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AEC RESEARCH AND DEVELOPMENT REPORT

PROTOTYPE MONITOR FOR AIRBORNE IODINE AND FISSION PRODUCTS

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Instruments
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PROTOTYPE MONITOR FOR AIRBORNE IODINE AND FISSION PRODUCTS

by

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ABSTRACT

The design is presented for a new system for monitoring gases from the dissolution of irradiated uranium in radiochemical separations processes at the Savannah River Plant. The system includes filter paper and activated charcoal to trap particulate activity and iodine vapor; as activity builds up, it is detected by a concentrically mounted GM tube. Early operating experience is also discussed.

PROTOTYPE MONITOR FOR AIRBORNE IODINE AND FISSION PRODUCTS

Gases from the dissolution of irradiated uranium in radiochemical separations processes at the Savannah River Plant contain small amounts of radioactive iodine, fission products, and noble gases. Careful monitoring of the gases is necessary for protection against abnormal releases of I_2 and fission products (principally Ru) to the environment.

I^{131}, present in dissolver gases as a vapor, causes the greatest concern because it can disperse over a wide area and become a health hazard. The fission products in the gases are attached to particles, which can also be dispersed as they leave the stack. An instrument to monitor dissolver gases must distinguish between radioactivity from iodine and fission products and from that of noble gases.

Background

A caustic scrubber and a single channel pulse height analyzer were formerly used to collect and measure the activity in dissolver-gas samples. Samples of gas were bubbled through an aqueous solution of NaOH to remove iodine and other fission products; the caustic solution was then passed by a sodium iodide (Tl) crystal and counted. A single channel pulse height analyzer was set to detect the 0.36-Mev peak for I^{131}.

Operation of this equipment was not satisfactory. Accurate measurements were difficult because spurious counts were introduced into the 0.36-Mev region by scatter from higher energy disintegrations. The average indicated error, from this and other sources, compared to laboratory counting, was +158%. The error ranged from -46% to +2430%.

Maintenance required by the scrubber system and analyzer was excessive. The agitator, mechanical components, pumps, and valves leaked and required frequent repair. The electronic equipment was corroded by chemical vapors which (along with other troubles) rendered it inoperative for as many as 6 days per month. In addition, a calibration routine had to be performed each day to ensure proper operation of the monitor.

New Monitor

A new monitoring system (Figure 1) was designed with a filter paper and an activated charcoal canister. Gas passes through the monitor at a rate of 5 cfm, and the activity is trapped on the combination filter-adsorber (Figures 1 and 2). Particulate activity (primarily Ru^{106}) is trapped on the filter paper and gaseous activity (primarily I^{131}) is trapped on the activated charcoal. As activity builds up, it is detected by the concentrically mounted GM tube; the amount detected is indicated on a log count rate meter and recorder. When the activity goes above a preset point, an alarm is sounded. If identification of individual isotopes is required, the filter assembly may be readily removed for counting with a scintillation probe and multichannel pulse height analyzer.

The four principal sources of error are:

- Sampling errors, which were also a problem with the old system, are due to nonuniform sampling and line losses. These errors vary with process conditions, but are generally less than ±15% for I^{131}.
- Variations in instrument filter and adsorber efficiency cause an error of less than ±15%.
- Instrument accuracy is about ±20%.
- Noble gas background is a problem for only a short time after a new filter is installed. At the point of sampling, xenon and krypton activity in a gas sample will be five to twenty times that of other fission products.

Accumulation of these errors could lead to a result which is in error by 50%. This error is not excessive for an instrument of this kind that covers five decades.

Figure 2 is a cross-sectional view of the prototype detector cell. Sample gas flows in at the top left, through the filter, and out at the lower right. Activity is captured on the filter paper or on the surface of the charcoal. The GM tube in the center of the assembly measures the activity. A thin shield is placed around the GM tube to prevent it from becoming contaminated in event of a filter breakthrough. Stainless steel construction is used throughout the cell to prevent corrosion. Lead shielding is placed around the detector to reduce the background count.

