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DP-856

AEC RESEARCH AND DEVELOPMENT REPORT

# A SENSITIVE RADIATION MONITOR FOR A LARGE LABORATORY AREA

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DP-856

Instruments  
(TID-4500, 23rd Ed.)

A SENSITIVE RADIATION MONITOR  
FOR A LARGE LABORATORY AREA

by

LeConte Cathey  
Richard A. Moyer

Approved by

J. L. Crandall, Research Manager  
Experimental Physics Division

November 1963

E. I. DU PONT DE NEMOURS & COMPANY  
EXPLOSIVES DEPARTMENT - ATOMIC ENERGY DIVISION  
TECHNICAL DIVISION - SAVANNAH RIVER LABORATORY  
AIKEN, SOUTH CAROLINA

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#### ABSTRACT

An instrument has been built to survey releases of radioactivity within the 22-acre enclosure of the Savannah River Laboratory. The device consists of a 2-in.-diameter x 2-in. sodium iodide scintillation crystal with associated detector counting and recording circuits which provide a permanent record of radioactivity movements within the Laboratory area. The monitor detects signals of 6.9  $\mu\text{r/hr}$  from a 0.48-curie cobalt-60 source located 265 ft away.

CONTENTS

	<u>Page</u>
Introduction . . . . .	4
Discussion . . . . .	4
Description of Area Monitor . . . . .	4
Instrument Performance . . . . .	7
Determination of Monitor Sensitivity . . . . .	7
Interpretation of Monitor Data . . . . .	10
References . . . . .	11

LIST OF FIGURES

<u>Figure</u>		
1	Detector Housing . . . . .	4
2	Detector Chassis . . . . .	5
3	Circuit Diagram . . . . .	6
4	Continuous Monitor Record . . . . .	8
5	Radiation Transparency Measurements . . . . .	9
6	Laboratory Area Map . . . . .	10

# A SENSITIVE RADIATION MONITOR FOR A LARGE LABORATORY AREA

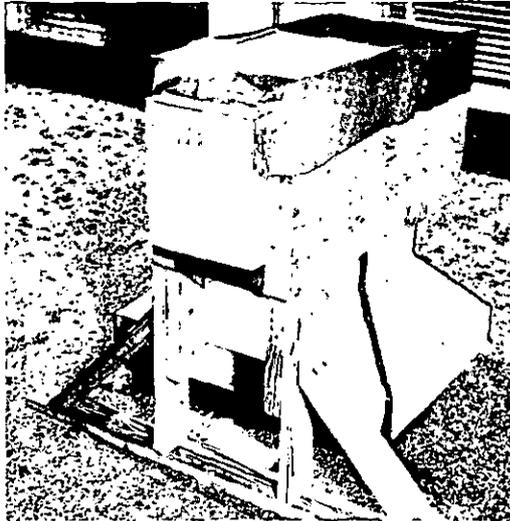
## INTRODUCTION

Large quantities of irradiated reactor fuel pieces, irradiated fuel processing solutions, separated radioactive isotopes, and other radiation sources are handled at the Savannah River Laboratory. To safeguard these various operations, an elaborate system of safety devices, radiation monitors, and handling procedures is in operation. In general, however, such safety precautions are more concerned with the individual operations than with the Laboratory as a whole. Since the Laboratory area is a 22-acre enclosure containing five buildings, a radiation monitor is needed to survey the Laboratory as a unit<sup>(1)</sup>, to supply the operators of low level counting equipment with information on significant changes in gamma background, and to detect the presence of an abnormal radiation level anywhere within the Laboratory work area.

