2018
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HEDL-TME 71-114

AUGUST 1971

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BY JH Kahn/amb
DATE 10/12/71

CCTL MARK II SUBASSEMBLY
SHIPPING PROCEDURE

TESTING AND SHIPPING REPORT

HANFORD ENGINEERING DEVELOPMENT LABORATORY
UNITED STATES ATOMIC ENERGY COMMISSION

Operated by

CONTRACT AT(45-1)-2170

R1668

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HANFORD ENGINEERING DEVELOPMENT LABORATORY

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CCTL MARK II SUBASSEMBLY SHIPPING PROCEDURE

TESTING AND SHIPPING REPORT

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August 1971

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CCTL MARK II SUBASSEMBLY SHIPPING PROCEDURE

TESTING AND SHIPPING REPORT

Introduction

When the Mark II Test Assembly was shipped from HEDL to ANL via air freight in April 1970, instrumentation indicated that the assembly experienced a 30g shock. After approximately 7000 hours of sodium flow testing in the Core Components Test Loop (CCTL) at ANL, the Mark II test assembly was shipped back to HEDL for interim examination before undergoing more sodium flow testing at ANL. This report discusses the testing of the shipping procedures and the return shipment to HEDL.

Purpose

The purpose of the testing prior to shipment to HEDL was to determine if the assembly would experience shocks and vibrations during transport of sufficient magnitude to cause fretting of components and therefore cloud the data derived from the sodium flow testing. Westinghouse ARD had set the single amplitude limits at .25g maximum background vibration with a few isolated shocks of approximately 1.0g maximum allowed.

On the previous shipment from HEDL to ANL the assembly was loaded on a truck at HEDL and unloaded at ANL under control of knowledgeable personnel. However, at Portland, San Francisco, and Chicago it was handled by air freight personnel. Even though many of these handlings were observed by a knowledgeable person, it is postulated that the aforementioned 30g shock occurred during one of these periods of air freight handling. The equipment proposed for the present shipment was an exclusive use air-suspended tractor and air-suspended enclosed trailer. This equipment was chosen because of its relatively smooth ride characteristics and the fact that all handling of the assembly would be controlled by HEDL personnel knowledgeable of the shipping requirements.

Description of Equipment

The vibration detection system used during all tests and during the first day of shipment consisted of the following:

1. Systron-Donner servo accelerometers with a range of 0-3g.
2. Geo-Recon electronic balance and DC power supply.
3. Precision Instrument FM tape recorder.
4. Portable AC motor generator.

Three separate servo accelerometers were used, each providing individual response outputs for a vertical, longitudinal and transverse axis. Each accelerometer functions as a miniature servo system responsive to input acceleration along its sensitive axis. As illustrated by the functional block diagram, Figure 1, input acceleration (a) causes a force ($F = Ma$) which tends to move the seismic (acceleration sensitive) mass (1). This movement, which upsets the servo's balance, is detected by the position-error detector (2). The servo-nulling amplifier (3) requires a given, pre-set input from the position-error detector. The amplifier sends a feedback current through the restoring coil which is located in a permanent magnetic field (4) causing a force ($F = HLi_s$) exactly equal and opposite to the input force caused by acceleration.

Figure 1. Functional Diagram: Donner Model 4310 Linear Accelerometer Illustrating Principle of Closed Loop Operation.

The restoring force returns the seismic system to its original position and in turn reduces or increases the output of the position-error detector until it reaches null. The servo system would then be in a "force-balance" condition. The servo current required to achieve this balance is directly proportional to the acceleration according to the equation ($M_a = F = HLi_s$). Analog voltage output directly proportional to the input acceleration is obtained by measuring the drop in current produced across a known resistor (5).

The accelerometers used for this study produce an output voltage of ± 15 volts/g and have a linear response from DC to 150 Hz.

The function of the Geo-Recon system is to provide the electronic balance and supply ± 28 VDC to each servo accelerometer. The Geo-Recon systems are also equipped with Century 409 oscillographs for recording the output over one minute intervals. The oscillographs were used for periodic signal monitoring only.