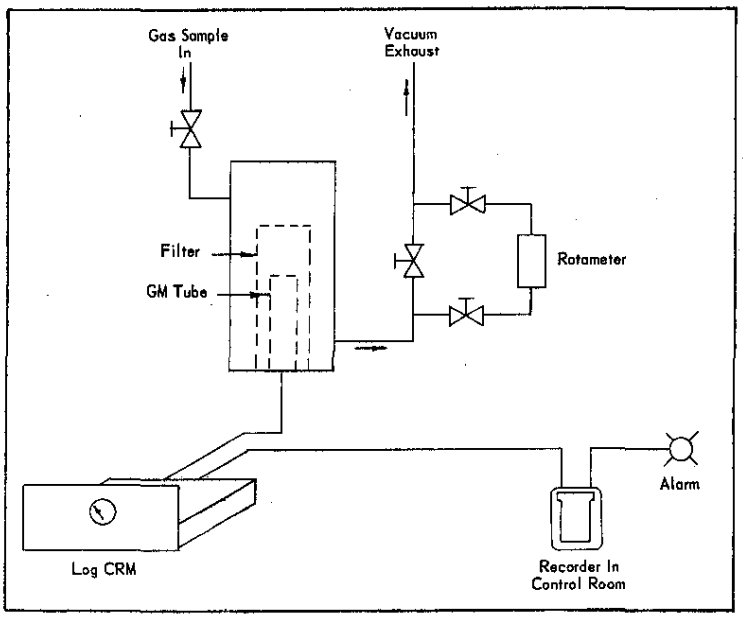

FIG. 1 SCHEMATIC OF SIMPLIFIED MONITOR

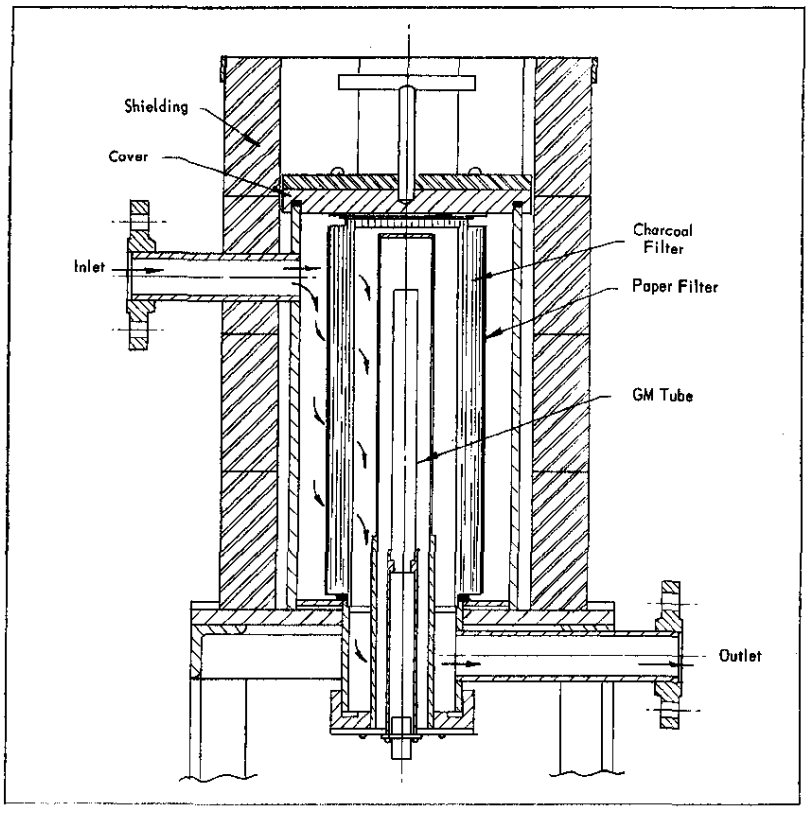

FIG. 2 CROSS SECTION OF DETECTOR CELL

HV 70 filter paper is used in the monitor. Tests[1] at other sites and at the Savannah River Plant (SRP) have shown that this filter paper has an efficiency greater than 99% for particles larger than 0.3 micron. Dorex type H-42 charcoal canisters have been tested[2] and found to be 99.99% efficient in the collection of iodine. However, collection of iodine at SRP has not exceeded an efficiency of 85-90%. This difference in efficiency has not been fully explained, but it is believed to result from the reaction of iodine with other stack-gas constituents to form compounds which are not trapped as efficiently as iodine itself. An efficiency of 85% is more than adequate for this usage.

