Savannah River Site Experiences in In Situ Field Measurements of Radioactive Materials

by

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During the Cold War the Savannah River Site was an important production site for nuclear weapons materials. It contained production reactors, separation plants and experimental facilities. Currently many of these facilities are being decontaminated and decommissioned. In support of this mission there is a continuing need for in situ identification of potentially contaminated materials. The proper identification of a suspected contaminated area as natural, fission products, or TRU can significantly reduce decontamination costs. In situ identification and measurement of radioisotopes in different storage handling processing facilities, and remote field identifications requires using portable gamma-ray spectrometers, both HpGe and NaI, coupled with portable electronics systems such as ISA bus MCA cards in portable computers, Ortec microNomad and Canberra Inspector systems.

Applications include:

(1) Locating leaks in underground piping.

(2) Assaying soil samples at a dam site for possible contamination.

(3) Identifying the source of nonsemearable radioactivity found in an uncontaminated building.

(4) Determining the severity of radioactive uptake in trees.

This paper will discuss some of the field gamma-ray measurements made at the Savannah River Site, the equipment used for the measurements, and lessons learned during in situ identification and characterization of radioactive materials

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During the Cold War the Savannah River Site was an important production site for nuclear weapons materials. It contained production reactors, separation plants and experimental facilities. Many of these facilities are now being decontaminated and decommissioned. In support of this mission there is a continuing need for in situ identification of potentially contaminated materials. The proper identification of a suspected contaminated area as natural, fission products, or TRU can significantly reduce decontamination costs. In addition, in situ identification reduces the time required for identification as well as the radioactive waste produced when materials must be removed and transported to a lab for identification.

To facilitate this work, we have made extensive use of portable gamma ray spectrometers using ISA bus multichannel analyzer (MCA) cards installed in portable computers, as well as computer controlled

dedicated systems, such as the Ortec microNomad and Canberra Inspector. Both NaI and HpGe detectors have been used to support this work. The use of portable instead of desktop computers results in considerable savings in weight and bulk.

In this paper a we use a broad definition of "field measurements". We include temporary counting systems set up to support a short time series of measurements in remote locations as well as true field measurements in such locations as excess yards, burial grounds, storage pads etc. We also include loaner setups supplied to an experimenter who does not usually need nuclear counting equipment to support his experimental program

An early example of the utility of in situ measurements was a leak in underground piping connecting two buildings, which had allowed Uranium to seep into the ground. The questions to be answered included: where is it, how much, and which isotope? The two buildings were located in separate secure areas, with several fences between them. Excavating the line would involve moving these fences, and providing 24 hour security while the work was in progress. Instead a 2"x2" NaI detector and preamp were mounted in a rigid housing, with the connecting 100 foot long cables sheathed in a semi-rigid tubing to use as a "pusher "to move the detector down the pipe. The detector was lowered into a manhole, inserted in the pipe and pushed along, stopping every 2 feet to obtain a gamma spectrum. (figure 1)

The MCA consisted of a Compaq portable computer with a backpack holding a Canberra NaI+ card. This card contains the amplifier and high voltage power supply as well as the MCA circuitry providing a single unit counting system. An extension cord was run from a nearby building to the MCA which was set up next to the manhole. In less than ½ day the location of the leak had been determined and spectra taken. Subsequent analysis showed that the leak was a small amount of depleted Uranium and that extensive remediation was not necessary.

Over the years a significant amount of excess equipment has accumulated. Much of this is believed to be clean, based on surveys made many years ago. When this material is excessed, it is carefully surveyed by SHO personnel. When surveyed, a very small amount of this equipment surveys as "hot". When this occurs, we take a portable gamma spectrometer to attempt to determine if the activity is fission products or natural radioactivity picked up by the equipment during use. One example was an old hot water tank which had never been used in a contaminated area, but which surveyed as hot near the water intake. The gamma spectrum determined that the radioactivity was natural U and Th which had precipitated out of the water onto the rusty surface in this region of the tank. Sandblasting the rust off the tank resolved the problem.

Several large electric motors have been found to have Cs-137 contamination on the windings when taken to the motor shop for repair. This had been missed when the complete motor was surveyed when removed from service for repair.

