LA-UR-74-1231

LA-UR-741231
Conf-741212--1

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SUBMITTED TO: IEEE 1974 Nuclear Science Symposium and
14th Scintillation and Semiconductor Counter Symposium
December 11-13, 1974
Washington, D. C.

MASTER

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Form No. 836
St. No. 2629
1/73

UNITED STATES
ATOMIC ENERGY COMMISSION
CONTRACT W-7405-ENG. 36

AUTOMATED NONDESTRUCTIVE ASSAY INSTRUMENTATION FOR NUCLEAR MATERIALS SAFEGUARDS*

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Four systems developed at the Los Alamos Scientific Laboratory for nondestructive analysis of nuclear fuel materials will be described. These systems utilize either minicomputers or a programmable calculator for measurement control and data analysis, and are typical of a variety of automated measurement systems developed for nuclear materials safeguards applications.

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

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SUMMARY

Several automated systems have been developed at the Los Alamos Scientific Laboratory to perform nondestructive analysis on a wide variety of nuclear fuel materials. These systems utilize programmable calculators or minicomputers for measurement control and data analysis. This paper will briefly describe four of these systems: a passive gamma-ray scanning system for low density scrap and waste, an active neutron interrogation system for bulk samples of HTGR feed material, an active neutron interrogation system for assaying irradiated Rover fuel material, and finally a "Multienergy Californium Assay System" being developed for high precision assay of small samples.

The passive gamma-ray assay system is a fully automated version of the "segmented gamma scan" instrument[1] developed for the routine analysis of low density scrap and waste containing ^{235}U or ^{239}Pu. A minicomputer is used to collect pulse-height spectra

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from a Ge(Li) spectrometer via a stabilized analog-to-digital converter, control a stepping-motor-driven scanning table, drive a CRT data display, and analyze selected regions of the pulse-height spectra to determine the amount of ^{235}U or ^{239}Pu present in the sample. A view of the complete system is shown in Fig. 1.

The bulk sample neutron interrogation system to be described is the latest version of the "Random Driver" assay unit[2-3] developed for the assay of uranium in HTGR uranium-thorium fuel particles. The system employs a random source of fast neutrons consisting of four AmLi (α, n) sources to induce fissions in the ^{235}U present in the sample. Fission events are detected by coincidence counting prompt fission neutrons using a pair of fast plastic scintillation detectors. Four ^{3}He-filled proportional counters are also used to monitor the thermal-neutron flux within the counting chamber. Pulses from the various detectors are fed to scalers which are then read by a minicomputer. The computer was programmed in a high-level interactive language in order to allow easy modification of data analysis algorithms during development of the system. Figure 2 shows the electronics console containing the system's scalers, minicomputer, coincidence logic, and power supplies.

The assay system for irradiated Rover fuel material uses a RaBe (α, n) neutron source to induce fissions in the ^{235}U present in the fuel. Prompt neutrons from the induced fissions are detected by

^{4}He-filled proportional counters. The assay station is located within a hot cell and operated remotely from outside the cell. A programmable calculator is used in this instance to perform scaler readout, data analysis, and hardcopy output functions. A hard-wired logic unit interfaced to the calculator is used for system control.

The final system to be described is the Multienergy Californium Assay System presently under development to measure the fissile and fertile contents of small samples using fast neutrons from a ^{252}Cf source. The source is surrounded by a neutron energy tailoring assembly that can be changed by rotating an inner core to produce different neutron irradiation spectra. A minicomputer is used to control the tailoring assembly and sample positioning, and to accumulate and process data. Since this system will be used to investigate the applicability of multienergy californium source neutron interrogation for a variety of sample types, strong design emphasis has been placed on versatility in both the system hardware and software.

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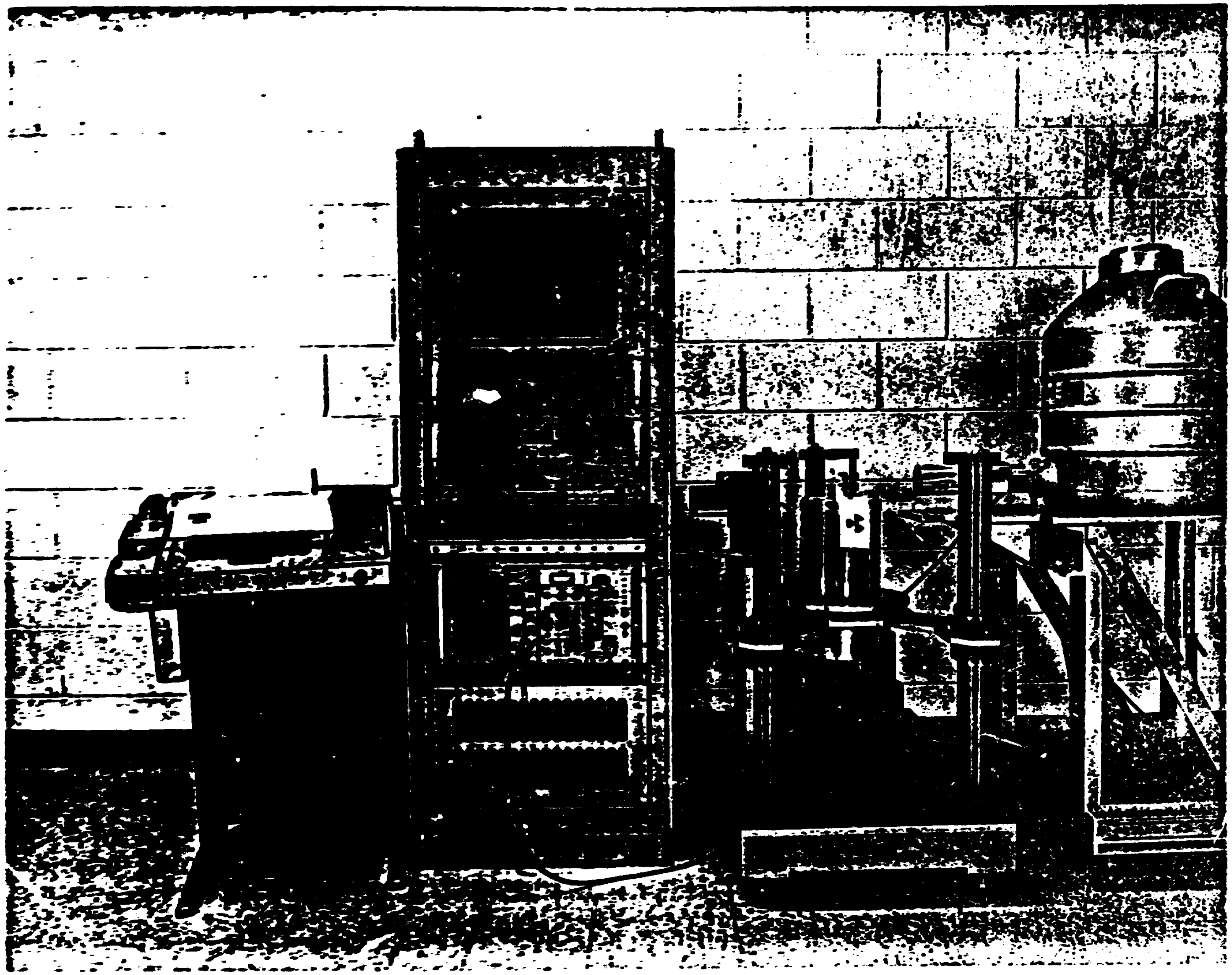

Fig. 1. Computerized segmented gamma scan system.