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TITLE: A MULTIPURPOSE RADIAC FOR FIELD SURVEYS AND TRAINING

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A MULTIPURPOSE RADIAC FOR FIELD SURVEYS AND TRAINING

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Abstract

The Instrument Technologies Group at Los Alamos has developed a multipurpose radiac. It uses a variety of detectors coupled with a CMOS microprocessor to provide ease of use and an unambiguous display. It allows concurrent surveys for alpha, beta, gamma, and neutron radiation. In addition, it has an external data link for coupling to and from data acquisition/storage equipment, hence making it a perfect training tool. The instrument is small (4x8x2.5 in.) and lightweight (<2 lbs.). It runs for 50 hours on common batteries.

Introduction

When a nuclear accident occurs, it is important to be able to rapidly assess the spread of contamination. This contamination can be of several forms, each with its own characteristic pattern of radiation. This assessment must also be made with minimum exposure of personnel to harmful radiation.

In the past, such a survey has been done with several personnel using a variety of instruments. There have been alpha detectors and beta/gamma detectors of several types. In addition to the obvious waste of time and manpower necessitated by the multiple surveys for different radiation types, the maintenance problems associated with having several types of instruments in the field require a large stock of spares. Further, the operators must be trained in the use of these instruments, each of which has its own peculiarities.

In order to address these problems, the Instrument Technologies Group at Los Alamos has developed a multipurpose radiac. Based on our earlier work [1], this instrument employs a variety of detectors coupled with a microprocessor. It is designed to measure alpha and gamma radiation as well as detect the presence of significant amounts of beta and neutrons. Since the instrument is controlled by a microprocessor, the presentation of data to the operator has been made unambiguous and the operator controls have been simplified to only 3 pushbuttons, On/Off, Backlight, and Alpha/Gamma.

General Description

The complete instrument is 4"x8"x2.5" and weighs approximately 2 pounds. It is powered by 2 nine-volt transistor radio batteries. Battery life is approximately 50 hours. Space is provided for 2 spare batteries. It might be interesting to note that the size and weight of this instrument is less than just the probe on a PDR 56 alpha meter, which is one of the instruments it was designed to replace.

The display is unambiguous and auto-ranging. It has both a 3-digit digital

display and a 4-decade log bargraph. Annunciators display the type of radiation being currently displayed, the units of measure (CPM, mR/hr, etc.), and condition of the battery.

In addition to the benefits in operator interface provided by the microprocessor, it also provides several features unavailable in any other similar instrument. One is a self-check mode. This allows the instrument to go through a self-diagnostic routine upon powerup to insure that it is functional. Another is the addition of a serial data interface to allow the radiac to be coupled to other instruments such as a position-sensing transponder [2], to enable faster, more complete field surveys to be accomplished.

Electronics Design

The electronics in the radiac are shown in the block diagram (Fig. 1). There are 5 separate detectors, 3 silicon surface barriers (SSB) and 2 Geigers. One SSB detector is positioned behind an opening covered with metallized Mylar and is used to detect alpha particles. The second SSB has a covering of 18-mil Teflon. This detector is used to detect beta particles. The third SSB has a covering of polyethylene and is inside the case. This detector senses neutron fields by detecting knockout protons from the poly. The Geiger tubes are of two sizes to cover the large dynamic range required. The larger tube covers the range up to 1R/hr, while the smaller one covers the range from 2R/hr to 500R/hr.

Figure 1

The detectors are coupled via suitable signal conditioning circuits to scalars. These scalars are read by the CMOS microprocessor and the data stored and displayed as required. The display is a custom liquid crystal (LCD). It was designed to operate over an extended temperature range (-40C to +55C). The microprocessor is coupled to a serial data link which is used for a variety of applications, in addition to the position-sensitive transponder mentioned above. Some of these include auto calibration, data links or data loggers to free the operator from having to record readings, and others. The link is bidirectional and the software allows simulated data and alarms to be transmitted to the radiac for training purposes.

Functional Description

Since the instrument is intended for use by emergency response teams, the operation of the radiac has been simplified as much as possible to enable the operator to concentrate on making the survey rather than on operating the radiac. In keeping with this concept, there are only 3 operator controls: On/Off, Alpha/Gamma, and Backlight. On/Off is the power control; Alpha/Gamma switches the display between CPM of alpha and R/hr of gammas; Backlight turns on an electroluminescent backlight for the display to enable it to be read in darkness.

The beta and neutron detectors are used as alarming devices only and flash annunciators on the display when the beta or neutron fields exceed preset thresholds.

The display consists of a 3-digit numeric display, a 4-decade log bargraph, a battery status indicator, and annunciators for alpha, beta, gamma, and neutron. The digital display is autoranging and unambiguous, making it easy for the operator to make error-free readings.

Summary

The combination of a variety of detectors and microprocessor control has made a uniquely useful and easy-to-use instrument. It has the potential to make accident response surveys faster and safer for personnel. The instrument is a convenient size and allows one-handed operation. The operation has been so simplified that operator training requirements are minimal. The addition of a data link allows the instrument to be coupled to data acquisition devices, allowing the operator to concentrate on the task at hand without worrying about recording individual readings. The same data link allows the radiac to be used for personnel training by inputting simulated radiation data into the device.

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Figure 2