Lawrence Livermore Laboratory

ENVIRONMENTAL TESTS OF THE METEOROLOGICAL DATA ACQUISITION
SYSTEM'S REMOTE STATION

C. C. Aaron, Jr.

May 10, 1976

MASTER

This is an informal report intended primarily for internal or limited external distribution. The opinions and conclusions stated are those of the author and may or may not be those of the laboratory.

Prepared for U.S. Energy Research & Development Administration under contract No. W-7405-Eng-48.

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

CONTENTS

Abstract	1
Introduction	1
Vibration Tests	1
Road Tests	3
Temperature Test No. 1	3
Temperature Test No. 2	3
Appendix: Test Report No. 301706-2	13

MASTER

ENVIRONMENTAL TESTS OF THE METEOROLOGICAL DATA ACQUISITION
SYSTEM'S REMOTE STATION

ABSTRACT

We subjected the Meteorological Data Acquisition (MEDA) remote station hardware to temperature, vibration, and road tests. The MEDA equipment was designed at the Lawrence Livermore Laboratory (LLL) for the Air Resources Laboratory (ARL). ARL supplied all MEDA sensors. The prototype system passed these tests.

INTRODUCTION

The Meteorological Data Acquisition (MEDA) remote stations will collect surface weather data. Temperature and wind speed/direction sensors only were used during these tests, but the stations will accept other sensors.

VIBRATION TESTS

MEDA remote stations will be housed in small, two-wheeled trailers and will receive road vibrations when moving to and from operating locations. During operation the stations are stationary.

These tests were performed to check the rack-mounted equipment. Sensors were not vibrated. In Test No. 1 the rack held the radio shelf, a lead weight equal to the radio weight, and two blank front panels. In Test No. 4 we installed a remote chassis, LEA 74-2209, and we replaced the lead weight with a GE Master II radio.* Figure 1 shows the rack's upper portion in the Test No. 4 configuration.

The appendix gives Dale Norton's Test Report No. 301706-2 describing the procedures and results of these vibration tests.

* Reference to a company or product name does not imply approval or recommendation of the product by the University of California or the U.S. Energy Research & Development Administration to the exclusion of others that may be suitable.

NOTICE
This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Energy Research and Development Administration, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

Fig. 1. System setup for vibration Test No. 4. The upper chassis is the MEDA remote, LEA /4-2209. The GE Master II radio is at the bottom.

ROAD TESTS

We conducted a road test after the vibration test results had been analyzed, with the following changes from the vibration test configuration:

- Deleted top tether cables for easier equipment access and instead secured the top of the rack to the trailer wall.
- Moved radio to rack exterior for easier access.
- Deleted foam rubber vibration mounts and decided to accept the Aeroflex isolators "non-isolation" above 100 Hz.

Figure 2 shows the road test configuration. (LEA 75-188404-AB shows it in more detail.) A remote chassis was in the rack during these road tests; a steel weight simulated the radio.

In this road test we towed the trailer over several Nevada Test Site surfaces of the type used in station deployment. These were asphalt and gravel roads, gravel and dirt roads with rough places and pot holes, and off-road terrain with rocks and bushes. An observer rode in the trailer during the test.

The system passed the test without problems.

TEMPERATURE TEST NO. 1

Temperature Test No. 1 checked equipment operation over the range -40°C to $+60^{\circ}\text{C}$ ambient air. Figure 3 shows the test block diagram. Figure 4 shows the equipment inside the chamber, ready to test. Figure 5 is a plot of chamber air temperature during the test; the data for this plot are given in Table 1.

The only problem encountered in this test was with the wind speed sensor, which stopped turning when colder than -30°C . The anemometer cup's shape became permanently distorted below -35°C .

Temperature data was checked more carefully during Temperature Test No. 2.

TEMPERATURE TEST NO. 2

Temperature Test No. 2 checked equipment temperature measurement accuracy. Figure 6 shows the test block diagram. Figure 7 describes a copper block used to heat couple the MEDA probe to the standard's probes. Figure 8

Fig. 2. Road test configuration.

64-ft³ temperature chamber

1 Four thermocouples were connected to external analog recorders:

2 sensed chamber air

1 sensed LEA 74-2209 interior air

1 sensed LEA 74-2209 power supply module

2 Power voltage and current were recorded

Fig. 3. Temperature Test No. 1 block diagram.

Fig. 4. Equipment inside the chamber, ready to test:
Test No. 1.