## DISCUSSION

### DESCRIPTION OF AREA MONITOR

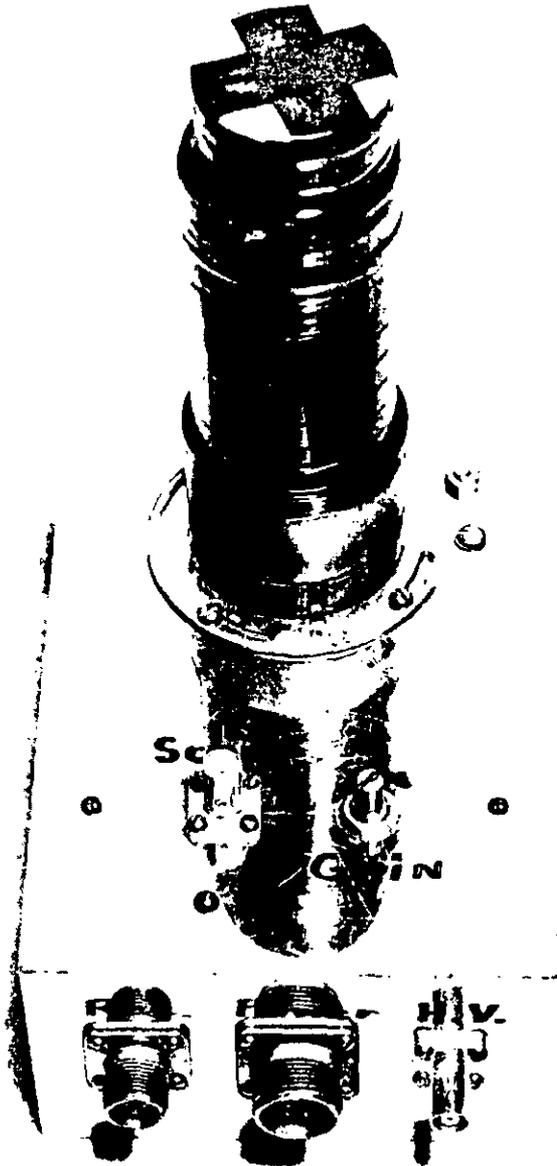
A very simple gamma detection device was built to provide area radioactivity monitoring for the Savannah River Laboratory. The area monitor is mounted on the roof of the main Laboratory building. Figure 1 shows the instrument housing.