On several occasions, grinders and welded areas have surveyed "hot". On all these occasions gamma PHA has shown that the radioactivity was normal. It was Thorium splattered from Thoriated welding rods during the welding process, or produced when the Thoriataed welding rods had their tips ground. In these cases, showing that the radioactivity was normal has permitted returning the items to service instead of disposal with the resulting costs.

An experimental reactor facility, the HWCTR, was being demolished. The approximately 2 foot diameter cooling water intake pipe sections showed signs of contamination. These pipe sections were lying in a storage yard far from electric power. Therefore, the Ortec microNomad system was used. This compact system is controlled by a laptop PC, and can be run in "field mode". In field mode the laptop is disconnected and the microNomad is powered by 8 AA flashlight batteries. All that was carried to the workplace was the one pound microNomad, 8 feet of connecting cable and the 2"x2" NaI detector. The "contamination" on the pipes turned out to be natural U from the ground water flowing through the pipe. A subsequent survey of a steam generator within the HWCTR containment building turned up Co-60, which had leached from the reactor vessel and been carried into the steam generator by the hot coolant water.

The dam face of an old cooling water pond required repair. The water in this pond was known to have been contaminated. Had there been radioisotope migration through the dam and if so, what protective measures must be undertaken to protect the workers and the environment? To answer these questions a series of test borings were made in the face of the dam, and soil samples removed for laboratory analysis. Hence there was a need to survey the samples as they were taken to determine sample transportation requirements, and also to evaluate whether field gamma ray measurements could replace some or most of the samples in future work.

For this work an Ortec microNomad was used with a 2"x2" NaI detector. The NaI detector was enclosed in a ½ inch thick steel collimator to minimize background from the ground, and the bag of soil placed next to it. (Figure 2). Although the microNomad can be run on 8 AA batteries in field applications, because this work was scheduled to last a week, a portable generator provided power for the experimental setup. In this proof of principle experiment 4 nCi/Kg of Cs-137 was easily resolved.

On another occasion it was decided to survey a building on the SRS site which had never had any radioactive material in it. Approximately a dozen "hot spots" were found on the floor. They were not removable therefore we were called in to perform an in situ gamma analysis. One spectrum with a comparison spectrum from Uranium ore is shown in (Figure 3). The Central Savannah River Area is known to have scattered Uranium bearing rock formations. Some of the aggregate used in the concrete was quarried from these rock formations. Whenever a piece of Uranium ore happened to be at the top of the pour, a hot spot appeared. This work was also done with a Compaq computer and a Canberra NaI+ card.

Early reactor seepage basins holding contaminated water were very conservatively fenced years ago;. The entire area within the fence now has to be considered potentially radioactive during remediation. To minimize the costs of redemption it would be useful to move the fences in if the ground can be shown to be uncontaminated and an accurate boundary of the contaminated area obtained. Cs-137 is known to be taken up by pine trees. Is it possible to use this uptake to define better the limits of the contaminated area? A battery powered Ortec microNomad was used to answer this question. Several trees in a known contaminated area had a piece of the bark removed and a 3"x3"NaI detector used to determine the uptake. The seepage pond background made this impossible, however borings were also taken from the trees for analysis. Examination of the borings in a clean area of the seepage basin showed that this method has potential for shrinking the boundary of the contaminated area.

A large, truck mounted, deionizer used to remove Cs-137 from the reactor storage basin water was removed from service and to be disposed of. For disposal purposes the approximate number of Curies of Cs-137 it contained was needed. An Ortec microNomad was used to map out the distribution of the Cs, and this data combined with dose rate readings was used with the Microshield code to estimate the Curie content of the deionizer. (Figure 4)

. Because of density or fill height questions regarding some assayed waste boxes, we were requested to confirm the waste assay values assigned to the boxes. The boxes were stored in an otherwise unused storage building. A Canberra Inspector and a HpGe detector were used to assay the boxes. This work is being reported on separately at this meeting. The Inspector can be battery opperated, however in this case an extension cord was available. (Figure 5)

On another occasion we were requested to perform a waste assay of a number of Hepa filters located in a storage area in the decontamination facility. Once again we used the Inspector and HpGe detector. Again power was provided so the capability for battery operation was not necessary. In both cases, the size and weight of the Inspector made it possible to take the instrumentation to the samples, not bring the samples to the detector.