A logarithmic count rate meter over the range of 10 to 10^6 cpm (30 millicuries to 200 curies) is used with a transistor version of the Cooke-Yarborough circuit[3]. Figure 3 is a schematic diagram of the circuit.

Operating Experience

In May 1962, an improved prototype monitor was installed in the field to count gross activity in gas samples. Since installation no maintenance, other than weekly replacement of the filter assembly, was required. Analysis of the canister and filter paper on a multichannel pulse height analyzer revealed good separation (Figure 4) of particulate and gaseous fission products. As a result of the good separation with charcoal and paper filters, the two filters were physically separated in later field installations. Passage of dissolver gas samples through filter paper and charcoal in series makes it possible to count each separately.

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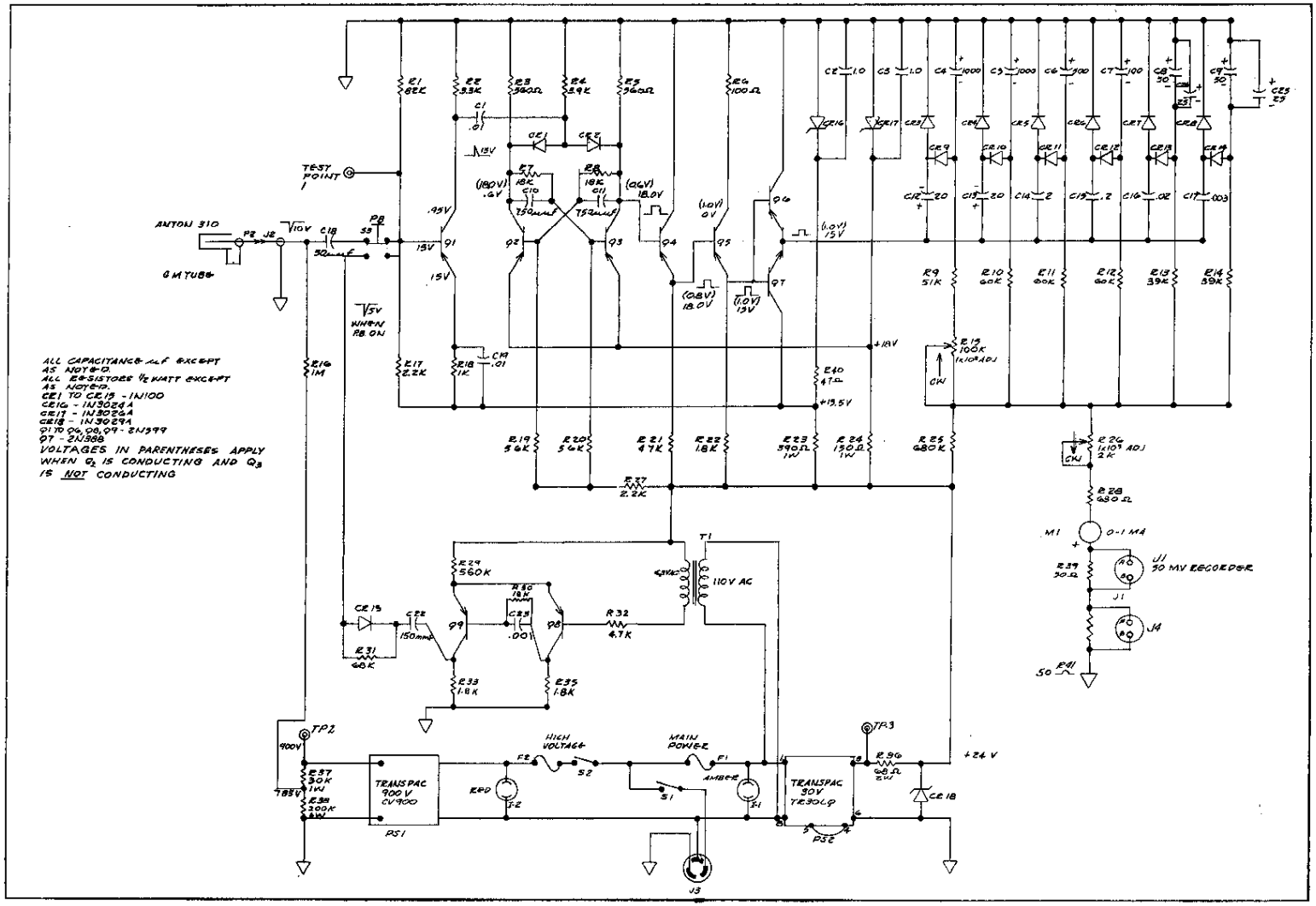

