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UCRL - 73816
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CONF-720312--10

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PORTABLE DATA SYSTEM

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March 17, 1972

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This paper was prepared for presentation at
UNDERGROUND NUCLEAR TEST MEASUREMENT SYMPOSIUM II

Stanford Research Institute
Menlo Park, California
21-22 March 1972

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UCRL - 73816

PORTABLE DATA SYSTEM (U)*

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ABSTRACT:

A compact, shock resistant, portable instrumentation system for dynamic measurements at remote areas has been recently developed. The tape recorder, signal conditioners, VHF receiver, power supplies, etc., for up to 30 data channels fit in a 11" x 15.5" x 21.5" weatherproof case. The battery powered system can be operated locally or by remote control via radio link or hardwire signals.

Prototype units of this system have been used for ground motion and structural response measurements during CANNIKIN, MINIATA, and CARPETBAG events and a DOD-Sandia event. It is estimated that these measurements were made at one-fifth (1/5) the cost of conventional systems.

Many features of the system contribute to this significant reduction in cost, but the major factor is its portability. This system does not require support for transportation, shock mounting, diesel generators, air conditioners, or a work trailer in the field. Other major features that contribute to the cost reduction are pre-calibration of transducer and system set-up and check-out prior to installation in the field.

Characteristics of the system and results of typical measurements are presented in this paper.

PURPOSE OF PORTABLE DATA SYSTEM:

The primary purpose of this system is to record dynamic data on the response of various structures to ground motion produced by underground nuclear detonations. Many desired measurements are at remote areas, i.e., locations not directly associated with the particular event, and, therefore, command signals are not available except via radio. In some cases the instrumentation must be installed the day before the event and the measurement system must therefore be passive and not interfere with the primary program of the event.

*Work performed under the auspices of the U.S. Atomic Energy Commission

SYSTEM REQUIREMENTS:

The primary requirement of this portable data system is to provide a low-cost reliable instrumentation system that can be operated in remote areas and in severe environments.

The original basic requirements for this system were:

1. Portable suitcase-type units.
2. Battery powered.
3. Control signals via standard radio links.
4. Record through ground shock arrival with shock accelerations up to 30 g.
5. Operate outdoors in remote areas under test site environmental conditions.
6. Electronically compatible with NTS and STS systems.
7. Minimum number and cost of cables.
8. Transducers: "Standardized" mounting brackets and canisters; Accelerometers; gage ranges from ± 1 to ± 50 g. Velocity gages; gage ranges from ± 1 to $50 \pm$ fps. Strain gages; from 100 to 6000 μ inches.
9. Unit capacity: minimum of 3 gages per recording package.
10. Total capacity: about 40 gages at any one time.
11. Minimum interference with other programs.
12. Minimum maintenance and operational adjustments in the field.

DESCRIPTION:

We have recently developed a system that meets the above requirements. It is based on FM multiplexing at or near the transducer and remote recording with shock resistant components. Two basic units make up the system: (1) recording and control unit and (2) transducer assemblies. Block diagrams of these units are shown in Fig. 1 and 2. A typical set up of this system at a remote location is shown in Fig. 3. The recording and control unit is in the foreground and the transducer assemblies are in the upper right corner.

RECORDING AND CONTROL UNIT:

The recording and control unit is the heart of the system. This unit provides control, distributes power, and records the multiplexed data channels on magnetic tape. The tape recorder is a 3 track, air-borne unit capable of recording during a 100 g shock environment in each of the three major orthogonal axis. The frequency response range for ± 3 db is from 1 to 100 kHz. This Astro-Science Corporation Model ART-600 recorder operates in 28 Vdc with a recording time of 4 minutes at 30 ips. A 100 kHz reference signal is multiplexed on one tape track and a 93 kHz FM time code is added on another track.

EG&G was finishing development of the Auxiliary Command System at the same time we procured several ART-600 tape recorders as surplus equipment from other ILL programs. The Auxiliary Command System was developed to provide command and control signals for remote installations.

Operating command signals are received over a VHF radio link by an Auxiliary Command Slave Unit. The watertight case of a slave unit is 11 x 15.5 x 21.5 inches and the system was designed to operate in exposed locations with a 30 g shock environment. For our use a slave unit includes a VHF receiver, power supply, synchronizer module and one command module with six relay closures. These are the dark components shown in Fig. 4. These modules left just enough room for installing the tape recorder and associated electronics (white components in Fig. 4) into the slave unit case. When hardwire signals are available the VHF receiver module is deleted.