An entirely different application is in the preventive maintenance of neutron monitors used in the separations canyons. The neutron monitors feed the output of the detectors into an Amp/SCA. The SCA output is then fed to a rate meter and thence to the control room. The output pulse spectrum from a BF3 or He3 detector has a characteristic shape. We have supplied several Compaq portable PCs with Oxford PCAII or PCAIII cards to the canyon engineering groups. By examining the shape, number,and location of

peaks in the spectrum, the condition of the detector may be monitored. Figures 6 and 7 show a new and a bad BF3 tube. (Moore ,et al. 1996)

Recently, we were requested to assay a large number of Co-60 slugs in two reactor storage basins. To support this project we used a portable computer with a Canberra NaI+ card installed (Figure 6). Since all the counting electronics are contained on the card, power and space requirements at the storage basins were minimized. This work is being reported more completely at this meeting. (Salaymeh et al. 1999).

There are a large number of decontamination experiments going on here at SRS. Many of these experiments involve the use of ion exchange methods to separate specific contaminants. Radioactive experiments must be carried out in hoods and glove boxes. Some of these experiments when carried to completion require several days of 24 hour surveillance. Periodic samples are taken at intermediate stages in the process for radiochemical analysis. These analyses can require 1-3 days. We have provided several experimenters with portable gamma pulse height analysis systems to do a fast, in situ test for breakthrough of the column. If they have demonstrated breakthrough, they can terminate the experiment immediately instead of carrying on either to completion or return of samples form lab analysis. A system using a shielded detector and an NaI+ card has worked well in these situations. We set up the system, calibrate the detector, preset the counting time, and demonstrate the operation to the experimenter. All he has to do is count his sample, take down his data, and clear the MCA.

One of these experiments involved a "pilot plant" type experiment at a closed reactor storage basin. The experiment was to run for several weeks and to determine the capacity of the proposed resin bed. Samples would be taken periodically and taken to the lab (10 –15 miles away) for analysis. We set up a shielded NaI detector system in the basin area. The samples could be immediately checked for gross breakthrough, before sending them out for detailed analysis. After we set up the portable MCA system, the manufacturer's representative said " I have done a lot of these demonstrations, but this is the first time anyone ever thought of doing this. This can save days!"

Portable, PC based multichannel analyzers and the battery capable field deployable systems have proved extremely useful at SRS. We have been able to promptly respond to requests for assistance and to provide measurement capabilities in situ. This has resulted in large time and cost savings.