FIG. 3 SCHEMATIC OF LOGARITHMIC COUNT RATE METER

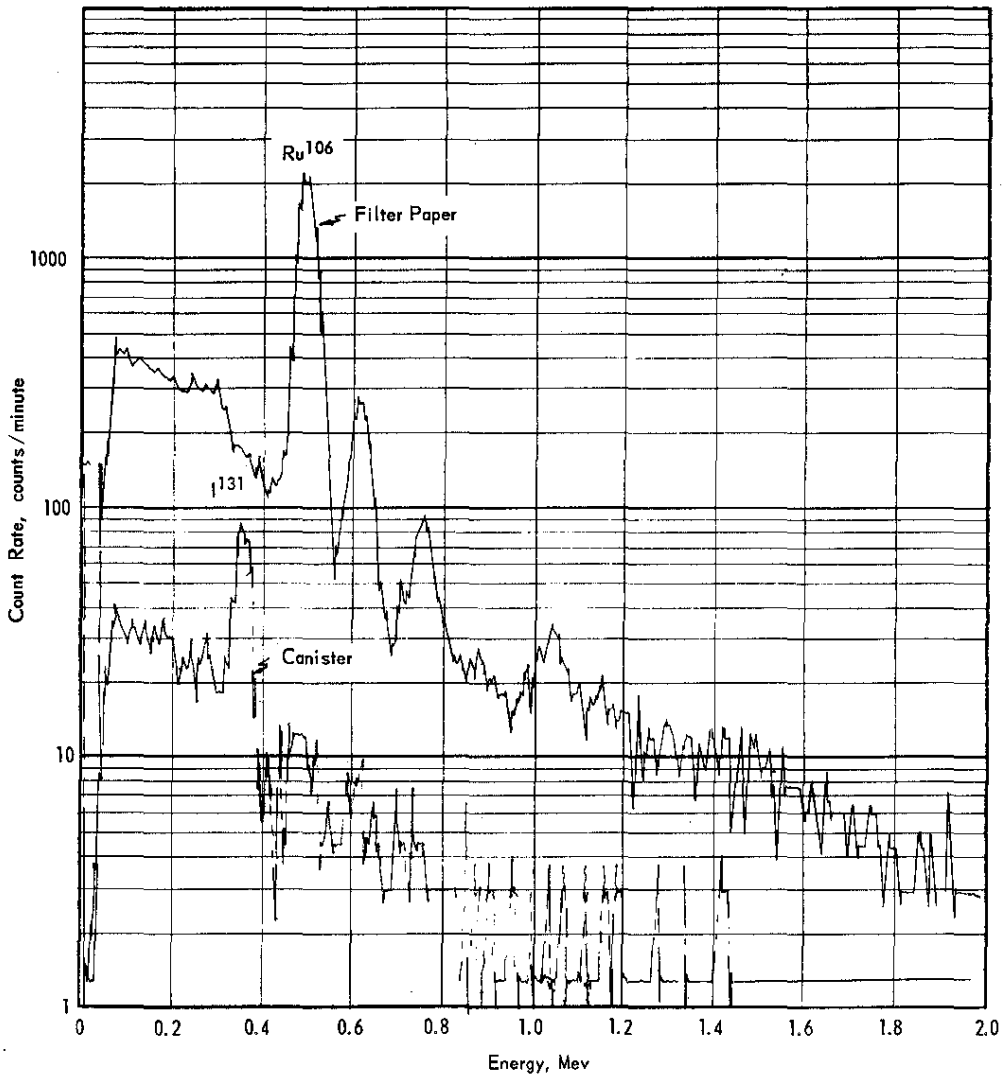

FIG. 4 SCAN OF FILTER ASSEMBLY MADE WITH PULSE HEIGHT ANALYZER