STI - 650

FIG. 1 DETECTOR HOUSING

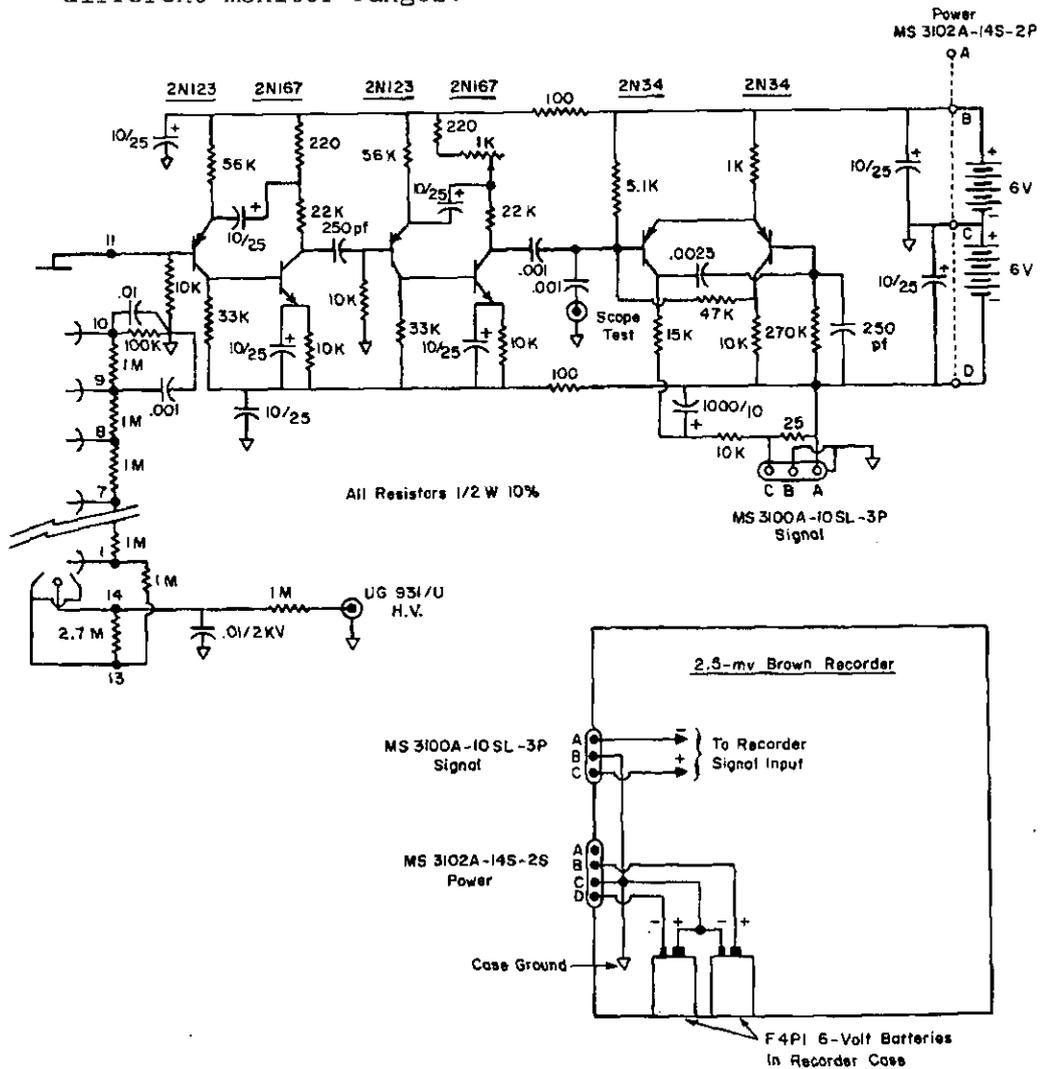
The detector and amplifier chassis is shown in Figure 2. The 1-1/2-in.-diameter x 1/2-in. NaI(Tl) crystal shown on the photomultiplier was used for circuit tests. A 2-in.-diameter x 2-in. crystal is used for the actual monitoring.



ST1-651

FIG. 2 DETECTOR CHASSIS

The circuit diagram of the monitor is shown in Figure 3. This transistorized pulse amplifier and count rate circuit are similar to a previous design except for the scintillation detector<sup>(2)</sup>. A pulse height discriminator maximizes the response to gamma rays between 40 kev and 1 Mev, thus eliminating most of the counts due to very soft cosmic rays. The circuit amplifies the detected pulses to a maximum pulse height of 2.5 volts. The maximum count rate that may be recorded by the system is 2000 counts/second; however, the resistor shunting the recorder input may be changed to select different monitor ranges. Changing the shunt resistor rather than the count rate RC circuit has the advantage of not altering the time constant of the discriminator and results in a stable system with a close correlation between the different monitor ranges.