All signal output from the accelerometers was recorded directly on a Precision Instrument eight channel FM tape recorder operating at 1-7/8 ips. Outputs from two of the triaxial accelerometers at a time were recorded on six channels, WWV time signal on one channel and voice communication on one channel. This method (using a tape recorder that has fixed heads with no mechanical resonance) provided a wide latitude in the amount and type of data that was collected and also eliminated any potential inaccuracies that could result from mechanical resonance of galvanometers in an oscillograph recorder. The extent of analysis discussed in a later section of this paper was possible only with magnetic tape recording of data.

Portable AC power was necessary to operate the tape recorder and to keep a full charge on the batteries used to provide DC power to the accelerometers. Two gas operated portable Honda AC-DC generators were mounted on the tractor with extension cords running back into the trailer. Each generator provided 300 Watts power for a period of approximately four hours on one tank of fuel. Only one generator at a time was required for operation of all systems.

A schematic of the detecting and recording system is shown in the following, Figure 2.

Figure 2. Schematic of Detecting and Recording System

Description of First Week's Tests (Tests #1-3)

Approximately 24,000 lbs. of sand bags were used for ballast for all tests (first and second week) because of indications that the smoothest ride occurred when the van was loaded to near capacity. The road tests were conducted in the following manner: the instrument engineer and his technician rode in the trailer and an observer rode in the cab with the driver. The observer's job was to describe the road and any landmarks via walkie-talkie onto the tape for use in playback. The roads selected were thought to be comparable to those that would be encountered on a cross country trip - from two lane, poorly-surfaced road to good, divided non-restricted access roads to expressways.

For the first test, in order to get the box over the rear wheels of the trailer, where it was thought to get the smoothest ride, 22,000 lbs. of sand was loaded ahead of the box with 1,000 lbs. along each side (see Figure 3A). The 15B inner box was positioned in the outer box with two inches of Shok Foam (B. F. Goodrich shock absorbing rubber) between the boxes. Between the outer box and the trailer floor a one inch thick layer of furniture pads and a six inch thick Shok Foam pad were used as cushioning. The box was strapped in place with four equally spaced woven nylon straps extending from the lowest attachment point on one wall of the trailer (16" above the floor) across the top of the box and fastened to the lowest point on the opposite wall. Additionally there was a strap from wall-to-wall across each end of the box to keep it from shifting front-to-rear. All of these straps were insulated from the box by one layer of Shok Foam (1") and one furniture pad (1/2"). The test consisted of a tour of approximately 70 miles of roads around the Argonne Laboratory. One of the air suspension bags on the tractor broke about eight miles after the start. It is questionable whether the ride was affected.

The playback of the tape from test #1 indicated that loading the 22,000 lb. of sand in the middle of the trailer about midway between the rear tractor wheels and the trailer wheels caused the trailer bed to bounce up and down in the middle. The bouncing showed up on the paper chart readout as a low frequency sine wave on which was impressed the 15 Hz road vibration primary frequency.

For the second test the ballast was redistributed and the box moved forward. The ballast configuration (8000 lb. ahead of the box, 2000 lb. along each side, and 12000 lb. behind) was used for all subsequent tests and the shipment (see Figure 3B). The tire pressures, as well, were reduced (from 100 to 80 in the tractor drive tires and from 90 to 70 in the trailer tires) for all subsequent tests. The same tie down and padding arrangements were used on this test. Redistribution of the ballast resulted in a noticeably smoother ride for the 50 miles of test.

The paper chart printout of this test indicated about .5g peak-to-peak background (normal driving) at about 15 Hz. Bumps caused accelerations of up to 2g's peak-to-peak. During the ride it was observed that the box seemed to be riding more roughly than the trailer floor. This phenomenon was thought to be caused by a "decoupling" effect between the box and the floor. This effect seemed to be a result of two things: first, the fact that the box was essentially strapped to the walls instead of the floor; and second, an excess amount of padding beneath the box. When decoupling occurs, the box and trailer bed move at different frequencies or at least out of phase at the same frequency. This differential motion causes an addition of acceleration forces (i.e. the box is going down when the trailer bed is going up), thus giving the box a rougher ride than the trailer bed.

