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A DUAL-RANGE ALPHA COUNTER FOR
HEALTH PHYSICS OPERATIONS

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Research and Ecology
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CONTENTS

Abstract	1
Introduction	1
Discussion	1
Mechanical Package	1
Electronic Circuitry	2
Costs	3
Summary	3

A DUAL-RANGE ALPHA COUNTER FOR HEALTH PHYSICS OPERATIONS

William H. Tyree

Abstract. A mobile, transistorized two-range alpha particle counter is described. The unit has the capability of detecting alpha-particle radiation with two air-proportional detectors. Integrated circuits and discrete components used in the unit provide pulse amplification, normalization, and current drive to a rate meter and aural readout. The system provides a low-power, low-cost counter for use within a process area for more reliable radioactivity-contamination control.

INTRODUCTION

The counter system described was developed for plutonium contamination control in industrial process areas, and is the outgrowth of several generations of similar instrument developments. The instruments provide the capability of detecting alpha-particle emitting materials, using air-proportional detectors. The counter can be easily moved to central locations in radioactive-material handling areas. In such locations, convenient access to the counter enables

operating personnel to check themselves for the presence of radioactive material.

DISCUSSION

Mechanical Package:

The two-scale, alpha-particle counter is shown in Figure 1. The unit weighs 68 kilograms (kg) and has dimensions of 60 centimeters (cm) wide by 49 cm deep by 120 cm high. Two air-proportional detectors for alpha-particle radiation are used. One detector (a), 15.5 by 35.5 cm, mounted within the cabinet near the floor, is used for checking the soles of shoes and shoe covers. Another detector (b), 5.1 by 25.4 cm, for monitoring hands is mounted sensitive side out at the top of the waist-high cabinet. The latter detector (b) (back view) is connected through a 122-cm cable to the instrument panel. The active detector desired is selected by a toggle-switch located on the front panel.

FIGURE 1. Two-Scale, Alpha-Particle Counter Showing Two Detectors (a) and (b).

15584-5

Access to the interior of the cabinet is obtained through two doors on the back of the unit (see Figure 1). The small door (1) located at the top of the units provides access to the electronics and batteries which are noted at bottom of Figure 2. The bottom door (2) provides access to the cable connecting the foot probe to the electronics in the top of the unit.

Electronic Circuitry:

The electronics of the unit provides for pulse amplification, normalization, and readout drive on one printed-circuit board. The box containing the board also holds the inter-connecting plugs for the high voltage input to the detector circuits and detector cables. An output plug connects the front panel controls to the circuit board. The board is mounted in an aluminum box 17.5 by 17.5 cm. The block diagram and schematic of the unit are given at end of text (see Figure 4, Page 3 and Figure 5, Page 4-5).

The circuit includes two separate amplifiers and trigger circuits with a common speaker and meter-drive circuit. The circuits produce standard pulses from signals received from the output of the external particle detectors. The width of the pulses produced from the output monostable

multivibrator is dependent upon the scale factor required in the meter circuit. Widths are 35 milliseconds (msec) for the small detector, and 12 msec for the large detector. The pulse widths produce full-scale deflection in the meter circuit for 500 counts per minute for the small detector, and 3000 counts per minute for the large detector.

The output of the monostable multivibrator is controlled by an external switch on the front panel of the counter. The monostable multivibrator, which is allowed to trigger, produces the drive pulse for the operation of the audio and rate-meter circuits.

The audio-drive circuit is a three-transistor, Darlington-configuration current driver. The pulse produces a large current pulse through a 45-ohm speaker. The meter-drive circuit has a resistance parameter in the base circuit of the output transistor to calibrate the full-scale response of the meter.

The rate-meter scales of the unit represent 0 to 500 counts per minute for the small detector and 0 to 3000 counts per minute for the large detector. The meter does not have a

FIGURE 2. Interior of Cabinet Showing Top of Unit (close-up view).

15584-7

calibration in counts per minute, only two colors. The lower half of the scale is green and the upper half is red.

The power dissipation of the unit (Figure 3) represents the total system power consumed at the indicated pulse-counting rate. In Figure 4, the block diagram of the system shows details. The schematic in Figure 5 provides the key to the various components.

Costs:

The system with complete electronics, batteries, and housing (without detectors) has been built for approximately \$500 in quantities greater than ten units. The cost of the hand detector was \$10 in large quantities, and for the foot detector a cost of \$25 in small quantities.

SUMMARY

A two-range, alpha-particle counter with 0 to 500 and 0 to 3000 counts-per-minute scales has been built. The unit is housed in a waist-high cabinet and may be easily moved to various locations within a process area.

The electronic circuit uses integrated circuits and discrete components to amplify and normalize the pulses received from the air-proportional detectors. The pulses produced

are 35 milliseconds (msec) for the small air-proportional detector and 12 msec for the large detector. The circuits require 3 milliwatts of power for quiescent operation, and produce readout pulses for rate-meter drive and speaker actuation. The system costs approximately \$500 for quantities of greater than 10 units.

FIGURE 3. Power Consumption versus Pulse-Count Rate.

FIGURE 4. Block Diagram of Hand and Foot Counter.

FIGURE 5. Schematic Diagram of Hand and Foot Counter.

FIGURE 5. (continued)