Acknowledgements

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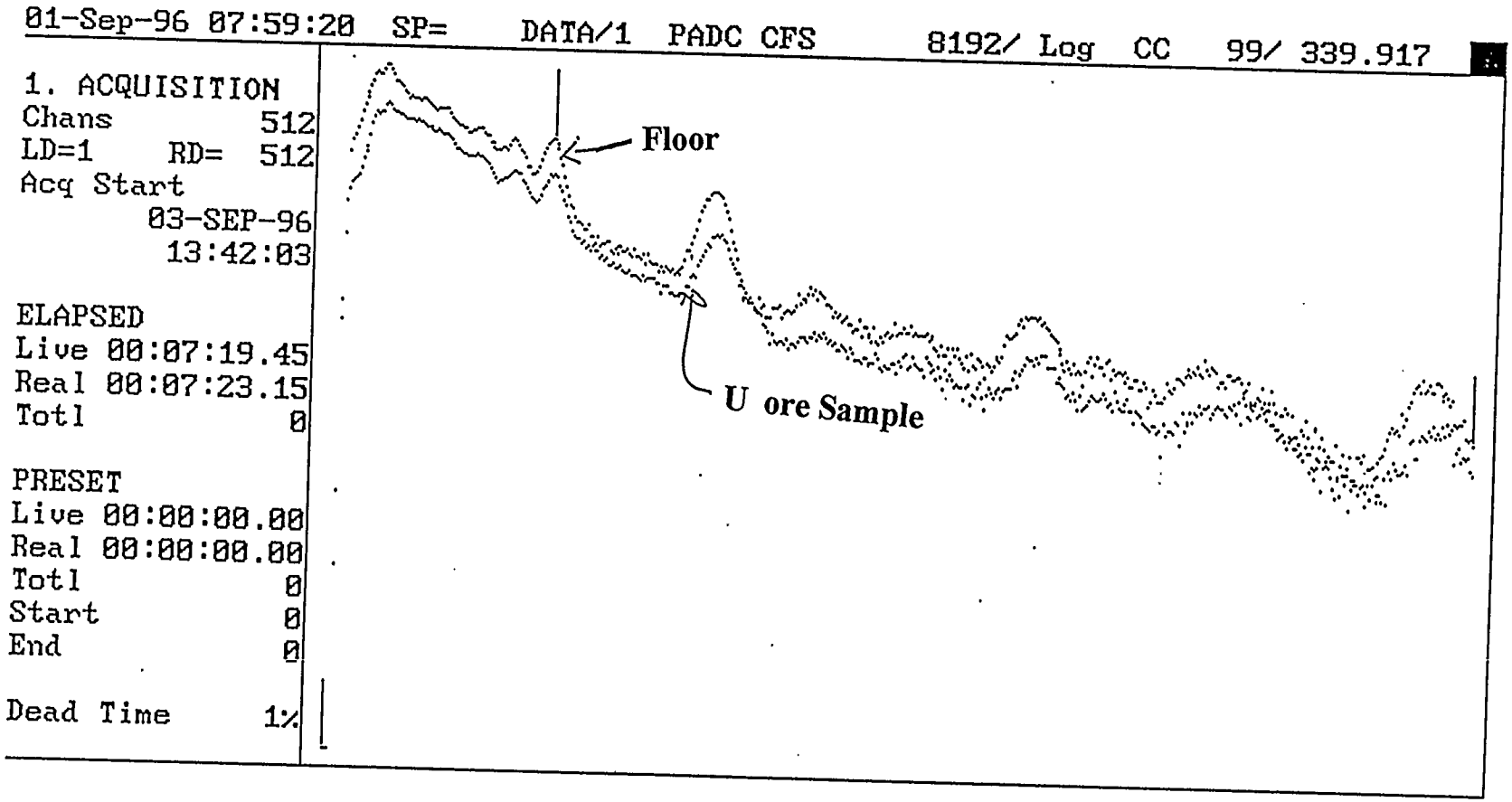
Fig. 1