Fig. 5. Plot of the chamber air during Test No. 1.

Table 1. Temperature Test No. 1, MEDA system.

Date/time	°F	°C	Date/time	°F	°C
<u>7-1-75</u>			<u>7-7-75</u>		
1515 (start)	75	24.0	0930 (start)	80	26.5
1535	141	60.5	1100	-36	-38.0
2300	142	61.0	1335	-36	-38.0
			1350	10	-12.0
			1420	25	-4.0
<u>7-2-75</u>			1515	35	1.5
0100	142	61.0	1550	36	2.0
0840	141	60.5	1600	39	4.0
0850	72	22.0	1630	48	9.0
0940	66	19.0	1640	70	21.0
0950	139	59.5			
1225	141	60.5	<u>7-8-75</u>		
1350	-38	-39.0	0800	70	21.0
2300	-39	-39.5	0810	89	31.5
			1025	91	33.0
<u>7-3-75</u>			1035	110	43.5
0100	-40	-40.0	1225	111	44.0
0620	-40	-40.0	1230	129	54.0
0830	-40	-40.0	1410	131	55.0
0835	-30	-34.5	1415	148	64.5
0850	-27	-33.0	1525	150	65.5
0852	-20	-29.0	1530	156	69.0
0900	-17	-27.0	1620 (stop)	156	69.0
0925	98	36.5			
9040	100	38.0			
1045	100	38.0			
1050	140	60.0			
1600 (stop)	140	60.0			

is a plot of chamber air temperature during this test; the data for this plot are given in Table 2.

Table 3 contains test readings. During alignment we compensated for the error caused by the particular MEDA sensor's tolerance. The sensor tolerance specification is $\pm 0.3^{\circ}\text{C}$.

Results were within system specifications.

64-ft³ temperature chamber

Fig. 6. Temperature Test No. 2 block diagram.

Fig. 7. Heat coupler. The copper block is $25 \times 75 \times 152$ mm. All holes are on the center line of the 25-mm side. The MEDA probe hole diameter is 3.6 mm, and the HP 2801 probe hole diameters are 10.0 mm. The probes were coated with thermal compound before insertion.

Fig. 8. Plot of the chamber air during Temperature Test No. 2.

Table 2. Temperature Test No. 2, MEDA system.

Date/time	°F	°C
<u>11-25-75</u>		
1600 (start)	75	24.0
1650	128	53.5
2300	128	53.5
<u>11-26-75</u>		
0100	129	54.0
0730	128	53.5
0850	90	32.0
0945	90	32.0
1100	50	10.0
1155	50	10.0
1315	11	-11.5
1405	11	-11.5
1530	-29	-34.0
1620	-28	-33.5
1725 (stop)	80	26.5

Table 3. Temperature Test No. 2 results.

Time	HP 2801 (Rounded to MEDA resolution, °C)	MEDA operate		HP2081 minus MEDA reading °C	MEDA test		10.1°C minus test reading °C
		Raw (octal)	°C		Raw (octal)	°C	
0726	53.5	1657	53.5	0.0	776	9.9	0.2
0940	32.2	1333	32.1	0.1	776	9.9	0.2
1150	9.9	775	9.8	0.1	775	9.8	0.3
1400	-12.2	440	-12.2	0.0	775	9.8	0.3
1615	-34.2	100	-34.4	0.2	774	9.7	0.4

APPENDIX: TEST REPORT NO. 301706-2

August 13, 1975

To: Carl Aaron

From: Dale S. Norton, Systems Test Section

Subject: MEDA Vibration Test

Description

An electronic rack containing Meteorological Data Acquisition (MEDA) remote chassis and radio.

Total Weight

150 lbs.

Purpose

To determine if Aeroflex series C-1260-13 3/16-in. wire rope shock and vibration mounts would be suitable as isolators for transporting the MEDA rack by trailer to and from areas of location.

Tests Performed

1. Static load-deflection of the Aeroflex mounts.
2. Vibration tests at several levels and frequencies of 5 to 500 Hz to determine the frequency response of the complete MEDA rack as it would be mounted in the trailer.
3. Static load-deflection of the neoprene foam rubber LLL stock catalog #5330-40723.
4. Vibration tests using foam rubber mounts in series with the Aeroflex mounts. See Figs. A-1 and A-2.