ST1-652

FIG. 3 CIRCUIT DIAGRAM

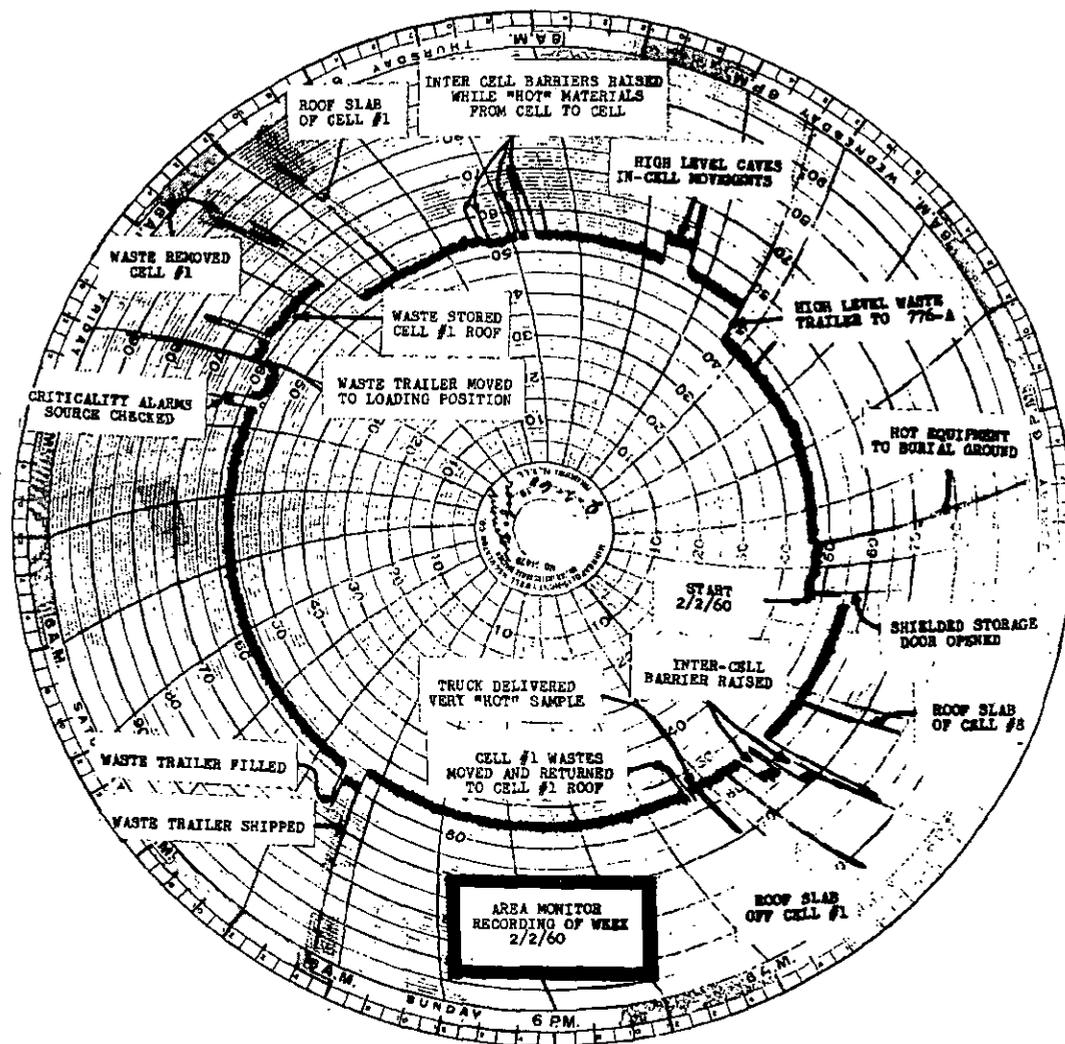
The output from the pulse amplifier is recorded on a circular chart Brown recorder with a chart cycle of one week. Typical recorder outputs are shown in Figure 4. The recorder actuates an alarm bell at a preselected level of radiation.

#### INSTRUMENT PERFORMANCE

The instrument was initially installed on the Laboratory roof without any special heating or cooling provisions. Although this arrangement worked well during the winter months, the summer heat reduced the monitor sensitivity by a factor of about 5 and finally softened the seal around the crystal until the crystal was released from its housing. The temperature problem was solved by exhausting 800 cfm of building air through the detector housing. The monitor has now operated very satisfactorily for almost four years.