Fig. 2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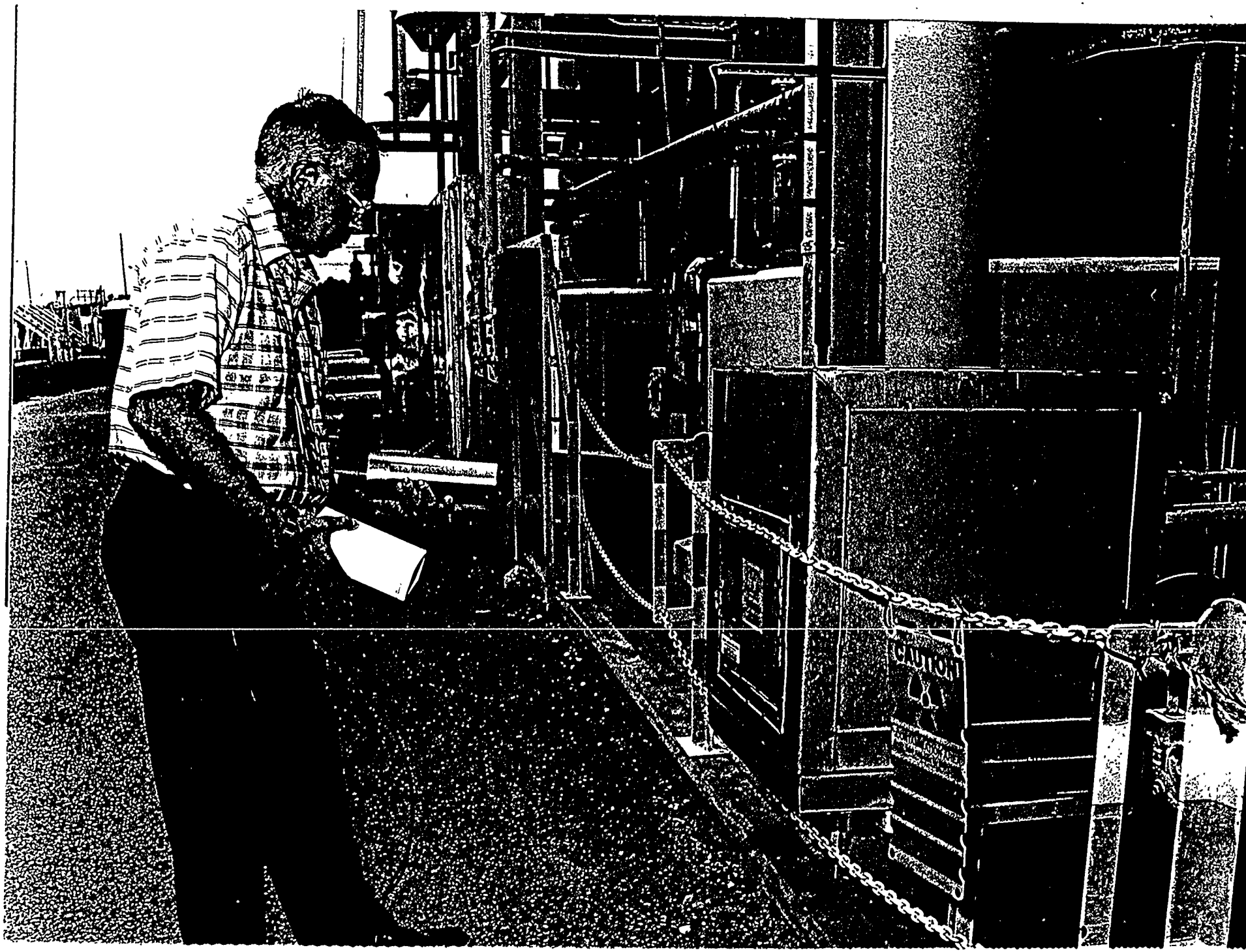
U ore Sample