Figure 3A. Trailer Configuration Test Run #1

Figure 3B. Trailer Configuration for Shipment & Test 2-8

For the third test all padding was removed from under the box and the box was more closely strapped to the floor by running two nylon straps over the box, out the side doors and under the trailer. This test produced somewhat lower background vibrations and slightly higher shocks from road bumps. These results indicated that a more positive coupling with the floor was desirable. After the third test, results of the first week's testing were discussed at HEDL.

Description of Second Week's Tests (Tests #4-8)

After consultation at HEDL the decision was made to return to Argonne and run more tests utilizing improved tie-down methods. The test data would then be taken to Pittsburgh and a decision made in conjunction with ARD people as to whether or not the test data indicated agreement with their criteria of .25g vibration.

The major difference between the first (test 1-3) and second (test 4-8) week's set of tests was that on the second set the box was strapped to the floor instead of to the walls of the trailer. Screws were removed from the floor of the trailer and replaced with eight 5/16" eyebolts - four along each side of the box. Each of the tests of the second set was run over a nine mile route comprising approximately one mile of Interstate 55 and eight miles of Illinois 83. About half of Illinois 83 was good, four lane, divided highway and half was two lane, relatively bumpy road. The only variables in the tests were the material used for padding beneath the box and the materials used for tie-down straps.

Tests #4 and #5 each had one layer (~2 inches) of BFG Pimcore foam rubber under the box. Test #4 had nylon tie-down straps. Test #5 had steel bands for tie-down straps. The results of these tests showed test #4 to be much the better of the two from both the shock and vibration standpoints. Tests #6 and #7 were run with no

padding and with nylon and steel tie-down straps, respectively. Both of these tests showed lower background vibrations and slightly higher shock accelerations than those with padding. Test #8 had one layer (1 inch) of Shok Foam for padding and steel tie-down straps. This test showed very slightly higher shocks than with Pimcore padding and slightly lower than with no padding. Back ground vibrations were lower than with Pimcore and slightly higher than with no padding. The detailed analysis of these tests is presented below.

DATA ANALYSIS

Visual

Upon conclusion of each test phase conducted at ANL, an oscillograph record was made from the FM tape data. No signal conditioning was attempted. Simultaneously, selected signals were monitored through a Hewellett-Packard RMS integrator to produce a new signal that provided an approximation of the average acceleration intensity over the range of 10-100 Hz. A visual analysis of these data was made in order to determine if changes in test procedures were necessary, additional tests were needed, and finally to provide information upon which a decision could be made concerning the final shipment procedure to be used between ANL and HEDL. No discussion, other than the previous descriptions of the first and second week's testing, of these early data will be made except to say that the preliminary visual analysis was not significantly different from the later detailed analysis. The one exception was that the conclusions drawn from the visual analysis were found to be quite conservative (higher than actual), compared to the final detailed analysis, particularly with regard to the average acceleration intensity.

Computer

Equipment availability at HEDL for playback dictated the need to transfer the Precision Instrument FM tape data to an Ampex FR 1300 FM tape system. Some spurious electronic noise was found to have been added in the tape transfer but was generally of a higher frequency than the signal and did not create any significant problems.

A series of computer programs was prepared to provide for analysis of the extensive amount of data (approximately 16 hours) in the shortest time. Advantage was made of a hybrid analog-digital computer system operated by Battelle Northwest to accomplish the analysis. This system consists of a Beckman analog computer model EASE 2133 coupled with a Digital Electronic Corporation model PDP-7 digital computer. Analog signals can be fed continuously into the EASE 2133 where they are conditioned, computed and selectively sampled for A-D conversion and transfer to the PDP-7 for simultaneous analysis.

Basic programs were prepared to perform the following functions:

1. Signal Conditioning - spurious electronic noise, above 100 Hz frequency, was removed and the signal pre-emphasized back to original transducer output of 15 volts/lg.
2. The pre-emphasized signal was continuously integrated over 30 second intervals to provide average acceleration intensity for all frequencies from DC to 100 Hz. Average acceleration intensity is synonymous with vibration level and is directly proportional to the force acting continuously according to the relationship $F = MA$. The value for average acceleration intensity was found by taking the sum of the instantaneous values over 30 second intervals and dividing the number of instantaneous values. This essentially represents the RMS (root mean square) of the signal. Over more extended periods

of time, the individual thirty second intervals were statistically averaged to produce one value representative of a given test.