Test No. 1

From the static load deflection plots:

$$K = \frac{100 \text{ lbs}}{0.19 \text{ deflection}} = 526 \text{ lbs/in.}$$

Fig. A-1. Assembly and installation of foam rubber vibration isolator.

Fig. A-2. Attachment of rack and
tether cables to base
channels, left-front view.
The coil-shaped pieces are
Aeroflex shock isolators.
Foam rubber vibration
isolators are mounted
between Aeroflex isolators
and channels.

Test No. 2: Vibration

Run No. 1: One sweep 5 to 7 Hz, 0.5 in. DA and 7 to 500 Hz at 2.5 g.

The specimen was tethered with 1/8-in. steel cables (Figs. A-3, A-4, and A-5). Cables were tensioned until a compression deflection of 0.02 in. was obtained on the top two Aeroflex mounts. A lead weight equal to the radio weight was bolted to the radio shelf.

Accelerometer locations: one on the lead weight, one on the aluminum base plate directly over one of the Aeroflex mounts.

A severe resonance occurred at 8 to 9 Hz and at 17 to 18 Hz. The radio shelf and weight resonated so badly that the test was halted. Stiffeners of aluminum angle were installed under the radio shelf.

Run No. 2: Sweep from 5 to 7 Hz, 0.2 in. DA and 7 to 500 Hz at 2.5 g.

The radio shelf was greatly improved. The Aeroflex mounts appeared to be too stiff for frequencies from 100 to 500 Hz. Transmissibility over this range of the sweep appeared to be practically 1:1.

Test No. 3: Static Load Deflection of Neoprene Foam Rubber

From the static load deflection plots:

$$k = \frac{51}{0.1} = 510 \text{ lbs/in.}$$

$$K = \frac{68}{0.1} = 680 \text{ lbs/in.}$$

$$K_{\text{average}} = \frac{680 + 510}{2} = 595 \text{ lbs/in.}$$

Before starting Test No. 4, a subplate with two sandwich foam rubber washers was installed under each of the four Aeroflex mounts (Fig. A-1). This permitted decoupling at the higher frequencies that could not be accomplished with the Aeroflex mounts alone.

Test No. 4: Vibration

Runs 1 and 2 were made from 5 to 500 to 5 Hz at 0.050 DA and 2 g. In both of these runs the radio and remote chassis were installed. The 0.050-in. DA, 2-g run level is the expected maximum level that the MEDA rack will see.

The visicorder record shows that the radio shelf Q was 4 in the frequency range of 50 to 70 Hz. There appeared to be no serious resonances. The MEDA rack equipment was operable and did not show any visual physical damage after Runs 1 and 2 of Test No. 4.

Fig. A-3. Rear view of rack mounted on shaker for Vibration Test No. 1. The round piece is a lead weight which simulated the radio.

Fig. A-4. Attachment of rack and tether cables to base channels, rear view. Foam rubber isolators are not installed.

Fig. A-5. Attachment of tether cables to rack top.

In conclusion it appeared that the Aeroflex mounts would adequately serve for a road chuckhole-type shock because of their unusual characteristic of becoming softer with increasing load, rather than stiffer. The combination of the Aeroflex and the foam rubber would more than adequately isolate over the frequency range of 5 to 500 Hz.

D. S. Norton
Systems Test Section

DSN/df
Att.
Distribution:
C. Aaron
K. Volkman

NOTICE

"This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Energy Research & Development Administration, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately-owned rights."

Printed in the United States of America
Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161
Price: Printed Copy \$; Microfiche \$2.25

<u>Page Range</u>	<u>Domestic Price</u>	<u>Page Range</u>	<u>Domestic Price</u>
001-025	\$ 3.50	326-350	10.00
026-050	4.00	351-375	10.50
051-075	4.50	376-400	10.75
076-100	5.00	401-425	11.00
101-125	5.25	426-450	11.75
126-150	5.50	451-475	12.00
151-175	6.00	476-500	12.50
176-200	7.50	501-525	12.75
201-225	7.75	526-550	13.00
226-250	8.00	551-575	13.50
251-275	9.00	576-600	13.75
276-300	9.25	601-up	*
301-325	9.75		

*Add \$2.50 for each additional 100 page increment from 601 to 1,000 pages:
add \$4.50 for each additional 100 page increment over 1,000 pages.

KC/11/bj/lmc

Technical Information Department

LAWRENCE LIVERMORE LABORATORY

University of California | Livermore, California | 94550