Fig. 3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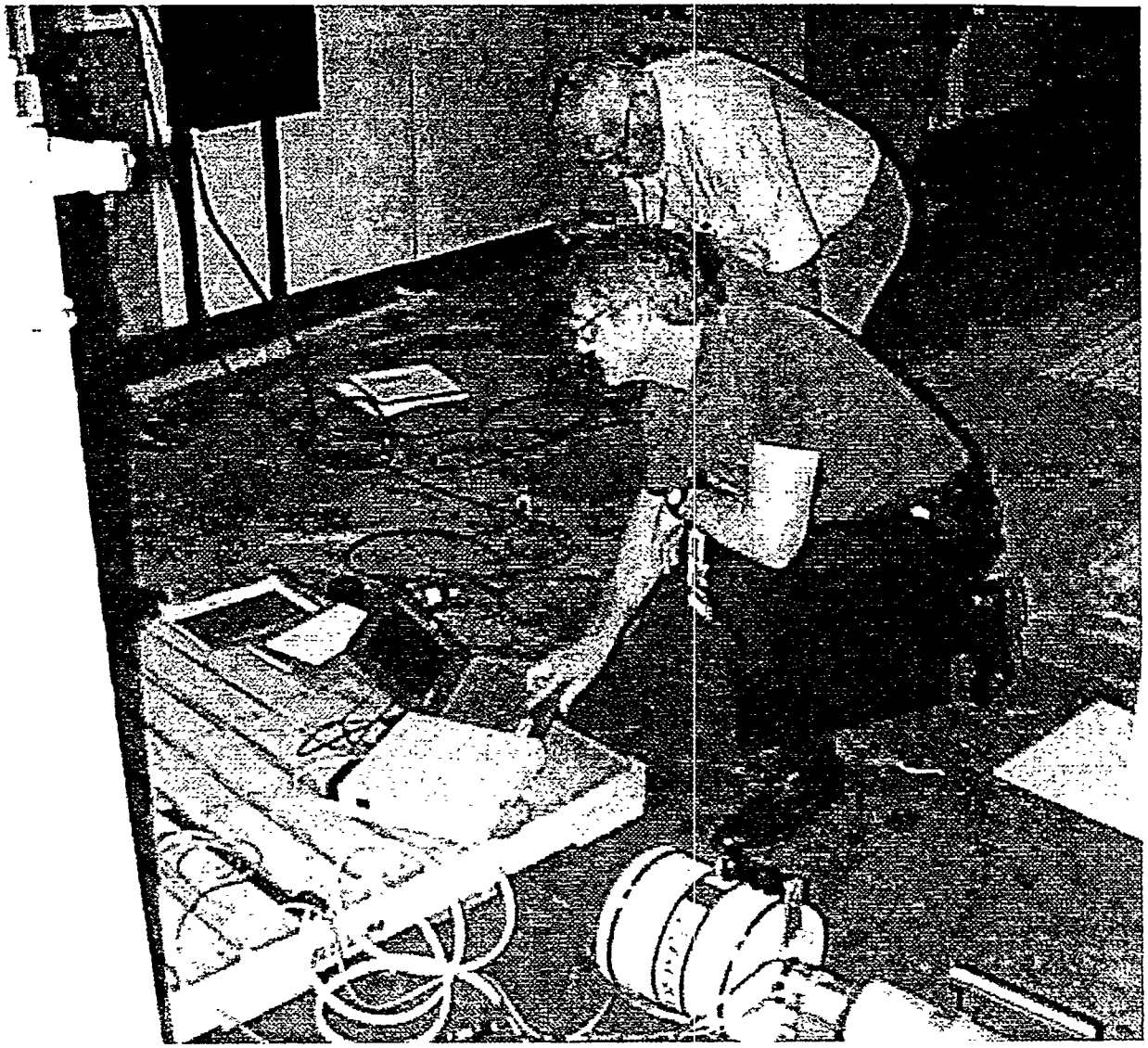

fig 5

Quantum Assayer Report
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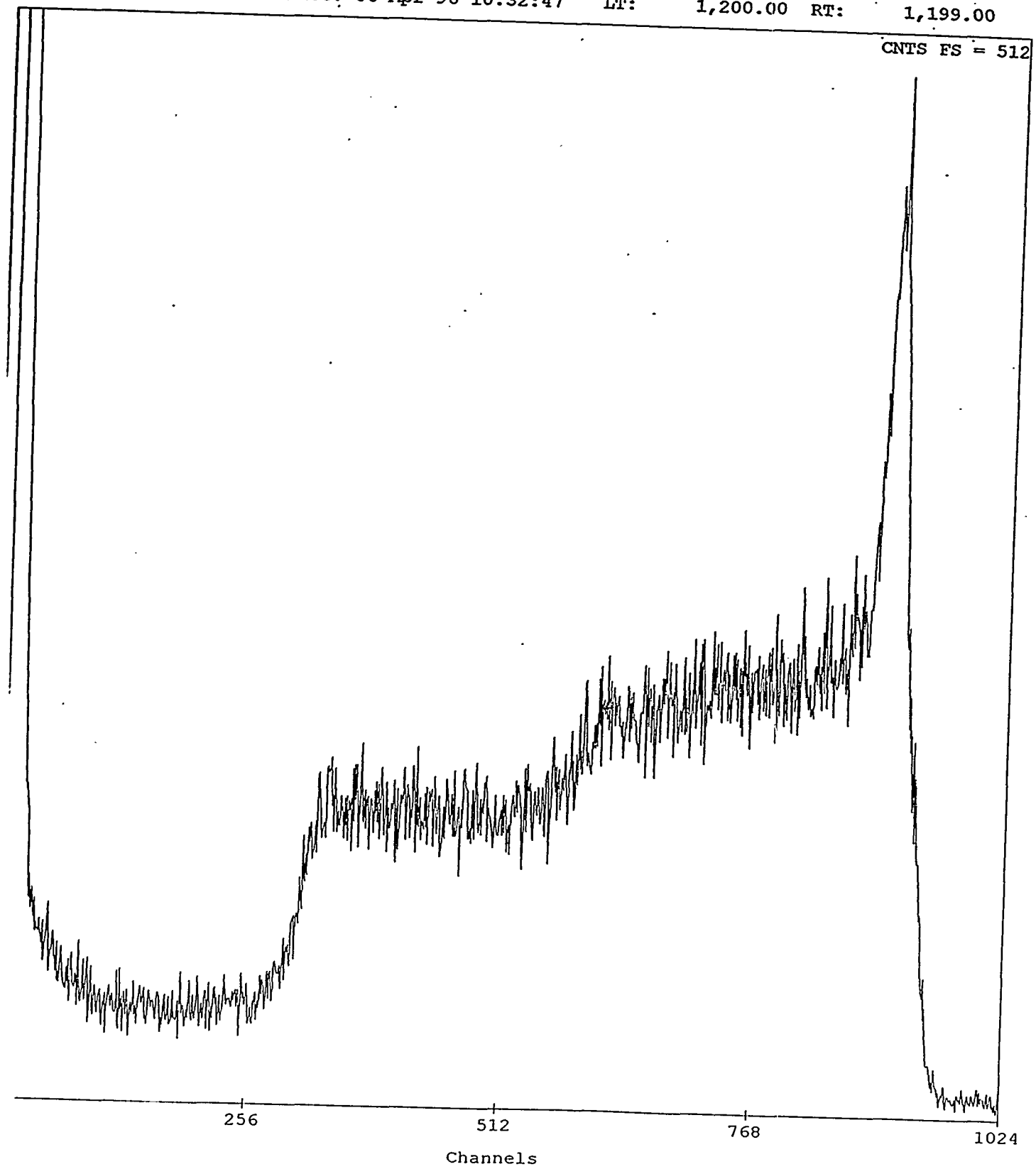