#### DETERMINATION OF MONITOR SENSITIVITY

In order to delineate the area of "vision" of the area monitor, an experiment was performed moving an unshielded 0.48-curie cobalt-60 source through the Savannah River Laboratory building. Readings on the roof monitor and on a second monitor located directly under the roof were noted. The roof is made of reinforced concrete 4 to 8 inches thick and provides significant shielding. The results of the survey are shown in Figure 5. The monitor readings are in microrentgens/hour; the upper number is the reading obtained from the roof monitor and the lower number is the reading obtained from the under-roof monitor. These experiments demonstrated that the monitor could reliably detect changes in radiation levels of 2.3  $\mu\text{r/hr}$ . Although somewhat better results were obtained for the main Laboratory building with the subroof monitor, the sensitivity of the roof top monitor was still adequate, and the roof location was preferred because of the extra sensitivity it gave in surveying the outlying area. A notable result of the survey is the fact that ordinary furniture or partitions offer almost negligible shielding against the cobalt-60 source.



ST1-653

FIG. 4 CONTINUOUS MONITOR RECORD



## INTERPRETATION OF MONITOR DATA

The area monitor is used by the SRL Radiation Control group as an aid in their control of radiation hazards at the Savannah River Laboratory. The roof-mounted area monitor provides continuous surveillance over the 22-acre Laboratory area shown in Figure 6. Recorded changes in gamma background

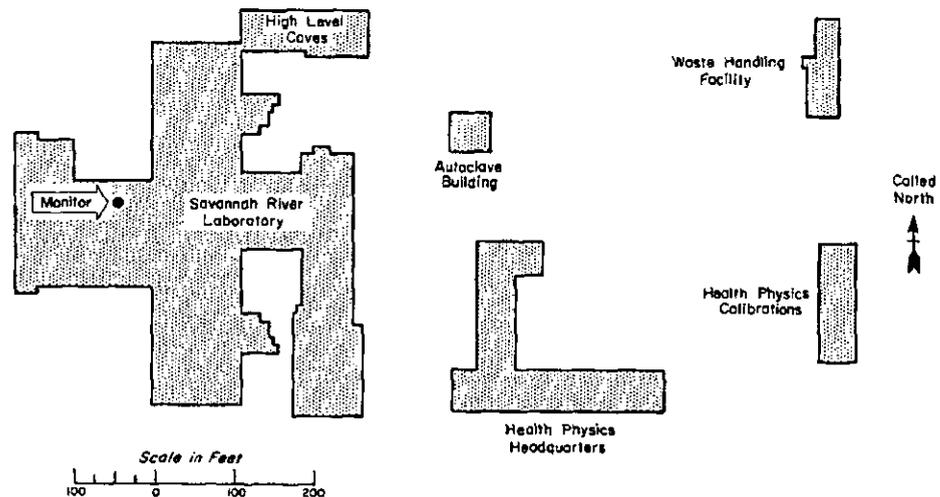


FIG. 6 LABORATORY AREA MAP

STI-655

are utilized to verify scheduled gamma excursions, detect unscheduled gamma excursions, and to decrease the number of repetitive surveys of known "hot" conditions. Routine operations in the high level caves in handling irradiated fuel elements account for greater than 90% of the gamma peaks detected by the monitor. An unexpected change in gamma background prompts a survey to determine the cause of the change.

The monitor records shown in Figure 4 depict some typical examples of events detected by the monitor. These include movements of hot waste within and from the area, intercell movements of highly radioactive materials in the high level caves, movements of the high level liquid waste trailer, and the handling of special radioactive materials within the Laboratory. Besides warning of any activity releases, the monitor charts also provide a permanent record of such releases. Such a record is particularly useful for the night shifts, when radiation control coverage is reduced. It also provides background information for a Health Physics Bio-Assay Group who are engaged in low level counting of biological materials in an adjacent building.

## REFERENCES

- (1) Cathey, L. "Area Radiation Monitor". Proceedings of the Sixth Tripartite Instrumentation Conference, Part 2: Radiation Dosimetry and Health Instruments, pp. 52-54. Atomic Energy of Canada Ltd., Chalk River, Ont. Report AECL-802 (1960).
- (2) Cathey, L. "Low Level Alpha Counting with Solid State Detectors". IRE Trans. on Nuclear Sci., Vol. NS-8, pp. 10-15 (1961).