TRANSDUCER ASSEMBLY:

This assembly consists of the transducing elements, electronic circuits, container and mounting brackets. The two basic configurations for these assemblies are shown in Fig. 2. The transducing element can be an accelerometer, velocity gage, displacement gage, strain gage or pressure transducer. Many types of transducers are available and the preferred type for a given application depends on the transducer environment and desired data.

A block diagram of a typical surface ground canister is shown in Fig. 2a. In this application the accelerometers are usually unbonded strain gage types, preferably with integral amplifiers built into their base. The velocity gages are the variable reluctance overdamped pendulous accelerometer type that has been used in earth motion measurements for many years (see Ref. 1 for a detailed discussion). This portable system uses the newer FM type where the transducer frequency modulates a dual oscillator circuit. The FM transducer electronics includes a

dual oscillator, calibration circuit, balanced modulator and bandpass filter. The present circuits are an improved version of the one designed by Mr. Sam Spataro (Ref 2) and are still being evaluated.

FM multiplexing is the most convenient means of combining the accelerometer's analog signals and the velocity gages's FM signals. The analog signals are converted to FM through voltage controlled oscillators (VCO's). All FM signals are then combined through a mixing amplifier and routed directly to the tape recorder.

IRIG $\pm 7.5\%$ proportional-bandwidth channels are used in the ground canister as shown in Fig. 2a. Channel assignments are based on data and transducer frequency requirements. Transducer temperatures are recorded when velocity gages are used.

For response and miscellaneous measurements a signal conversion unit is used (see Fig. 2b). This unit is the hub for distributing power and multiplexing signals when individual transducers are attached to separate structures at various locations. Transducers may be located several hundred feet from the signal conditioning unit and therefore analog amplification is accomplished at or near the transducer when required. The VCO's are bypassed when FM transducers are used. IRIG channel type and frequency are selected in accordance with data and transducer requirements and the tape recorder's capacity. In some cases this system is used to measure the response of shock mounted electronic equipment that is being used in a major program. In these cases all components of the portable system are electrically isolated from the other system.

Signal cables between the ground canister or signal conditioning unit and the recording and control unit are a pair of shielded cables and can be up to 6000 ft long.

This system has inherent high reliability because of its ruggedness and simplicity. Operating costs are also minimized because the system can be preassembled, set up and checked out in a shop before sending it to the field.

TYPICAL APPLICATIONS:

This system has been used successfully several times during the past year. One use was during MINIATA event where the surface ground motion at a nearby cased hole was measured. In this case the system was installed in the field a few days before the event. Some of the data is shown in Fig. 5.

Another recent application was during CAMBIKIN event at Amchitka Island. The ground motion at the recording trailer park (RTP) and the response of (9) shock mounted instrumentation and power trailers was measured. In this case the portable system interacted with other systems and was installed early in order to participate in the mandatory dry runs. It took about one day to install the system with 18 data channels.

The vertical ground motion at the RTP was over 11 ft yet all systems performed quite well. A few of the results are shown in Fig. 6.

The system has also been used to verify the input and response shock environment experienced by some of the new NADS electronic equipment located in a tunnel alcove during the event.

ACKNOWLEDGMENT:

I wish to thank the many people here at LLL who have helped on this system. I am especially indebted to the following EG&G personnel who have been responsible for the development and fielding of this system: Messrs P. Mulhall, J. Montgomery and D. Jackson.

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A = Accelerometer
 U = Velocity gage
 H = High level
 L = Low level

V = Vertical
 R = Horizontal-radial from SGZ
 T = Horizontal-tangential from SGZ
 SGZ = Surface ground zero

Figure 2 - Block Diagram of Transducer Assemblies

Figure 1 - Block Diagram of Recording and Control Unit

Figure 4 - Recording and Control Unit with Cover Removed

Figure 3 - Typical Remote Field Set-up of Portable Data System

Figure 5a - Vertical Surface Ground Motion at U4d during MINIATA Event

Figure 5b - Vertical Surface Ground Motion
at U4d during MINIMATA Event

Figure 6b - Vertical Surface Ground Motion and Trailer Response
at RTP during CANNIKIN Event

Figure 6a - Vertical Surface Ground Motion and Trailer Response at RTP during CANNIKIN Event

Figure 6c - Vertical Surface Ground Motion and Trailer Response at RTP during CANNIKIN Event