Good BF-3

Fig. 6

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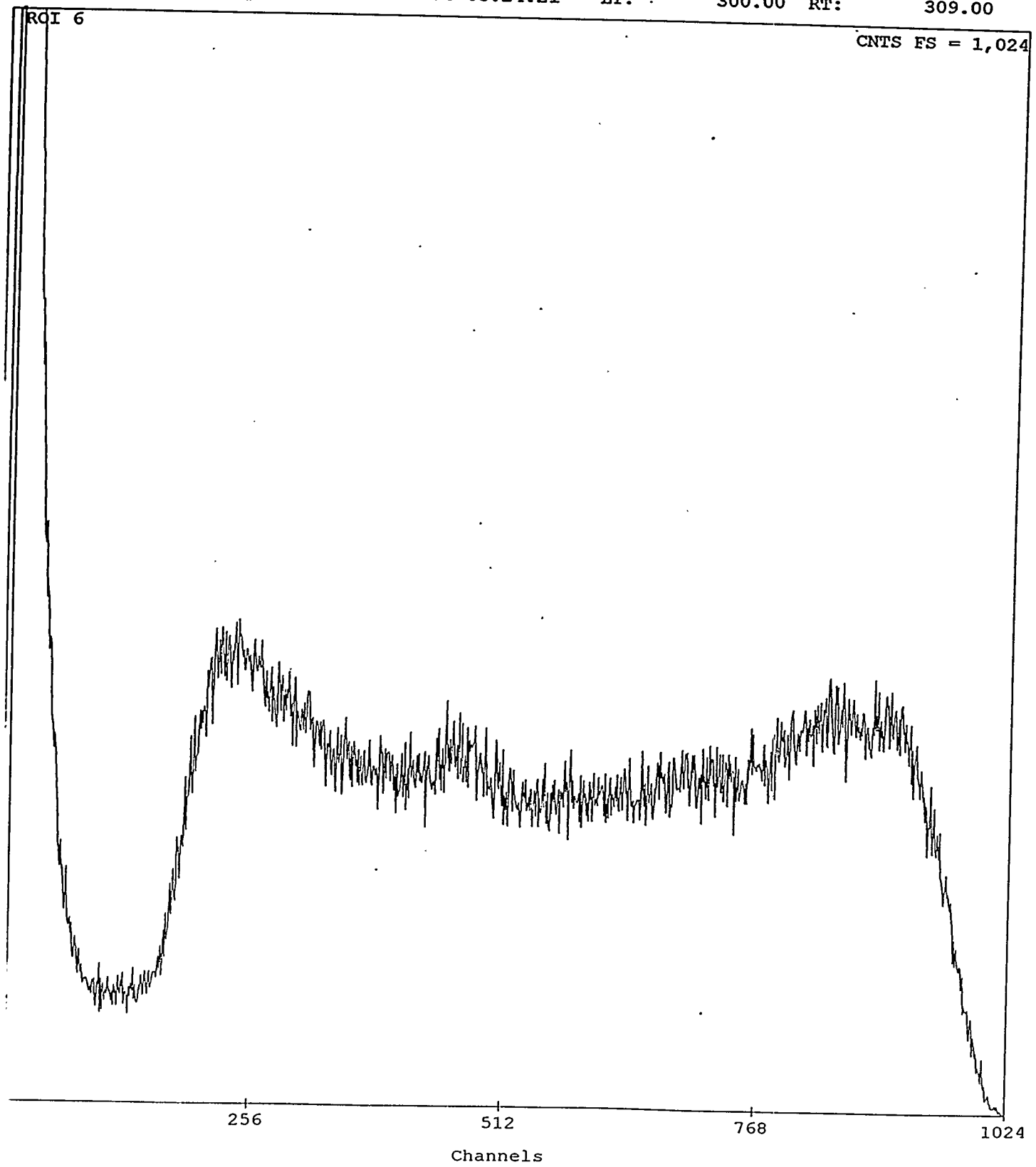