3. A continuous count was made of the number of times the signal exceeded shock levels comparable to $3/4$, 1, $1-1/4$, $1-1/2$, and 2g. The results represent zero-to-peak values of shock, the maximum instantaneous force that is applied. The amount and type of damping present will determine the level of acceleration during the following cycles. With any damping present whatsoever the following cycles will show a significant decrease in amplitude.
4. The analog computer was programmed to sample up to eight signals simultaneously for five second intervals. A-D conversion was made automatically and stored on tape on the PDP-7. The PDP-7 was then programmed to apply a fast Fourier transform of each five second sample in sequence and provide an output of the signal sample and power density spectra of the same sample. An example of this last program output is shown in the Appendix in Figures A-1 and A-1A for a 100 Hz, 1g peak-to-peak calibration signal recorded on the tape at the beginning and end of the tests at ANL.

Results

There are two predominant types of potential damaging forces - shock and vibration. These two forces frequently exist simultaneously. Vibration is the application of a periodic force for some sustained period of time. Shock is the force that results from a sharp impact. A small shock induced on a high vibration level will have almost the same damage potential as a large shock

superimposed on a small vibration level. While neither condition is desirable, the latter condition is preferable because of the lower probability of occurrence and the lower total force to which the system will be subjected. The simultaneous analysis of shock and vibration is extremely complex, particularly under transient conditions. Because of the time involved in a simultaneous analysis and the limited potential for any significant difference in the results of these particular tests, vibration and shock were analyzed separately.

Table 1 is a summary of the average acceleration intensity for the vertical, transverse (front-to-back), and lateral (side-to-side) axes. The data statistics are included to provide the reader with some indication on data accuracy and reliability.

The sample taken from the trailer floor during tests 4 through 8 is representative of the acceleration intensity that would be present if complete coupling were in effect between the floor and the Mark II assembly. The average vertical intensity is only slightly higher than the average lateral intensity. The transverse vibration intensity is about half of the lateral and one third of the vertical. Representative power density spectra and signal samples for each axis (V: vertical; T: transverse; and L: lateral) are shown in Figures A-2 through A-4A in the Appendix. Any decoupling of the shipping container from the floor by a pad which acts as a spring or the method of tie-down which acts as a damper can either attenuate or amplify the input energy. The optimum condition occurs when the acceleration intensity is reduced and the signal spectrum is either distributed broadly or changed from the dominant response frequency of the trailer. A resonant condition occurs when the dominant response frequencies of the container and trailer are the same and would have the maximum potential for producing damage.

Test#	Average Accel. Intensity Per 30 Sec.	Sample Time	Variance	Deviation	Error $\pm$
1 - Container on Shok Foam Base Nylon Tie-Down to Trailer Walls	Vert. .099 Trans. .102g Lat. .088g	21 Min. 21 Min. 21 Min.	.088g .042g .035g	0.30g 0.21g 0.19g	0.05g 0.03g 0.03g
4 - Container on Pimcore Foam Base Nylon Tie-Down to Trailer Floor	Vert. .185g Trans. .121g Lat. .100g	18 Min. 18 Min. 18 Min.	.296g .021g .090g	0.54g 0.15g 0.30g	0.09g 0.02g 0.05g
5 - Container on Pimcore Foam Base Steel Tie-Down to	Vert. .308g Trans. .061g Lat. .100g	13 Min. 17 Min. 16 Min.	.297g .032g .081g	0.54g 0.18g 0.28g	0.11g 0.03g 0.05g
6 - Container on Floor, Nylon Tie- Down to Trailer Floor	Vert. .218g Trans. .053g Lat. .116g	17 Min. 17 Min. 17 Min.	.396g .007g .101g	0.63g 0.08g 0.32g	0.11g 0.02g 0.06g
7 - Container on Floor, Steel Tie- Down to Trailer Floor	Vert. .184g Trans. .031g Lat. .107g	14 Min. 14 Min. 14 Min.	.93g .006g .023g	0.30g 0.08g 0.15g	0.06g 0.02g 0.03g
Floor Vibration	Vert. .125g Trans. .041g Lat. .084g	14 Min. 16 Min. 14 Min.	.111g .010g .168g	0.33g 0.10g 0.41g	0.06g 0.01g 0.07g

