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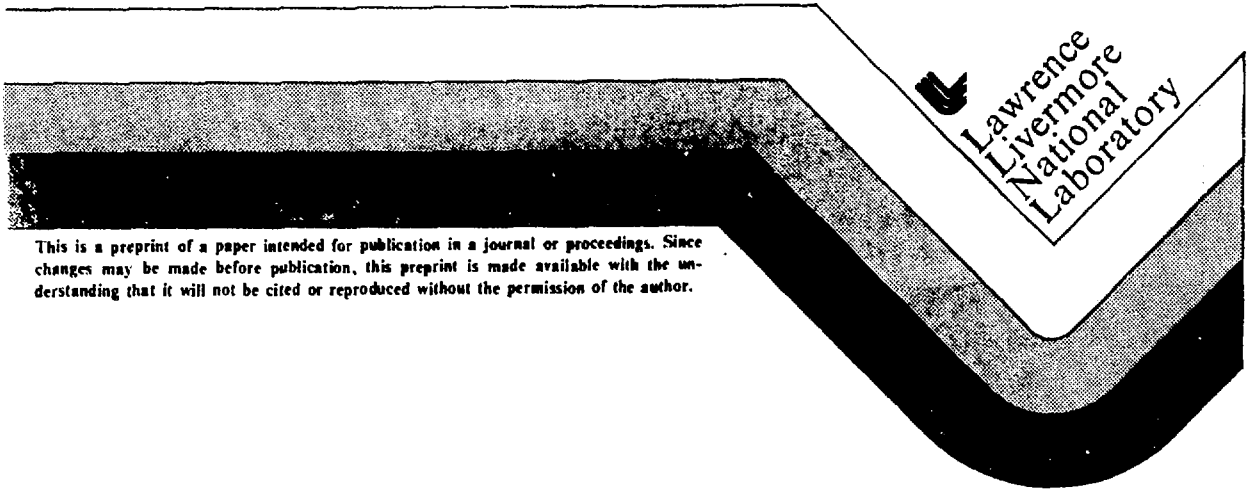

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NONDESTRUCTIVE ASSAY INSTRUMENTATION FOR SAVANNAH RIVER PLANT REPROCESSING ACCOUNTABILITY

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We have designed, developed, and calibrated three different types of nondestructive assay systems for the Savannah River Plant (SRP). These systems will be delivered to SRP in 1986 and become part of the nuclear material accounting instrumentation at one of SRP's reprocessing facilities.

Among the various types of nondestructive assay systems to be implemented are a neutron counter (Los Alamos National Laboratory - LANL), a four-station calorimeter (Mound Laboratories), a waste solution assay system (LANL), two gamma-ray solution concentration assay systems (LLNL), two x-ray fluorescence analysis concentration assay systems (LLNL), and one 2-detector plutonium solids isotopics system (LLNL). Los Alamos also has the responsibility of combining the individual measurement systems into an integrated accountability capability. Each NDA instrument will report results to a central Instrument Control Computer (ICC). Figure 1 illustrates schematically the integrated system with each Laboratory's contribution shown by dotted lines.

SOLIDS ISOTOPICS SYSTEM

A gamma-ray spectrometry system utilizing two detectors has been designed to measure plutonium isotopic ratios in feed scrap materials and oxides in sealed containers. A low-energy photon type germanium detector (LEPS) is used to measure the low-energy plutonium gamma-ray spectrum. At the same time this spectrum is being acquired, a large coaxial germanium detector is used to measure the higher energy gamma rays. Once both spectra are obtained, a

sophisticated analysis code (Multiple Group Analysis - MGA)[1] is used to simultaneously solve 120 linear equations representing all of the major peak regions in both spectra and determine the isotopic abundance with their attendant errors.

SOLUTION CONCENTRATION ASSAY BY GAMMA-RAY SPECTROMETRY

The second type of NDA system assays plutonium solution concentrations by gamma-ray spectrometry. A stainless steel cell mounted inside a glove box will hold 20 ml of nitric acid solution containing plutonium concentrations from 8 to 60 grams per liter. The cell is closely coupled to a LEPS detector located outside the glove box. The plutonium concentration and isotopics are determined from the measured intensity of the emitted gamma rays. Two collimator sizes (1-1/8 and 7/8 inches in diameter) are available under computer control to adjust the input counting rate. The smaller collimator includes a 10 mil cadmium absorber and will be used when solutions contain high concentrations of ^{241}Am. A sealed plutonium metal source can be moved into a position to periodically check the system calibration.