Bad BF-3

Fig. 7

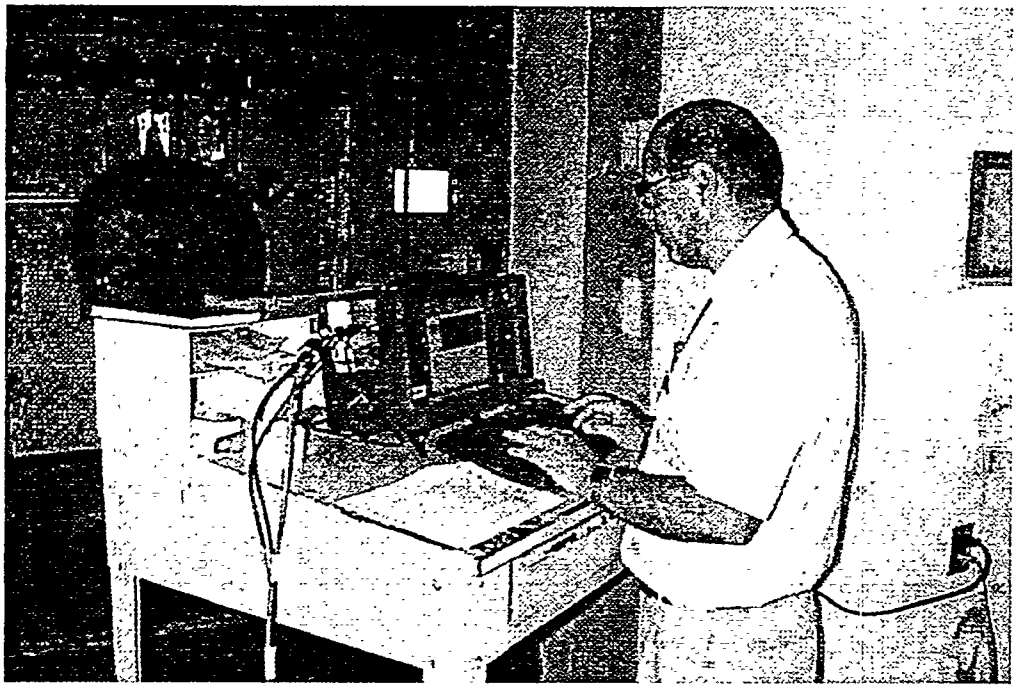

Fig. 8