Low-background Counting Facilities

A.R. Smith, R.J. McDonald, D.L. Hurley, and E.B. Norman

The LBNL Low Background Facilities (LBF) consist of a Berkeley site and an Oroville site specially configured for low-background gamma-ray spectroscopy. The Berkeley site was established in 1963 and consists of a 3m by 7m x 3m room surrounded by 1.6m of specially-selected low-background concrete shielding. The aggregate in this concrete is from serpentine gravel which is low in U, Th, and K. This barrier was made to shield against accelerator-produced neutrons and natural gamma radiation as well as some cosmic rays. Also, the low-activity concrete emits little radon, and a HEPA-filtered air system constantly purges the room to reduce airborne radon.

Detectors at this site include a 20 cm diameter by 10 cm thick NaI crystal, two 30% p-type Ge spectrometers (one of these with an external active cosmic ray suppresser), an 80% p-type Ge spectrometer and a 55% n-type spectrometer suitable for low-energy gamma-ray and X-ray measurements. These detectors each have small local shields consisting of 10 cm of Pb. The overall shielding reduces background to the point where internal activity in the detectors and cosmic-rays are the dominant source of background.

The LBF Oroville site is located in the powerhouse of the Oroville Dam, under 180 m of rock cover. This site now has a 115% n-type and a 30% p-type Ge spectrometer and is used for our most sensitive counting. Sensitivities of 50 parts-per-trillion (PPT) for U and daughters, 200 PPT for Th and daughters, and 100 parts-per-billion for K are realized at the Oroville site.

The LBF has been involved in a wide variety of experiments supporting programs from LBNL and a variety of other institutions. There are five main types of work the facility supports: low-activity materials certification, cosmic ray activation, neutron activation, nuclear science experiments and environmental health and safety activities. The ongoing materials certification work is for two large detector projects: SNO and the UCB Dark Matter Search. A variety of stock materials and components were surveyed for these projects. Cosmic-ray activation work, begun with the LDEF and HST, continued with a Pb-glass sample from Mir and a stainless steel sample from another Russian satellite. The latter study involved looking for excess Be-7 on the earth-facing side of the sample. Neutron Activation Analysis work continued on semiconductor-grade silicon, and verified parts-per-trillion sensitivity to 29 elements in wafer-sized samples (Ref. 1). A new initiative was begun with biological samples. Selenium-laden bacteria and sludges were studied as proof-of-principle for a program in bioremediation. Uranium uptake was measured in another bacterial sample. The facility supported research aspects of the Nuclear Astrophysics Group including looking for electron density effects on the half-life of ^{40}K, a half-life determination of ^{108}Ag, and measurements of a large sample of ^{150}Nd separated isotope proposed to be used in a double beta decay experiment. An additional program involved developing mixtures of natural La, Lu, and K as a "non-radioactive" calibration source. A substantial amount of the facility's time was involved with Environmental Health and Safety work. This included a major radiological survey of the building and site of the new waste handling facility, Building 85, measurements of sub-surface soils under the BEVALAC, characterization of concrete shielding blocks for disposal, and measurements of a variety of samples in support of the ES&H analytical lab.

During the coming year, new projects screening materials for semiconductor manufacturing are proposed, including both direct counting and neutron activation. Work in support of bioremediation is expected to increase. Cosmic-ray activated parts are expected from the second HST servicing mission in February 1997. Characterization work on LBNL radioactive and mixed waste will increase.

Footnotes and References

1. A.R. Smith, R.J. McDonald, H. Manini, D.L. Hurley, E.B. Norman, M.C. Vella, and R.W. Odom: J. Electrochem Soc. **143** (1996) 339-346