SOLUTION CONCENTRATION ASSAY BY XRF ANALYSIS

The third type of nondestructive assay system to be implemented also consists of a stainless steel cell into which about 15 ml of plutonium solution is drawn. Two collimated 20-mCi ^{57}Co sources are used to ionize a K-shell electrons from plutonium atoms, which is immediately followed by K x-ray emission. The emitted x-rays are measured by a LEPS detector. A third, highly collimated ^{57}Co source transmits a 122-keV beam through the solution into the

detector. A computer controlled tungsten shutter is used to eclipse the exciter sources so that the passive radioactivity spectrum can be measured. The data analysis software subtracts this spectrum from the fluorescence spectrum to obtain a net spectrum. The ratio of net fluoresced plutonium K x-ray intensity to 122-keV transmission intensity is measured to determine the plutonium concentration. This method measures concentrations independent of plutonium isotopics and minor variations in the composition and density of the solution.[2] Two x-ray fluorescence analysis and two gamma-ray solution assay systems ensure round the clock measurement capability.

THE COMPUTER-BASED ELECTRONIC SUPPORT INSTRUMENTATION

Each of the three types of NDA systems discussed above is microcomputer based and capable of stand-alone operation. Each NDA system is supported by a Canberra Series 90 MCA interfaced to a Digital Equipment Corporation MICRO/-PDP-11 computer. As shown in Fig. 1 the x-ray fluorescence analysis and gamma-ray solution assay systems share a multichannel analyzer and computer.

After design, development, engineering, and calibration, each of the NDA instruments were subjected to performance tests and a collective 100 hour mechanical and operational test before being accepted by SRP/DuPont. They were shipped to Los Alamos, where they have been integrated with other systems from Mound, SRL, and LANL and with the Instrument Control Computer. Once all of the systems have passed an integrated test and SRP personnel have been trained to operate the instruments, all of the spectrometer systems and computers will be shipped to SRP for installation. This talk will describe the three LLNL NDA systems; present some typical results obtained with associated errors; and describe the semi-automatic and remote operation of each system.

1. R. Gunnink, "Plutonium Isotopic Analysis of Nondescript Samples by Gamma-Ray Spectrometry," Conference on Analytical Chemistry in Energy Technology, Gatlinburg, Tenn., Oct. 1981.

2. D. C. Camp, W. D. Ruhter, and K. MacMurdo, "Determination of Actinide Process- and Product Stream Concentrations Off-Line or At-Line by Energy Dispersive X-Ray Fluorescence Analysis," Proc. 3rd ESARDA Symposium, Karlsruhe, Germany, May 6-8, 1981.

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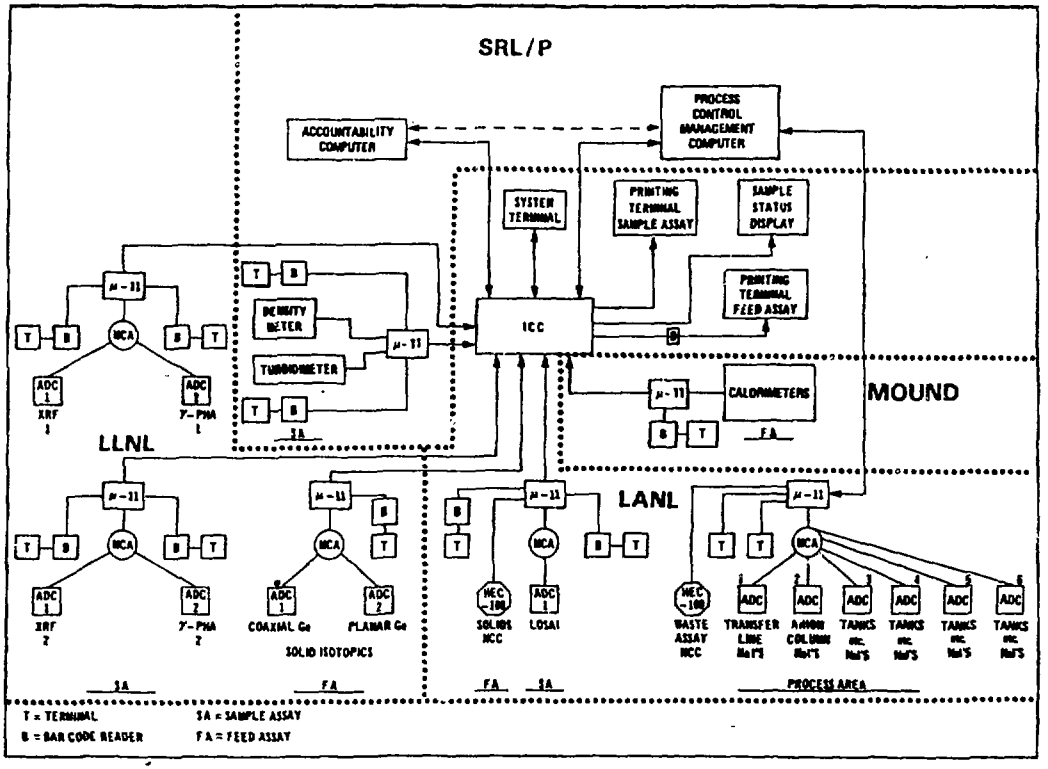

Fig. 1 Detailed schematic of integrated NDA accountability system.