sensitivity in column (3) and record as the standard accelerometer mV output in column (4).

4.4.6 Adjust the oscillator frequency control to each of the frequencies listed in column (1). At each frequency, adjust the oscillator output amplitude control to obtain the column (4) mV output on the EVM.

4.4.7 Verify that the TI vibration pickup displacement indications on the TI analyzer are within tolerance at each calibration point.

TABLE 2

1	2	3	4	5	6
Shaker OSC Frequency (Hz)	Shaker “G” Level	STD Accel Sensitivity (mV/g)	STD Accel mV Output (mV)	TI RANGE Setting (Mils)	TI Meter Indication (Mils)
15	0.575			50	44.5 to 55.5
50	5.113			50	35.6 to 44.4
100	10.23			25	17.8 to 22.2
200	30.68			25	13.3 to 16.7
200	20.45			10	8.90 to 11.1
300	23.01			10	4.45 to 5.55
400	24.54			5	2.67 to 3.33
500	31.96			5	2.22 to 2.78
1000	38.35			2.5	0.688 to 0.833
1000	25.57			1	0.445 to 0.555

NOTE

A Mil equals 0.001 inch displacement of the TI vibration pickup.

4.4.8 If no other are to be performed, set all power switches to OFF or STANDBY and disconnect the TI.

4.4.9 If all tests are satisfactory, affix “SPECIAL CALIBRATION” labels to the analyzer and pickup indicating that they be to be used only with the associated units with which they are calibrated.

4.5 VELOCITY TESTS (Model 870 with 970 Accelerometer)

4.5.1 Amplitude Linearity Tests

4.5.1.1 With the test configuration connected as shown in Figure 1, ensure the TI is set the AMPLITUDE VS FREQUENCY mode.

4.5.1.2 Adjust the oscillator frequency controls to each of the frequencies listed below. At each frequency, adjust the oscillator output amplitude to obtain each of the TI meter indications listed.

Oscillator Frequency (Hz)	TI Range Switch VEL-IN/SEC	TI METER Indications AMPLITUDE
2000	1	1
2000	1	.5
2000	1	.2
1500	1	1
1500	1	.5
1000	1	1
1000	1	.5
500	1	.4
500	1	.6
200	1	.7
100	1	.8
50	1	1

4.5.1.3 Using Worksheet No. 2 and steps 4.5.1.4 through 4.5.1.7, record and calculate the data for each frequency listed in column (1).

4.5.1.4 At each calibration point, record the EVM (item 2.3) indication in column (4) and the standard accelerometer (item 2.1) sensitivity from the Report of Calibration in column (5).

NOTE

Accelerometer sensitivity recorded must be in mV/g rms. To obtain rms, multiply peak value by 0.707.

4.5.1.5 Calculate the actual shaker output in G's by dividing column (4) by column (5). Record results on the worksheet in column (6).

4.5.1.6 Calculate the theoretical G level by the formula $G = \frac{VXF}{61.44}$

Where F is frequency and V is the TI indicated velocity in in/sec.

Record the results on Worksheet No. 1, column (3).

4.5.1.7 Verify that column (3) is within $\pm 8\%$ of column (6).

4.5.1.8 If no other are to be performed, set all power switched to OFF or STANDBY and disconnect the TI.

4.5.1.9 If all tests are satisfactory, affix "SPECIAL CALIBRATION" labels to the analyzer and pickup indicating that they are to be used only with the associated units with which they are calibrated.

NAVY CALIBRATION

WORKSHEET NO. 1

(1)	(2)	(3)	(4)	(5)	(6)
Oscillator Frequency (Hz)	TI Indication AMPLITUDE	Theo. Accel. (G's)	EVM Indication (mV)	Std. Accel. SENS: (mV/G)	Actual Accel. (G's)
1000	1	_____	_____	_____	_____
1000	.5	_____	_____	_____	_____
1000	.2	_____	_____	_____	_____
500	.4	_____	_____	_____	_____
500	.6	_____	_____	_____	_____
200	.7	_____	_____	_____	_____
100	.8	_____	_____	_____	_____
50	1	_____	_____	_____	_____

NAVY CALIBRATION

WORKSHEET NO. 2

(1)	(2)	(3)	(4)	(5)	(6)
Oscillator Frequency (Hz)	TI Indication AMPLITUDE	Theo. Accel. (G's)	EVM Indication (mV)	Std. Accel. SENS: (mV/G)	Actual Accel. (G's)
2000	1	_____	_____	_____	_____
2000	.5	_____	_____	_____	_____
2000	.2	_____	_____	_____	_____
1500	1	_____	_____	_____	_____
1500	.5	_____	_____	_____	_____
1000	1	_____	_____	_____	_____
1000	.5	_____	_____	_____	_____
500	.4	_____	_____	_____	_____
500	.6	_____	_____	_____	_____
200	.7	_____	_____	_____	_____
100	.8	_____	_____	_____	_____
50	1	_____	_____	_____	_____

CALIBRATION CHECKLIST

TEST INST (S) IRD Mechanicals Inc. 306 Vibration Meter with the 544 Vibration Pickup (Recent model)

PROC. NO.	NA 17-20SV-15		MFG.	MODEL		SER. NO.		
PROCEDURE STEP NO. (1)	FUNCTION TESTED (2)		NOMINAL (3)	MEASURED VALUES		OUT OF TOL (5)	CALIBRATION TOLERANCES (7)	
				FIRST RUN (4)	SECOND RUN (5)			
3.3	Visual Inspection							
3.4	Meter-Mechanical Zero							
3.7	Battery check		--	ck ()			0.9 or more	
4.1	Displacement Tests							
4.1.2	Recent Model 306 Displacement Test							
4.1.2.7	FREQ	G		TI				
"	(Hz)	Level	(Mils)	(G's)			(Mils)	
"	15	1.150	100				89	to 111
"	50	10.23	100				71.2	to 88.8
"	100	10.23	30				17.8	to 22.2
"	200	20.45	30				8.9	to 11.1
"	200	10.23	10				4.45	to 5.55
"	400	8.181	3				0.89	to 1.11
"	500	6.391	1				0.445	to 0.555
"	1000	10.23	.3				0.178	to 0.222
"	1000	5.113	.1				0.089	to 0.111
4.2	Velocity Tests							
4.2.1	Amplitude Linearity Tests							
4.2.1.6	FREQ	VEL	Std	TI				
"	(Hz)	(IN/SEC)	(G's)	(G's)				
"	1000	1	100				±11%	
"	1000	.5					"	
"	1000	.2					"	
"	500	.4					"	
"	500	.6					"	
"	200	.7					"	
"	100	.8					"	
"	50	1					"	
4.2.2	Battery Check		--	ck ()			0.9 or more	

