13 Laboratory Design and Management Principles

CHARLES PORTER$^{1,3}$ AND GLENN MURPHY$^2$

13.1. Introduction

The primary responsibilities in managing a radioanalytical chemistry laboratory are to perform accurate analytical measurements and report the results in a timely manner. Fine-tuning the design elements and management practices of the laboratory will invariably help a laboratory to meet those responsibilities. This chapter is designed to give students an overview of what a modern radioanalytical laboratory looks like and how it functions. The laboratory features discussed in this chapter apply directly to laboratories processing environmental and bioassay samples with low radionuclide content, but can be extrapolated to laboratory environments where higher level samples are processed.

The early part of this chapter discusses the design and operating practices that support analytical processes in an environment favorable for efficient work. The design incorporates state of the art technologies in sample flow during processing, hood design, ventilation systems, and waste disposal. The latter part of the chapter addresses the staffing, costs, and attitudes appropriate for a reputable laboratory. Management and operating considerations include personnel, operating costs, and service orientation.

13.2. Design and Operational Elements of a Radioanalytical Chemistry Laboratory

In the past, radioanalytical chemistry laboratories processed samples resulting from monitoring nuclear weapons development facilities, fallout from nuclear weapon tests in the atmosphere, and nuclear power stations. At present, monitoring cleanup of former nuclear facilities is a major source of samples, and efforts are
being devoted to preparation for monitoring radiological accidents and incidents. The laboratories are located at DOE contractor facilities, and other federal, state, and local agencies, or are commercially operated to perform contract analyses for government and private industry. If the demand for processing radioactive samples increases, building new radioanalytical chemistry laboratories or modernizing old ones will become necessary. The design presented here is based on a laboratory recently constructed in association with the authors. The original design includes a radioanalytical chemistry section for performing a variety of radiochemical analyses, as well as a section for the analysis of heavy metals, hazardous chemicals, and volatile and non-volatile organics. The combination characterizes a mixed waste laboratory designed to handle a sample stream of both radioactive materials and hazardous chemical materials. This chapter gives an overview of the salient features of a state-of-the-art radioanalytical chemistry laboratory.

A primary consideration in laboratory design is the magnitude of the radioactivity in the samples that the laboratory will process. The Department of Energy has designated four hazard levels for radiological samples:

1. High Level (Type A)
2. Intermediate Level (Type B)
3. Low Level (Type C)
4. Environmental Level (Type D)

Note: These hazard levels are not to be confused with the DOE classification of nuclear waste into high-level, low-level, mixed low-level, transuranic and 11e(2) byproduct material categories. These nuclear waste categories are established by DOE Order 5820.2A, which can be viewed online at http://www.directives.doe.gov (Dec. 2005). See DOE/EM (1997) for more information on nuclear waste. To reiterate, waste hazard levels are different than laboratory hazard levels, although the defining terminology is similar.

Recent experience at DOE sites has shown that most of the environmental samples collected today are levels C and D. Hence, the laboratory under consideration in this chapter is designed for the analysis of levels C and D samples. These are environmental or bioassay samples that contain radionuclides at low concentrations, i.e., approximating levels of naturally occurring radionuclides. Samples at levels A and B generally will be analyzed in on-site government laboratories for a variety of reasons, i.e. transportation restriction, sample assay limitations, sample security, and national security. In Table 13.1, the authors provide their suggested activity levels to match the four categories identified by the DOE.

Table 13.1 is merely a guide. Each laboratory should develop specific quantity limits. In some cases, the license under which the laboratory operates will specify the quantity limits. For instance, the NRC issues specific radioactive material licenses to facilities, and each license specifies the maximum quantity limit for a given radionuclide. At government owned and operated sites, the DOE facilities do