TABLE 1

Average Acceleration Intensities Along Each Axis

Analysis of the average acceleration intensity data indicates that the method used for final shipment of the Mark II assembly (test #4) allowed only slightly higher levels than the trailer floor in the vertical and lateral directions. In transverse direction during test #4, acceleration intensity was three times that of the floor. Both tests #6 and #7 are comparable to test #4 in the vertical and lateral motion levels but are significantly lower for the transverse mode.

Due to technical problems, data were not available from test #8, which was meant to compare Shok Foam with Pimcore foam and direct floor loading. In lieu of test #8, data from test #1 were analyzed. Test #1 had a number of differences from tests #4 through #7. The weight distribution of the sand ballast was different, the tie-down was to the trailer walls, and the road conditions for the test were not the same. The results are useful, however, for a relative comparison to show that Shok Foam has the potential for significant reduction in vibration levels for all directions of motion.

Representative power density spectra results along with the sample signal for each test are shown in Figures A-5 through A-19A in the Appendix. The power density spectra are normalized to the maximum energy present at some frequency between 0-100 Hz for the time interval sampled. The results represent the normalized forces applied at different frequencies over a five second interval of time with highest force set equal to 100. The frequency that appears to show the highest ratio of input energy is termed dominant. The frequencies where the second highest ratio of input energy is concentrated are termed subdominant. In the vertical mode, the trailer floor has a dominant frequency around 14 Hz and a subdominant response at approximately 28 Hz. Tests 4 through 7 all exhibit similar

response spectra and power densities indicating potential resonance conditions. Test #1 using Shok Foam showed a significant shift in the dominant frequency response to approximately 4 Hz. This method would have the potential for the least damage.

In the lateral mode, the trailer floor has a dominant response around 36 Hz with several subdominants at 4, 14, and 24 Hz. Each of the tests showed small differences in the dominant response frequency from the floor input. Test #6, with the container directly on the floor held down with nylon straps, has the broadest response and would be the most desirable.

In the transverse direction the floor spectrum is fairly random except for a gradual dominant around 28 Hz. Tests #6 and #7 (container on floor) exhibit similar patterns. Tests #1, #4 and #5 all appear to concentrate the energy into narrower bands. Since the energy input in the transverse direction was relatively low and the assembly was shipped in the horizontal position, the differences in spectra are not considered significant.

Table 2 lists the number of times a given shock level was exceeded on each axis for tests #4 and #7. No data are included for test #1 because the test conditions for shock are not comparable. Of the four tests shown it is obvious that test #5 using Pimcore with steel tie-down produced the most shocks at all levels. Test #4 using Pimcore with nylon tie-down produced the lowest number of shocks at all levels. A noticable difference can be also seen between tests #4 and #5 and tests #6 and #7 when nylon tie-down which provides a damping effect is replaced by steel tie-down with limited damping effect.

By combining the lowest possible acceleration intensity with the lowest shock level, the method of shipping represented by test #4, Pimcore with nylon tie-down appears to have been a good choice to use for final shipment.

Number of Excursions Above:

Test Number		.75 G	1.0 G	1.25 G	1.5 G
4 - Container on Pimcore Foam Base, Nylon Tie-Down to Floor	Vert.	196	28	9	2
	Trans.	0	0	0	0
	Lat.	2	1	0	0
5 - Container on Pimcore Foam Base, Steel Tie-Down to Floor	Vert.	3019	1464	818	464
	Trans.	96	42	14	0
	Lat.	238	124	48	0
6 - Container on Floor Nylon Tie-Down to Floor	Vert.	270	119	47	24
	Trans.	19	3	0	0
	Lat.	12	7	1	0
7 - Container on Floor Steel Tie-Down to Floor	Vert.	569	231	116	61
	Trans.	8	2	0	0
	Lat.	25	8	2	0

Table 2

Number of Excursions Above Given "G" Level for Each Channel on Each Test

particularly in the vertical mode. The method represented by test #6, container on the floor with nylon tie-down would have been a slight improvement if it was desired to have the minimum force in all three modes and the broadest power density input. Limited data from test #1, using Shok Foam indicates that this method could potentially provide further improvement in reducing both shock and vibration and should be investigated further.