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Report Number DP-856 S C (U) Approved by TLL NSR 9/9/63

Author(s) L. Cathey, & R. A. Moyer

Title A Sensitive Radiation Monitor for a Large Laboratory Area

Division Experimental Physics

Indicate known prior art \_\_\_\_\_

Approval (Introduction, Summary, Cover Letter) Internal Decision 8-20-63 (M. J. ...)  
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December 10, 1963

Mr. R. G. Erdley, Chief  
Patent Branch  
Savannah River Operations Office  
U. S. Atomic Energy Commission  
Post Office Box A  
Aiken, South Carolina

Dear Mr. Erdley:

REQUEST FOR PATENT REVIEW

Please review for patent matter:

DP-856, A Sensitive Radiation Monitor for a Large  
Laboratory Area, by L. Cathey and R. A. Moyer

If any technical clarification is needed please call J. E. Beach  
whose document review is attached.

Please telephone your comments to the TIS Office (Ext. 2765) and send  
me a confirming letter.

If you decide to pursue a patent on any development covered, I shall  
be happy to supply additional information required such as appropriate  
references and the names of persons responsible for the development.

Very truly yours,

Hood Worthington, Director  
Technical Division

By: J. E. Beach  
J. E. Beach

December 10, 1963

TECHNICAL DIVISION  
SAVANNAH RIVER LABORATORY

MEMORANDUM

TO: S. W. O'REAR

FROM: J. E. BEACH *JEB*

DOCUMENT REVIEW

Document: Report DP-856  
Title: A Sensitive Radiation Monitor for  
a Large Laboratory Area  
Authors: L. Cathey, R. A. Moyer  
Contractual Origin: AT(07-2)-1  
Present Classification: Unclassified  
References: 1) L. Cathey, "Area Radiation Monitor", ARSL-802,  
p. 52-4 (1961)  
2) L. Cathey, "Low Level Counting with Solid State  
Detectors", Transactions JNIS (IRE) pp. 10-15  
(Raleigh, N.C., 1961).

No items were noted that, in my opinion, should be called to the attention of the AEC for patent consideration.

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January 6, 1964

Mr. W. P. Overbeck, Director  
Savannah River Laboratory  
E. I. du Pont de Nemours and Company  
Aiken, South Carolina

Dear Mr. Overbeck:

The following items have been reviewed for all considerations,  
except for patents and classification.

DP-856 - "A Sensitive Radiation Monitor for a Large Laboratory  
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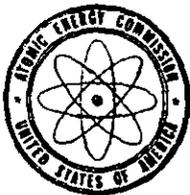
Mr. O'Rear's office was so notified by telephone this date.

Sincerely yours,

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G. O. Robinson  
Assistant to the Manager

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December 27, 1963

Mr. W. P. Overbeck, Director  
Savannah River Laboratory  
E. I. du Pont de Nemours and Company  
Aiken, South Carolina

Dear Mr. Overbeck:

The following items have been reviewed for all considerations,  
except for patents and classification.

DP-856 - "A Sensitive Radiation Monitor For a Large Laboratory  
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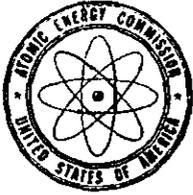
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December 26, 1963

Mr. Hood Worthington, Director  
Technical Division, AED  
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Wilmington 98, Delaware

Dear Mr. Worthington:

Subject: **REPORT NO. DP-856**

**Title: A SENSITIVE RADIATION MONITOR FOR A LARGE LABORATORY AREA**

**Authors: L. CATHEY AND R. A. MOYER**

The above-identified document, transmitted with your letter of December 10, 1963, has been reviewed by this office and from a patent standpoint there is no objection to release as proposed.

The TIS Office has been notified by telephone of the above determination and the draft copy of the above document is being returned.

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Randall G. Erdley, Chief  
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cc: J. E. Beach, SRL, w/encl.

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