Final Shipment

Visual analysis of oscillograph playback of the data from all the tests was used to make the decision concerning the method to be used for final shipment of the Mark II assembly from ANL to HEDL. The method represented by test #4, Pimcore foam with nylon tie-down, was chosen because it showed a relatively low shock and vibration levels.

During the first day of shipment between ANL and Des Moines, Iowa, the same instrumentation used in testing was used to measure vibration and shock and to record continuously on FM tape. Figures A-20 through A-25A in the Appendix are representative samples of power density spectra and corresponding vibration data during the trip. No significant difference in the power spectra can be seen between the final shipment and test #4. This fact indicates that the test procedures used were representative of the conditions seen during final shipment. Table 3 is a summary of the number of excursions above a given "G" value over an eight hour period.

Table 3

Number of Excursions Above Given "G" Level
Chicago, Illinois to Des Moines, Iowa

	<u>Number of Excursions Above:</u>			
	<u>.75 G</u>	<u>1.0 G</u>	<u>1.25 G</u>	<u>1.5 G</u>
Vertical	1031	60	18	2
Transverse	37	16	11	0
Lateral	24	11	2	0

The percentage of shocks above a given "G" value is similar to what was indicated from test #4.

From Des Moines, Iowa to HEDL, the servo accelerometer system was placed in a standby record status in the event any shock was felt greater than 1.5g vertical. No shocks greater than 1.5g were recorded. Another vibration monitor system (the Impact Register accelerometers mentioned below) with a range of 0-5g's was run continuously and showed that the shock level was comparable to that of the first day during the entire trip. This system indicated 14 excursions greater than 1.5g and one possible shock near 2.0g. An attempt was made to again record continuously on FM tape from Boise, Idaho to HEDL but was unsuccessful due to problems with the recorder power supply.

The following additional instruments were used to monitor the shocks seen by the assembly during the trip.

Humphrey Accelerographs:

The Humphrey Accelerograph consists of a seismic mass suspended from a cantilevered wire spring. A stylus attached to the mass traces acceleration amplitude on a glass wax coated recording disc. Each accelerograph records with equal sensitivity on two axes. By placing two at each location (near the top, middle, and bottom of the assembly) it was possible to monitor all three axes at the location.

Records: (peak-to-peak)

Near top of assembly

Vertical ~3.3 g max.

Lateral < .2 g max.

Transverse < .2 g max.

Near middle of assembly

Vertical ~1.1 g max.

Lateral < .2 g max.

Transverse < .2 g max.

Near bottom of assembly

Vertical ~3.5 g max.

Lateral < .2 g max.

Transverse < .2 g max.

Transit Guard Shock Recorder:

The Transit Guard System continuously records the on/off status of ten separate channels on inkless pressure-sensitive chart paper. For the shipment three transducers each monitoring all three axes were used at approximately the same locations as the Humphreys. One channel recorded each axis of each transducer,

so nine channels were used. The inertia switches in each transducer were set to turn on at a 6g's of acceleration. None of the channels turned on during the trip.

Impact Register Three Way Recording Accelerometers:

The Impact Register instruments are basically three-directional, pneumatically damped accelerometers with clock-driven recorders. The accelerometer (acceleration sensing) mechanism is completely mechanical, using pivoted mass elements (pendulum fashion) suspended by coiled springs. The damping is pneumatic, provided by a piston and cylinder with a variable orifice in the piston head so that the percentage of damping may be adjusted. Two of these recorders were used - one approximately two feet from each end of the element.

Records:

Near top of assembly

- 1 shock ~2.7g peak-to-peak
- 1 shock ~2.0g peak-to-peak
- 2 shock ~1.8g peak-to-peak
- 14 shock ~1.5g peak-to-peak

Near bottom of assembly

Suspect faulty instrument - showed no shocks over
.5g peak-to-peak.

Conclusions and Recommendations

The method of shipping a Mark II assembly - mounted on Pimcore foam and tied down with nylon straps in an exclusive use air ride moving van - was adequate to maintain the average acceleration intensity at less than 0.2g's vertical. Occassional shocks greater than 1.5g occurred, but were not prevalant.

Analysis of data from test #8 - Shok Foam with nylon tie-down - should be made to determine if additional improvements in reducing vibration and shock are possible.

APPENDIX

TEST OF THE ARGONNE 100 HZ CALIBRATION SIGNAL

Figure A1

TEST OF THE ARGONNE 100 HZ CALIBRATION SIGNAL

Figure A-1A

V2 TEST 4 (RETURNTRIP) SAMPLE 5 793

Figure A-2

V2 TEST 4 (RETURNTRIP) SAMPLE 5 793

Figure A-2A

L1 TEST 4 (RETURN TRIP) SAMPLE 4 752

Figure A-3

L1 TEST 4 (RETURN TRIP) SAMPLE 4 752

Figure A-3A

T1 TEST 5 (RETURN TRIP) SAMPLE 4 985

Figure A-4

T1 TEST 5 (RETURN TRIP) SAMPLE 4 985

Figure A-4A

U2 TEST 1 TAPE 1 SAMPLE 2 325

Figure A-5

U2 TEST 1 TAPE 1 SAMPLE 2 325

Figure A-5A

V2 TEST 4 SAMPLE 3 716

Figure A-6

V2 TEST 4 SAMPLE 3 716

Figure A-6A

V2 TEST 5 SAMPLE 2 909

Figure A-7

V2 TEST 5 SAMPLE 2 909

Figure A-7A

U2 TEST 6 SAMPLE 2 1185

Figure A-8

V2 TEST 5 SAMPLE 2 1186

Figure A-8A

V2 TEST 7 SAMPLE 3 1442

Figure 449

V2 TEST 7 SAMPLE 3 1442

Figure 1-9a

T1 TEST 1 TAPE 1 SAMPLE 4 640

Figure A-10

T1 TEST 1 TAPE 1 SAMPLE 4.640

Figure A-10A

T1 TEST 4 SAMPLE 2 719

Figure A-11

T1 TEST 4 SAMPLE 2 672

Figure .A-11A

T1 TEST 5 SAMPLE 1 878

Figure A-12

T1 TEST 5 SAMPLE 1 878

Figure A-12A

T1 TEST 6 SAMPLE 2 1186

Figure A-13

T1 TEST 6 SAMPLE 2 1186

Figure A-13A

TL TEST 7 SAMPLE 2 1419

Figure A-14

TL TEST 7 SAMPLE 2 1419

Figure A-14A

L2 TEST 1 TAPE 1 SAMPLE 3 430

Figure A415

L2 TEST 1 TAPE 1 SAMPLE 3 430

Figure A-15A

L2 TEST 4 SAMPLE 1 637

Figure A-16

L2 TEST 4 SAMPLE 1 637

Figure A-16A

L2 TEST 5 SAMPLE 3 950

Figure 2-17

L2 TEST 5 SAMPLE 3 950

Figure A-17A

L2 TEST 6 SAMPLE 3 1220

Figure A-18

L2 TEST 6 SAMPLE 3 1220

Figure A-18A

L2 TEST 7 SAMPLE 2 1419

Figure A-19

L2 TEST 7 SAMPLE 2 1419

Figure A-19A

V2 TAPE 3 SAMPLE 1

Figure A-20

V2 TAPE 3 SAMPLE 1

Figure 1-20A

V2 SAMPLE 13 TAPE 4 1333

Figure 2-21

U2 SAMPLE 13 TAPE 4 1333

Figure A-21A

T1 TAPE 3 SAMPLE 12

Figure A-22

T1 TAPE 3 SAMPLE 12

Figure -A-2A

T1 TAPE 3 SAMPLE 4

Figure 1A-23

T1 TAPE 3 SAMPLE 4

Figure 23A

L2 TAPE 3 SAMPLE 6

Figure A-24

L2 TAPE 3 SAMPLE 6

Figure A-24A

L2 TAPE4 SAMPLE 9 964

Figure A-25

L2 TAPE4 SAMPLE 9 964

Figure A-25A