



# Environmental ALARA Program Plan

Revision 4  
June 6, 2006

Ernest Orlando Lawrence Berkeley National Laboratory  
Environment, Health, and Safety Division  
Environmental Services Group

Prepared By: Linnea Wahl Date: 6/6/06  
Linnea Wahl, Environmental ALARA Program Leader

Reviewed/Approved By: Ron Pauer Date: 6/6/06  
Ron Pauer, Environmental Services Group Leader

## 1 ENVIRONMENTAL ALARA POLICY

It is the policy of Berkeley Lab to perform work in a manner that protects the health of the public and preserves the quality of the environment. (LBNL 2006a). In keeping with this policy, Berkeley Lab is committed to keeping radioactive emissions and external exposures as low as is reasonably achievable (ALARA). The Berkeley Lab Environmental ALARA Program was developed and implemented to systematically verify and document that environmental radiological impacts are ALARA as required by DOE Order 5400.5 (DOE 1993).

## 2 INTRODUCTION

ALARA is a radiation protection acronym that stands for “as low as reasonably achievable.” The ALARA concept is an approach to managing and controlling exposures (both individual and collective to workers and the public) and releases of radioactive material to the environment, by considering social, technical, economic, and public policy factors. The ALARA concept is not a dose limit, but rather a philosophy that has the objective of maintaining doses as far below applicable limits as is reasonably achievable. We follow the ALARA philosophy when we seek to answer the question, “Have we done all that we can reasonably do to reduce radiation doses?” (DOE 1991).

At Berkeley Lab, the ALARA policy is implemented in several ways (LBNL 2006a).

- Authorizations: Authorization programs provide a mechanism for assessing work with radioactive material and for implementing controls to limit exposure, thereby keeping exposures ALARA.
- Worker awareness: Workers who use radioactive materials and radiation-producing devices are responsible for understanding job requirements, radiological control measures, and ALARA practices.
- Workplace monitoring and surveillance: A workplace monitoring program ensures that contamination and doses in areas occupied by people do not exceed limits and that ALARA practices are followed.
- Environmental monitoring and surveillance: The impact on the environment and public of Berkeley Lab’s operations with radioactive materials and radiation-producing devices are reviewed, as described below.

The purpose of the Berkeley Lab Environmental ALARA Program is to ensure that releases of radioactive material to the environment and exposures of members of the public are kept as low as reasonably achievable below applicable limits. The Environmental ALARA Program Plan is reviewed annually and revised at least every three years. In addition, environmental ALARA activities are discussed annually in the Berkeley Lab environmental report (LBNL 2006c) and in this way are communicated to Berkeley Lab managers and workers.

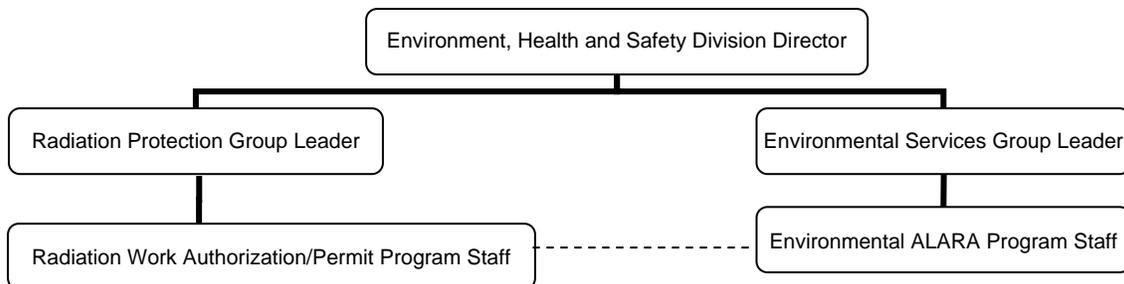
The Department of Energy (DOE) requires that the ALARA policy be implemented for all DOE activities and facilities that cause public dose, with no *de minimis* (DOE 1993). However, DOE guidance says that the ALARA policy should be applied in a graded manner and that activities with the potential to approach the DOE individual dose limit for the public (30 mrem for any single source or practice) should be identified and evaluated with a quantitative ALARA analysis (DOE 1997). Quantitative ALARA evaluations are not necessary for activities that have a potential for public exposure that is less than 1 mrem individual dose or 10 person-rem collective dose. Accordingly, the Environmental ALARA Program assesses radiological activities at Berkeley Lab qualitatively to determine if quantitative ALARA evaluations are necessary. Quantitative ALARA evaluations, when necessary, are performed in accordance with DOE guidance. All ALARA evaluations are documented.

### 3 ENVIRONMENTAL ALARA PROGRAM ORGANIZATION AND RESPONSIBILITIES

This section identifies and documents the organizational structure, responsibilities, and authorities of Berkeley Lab staff involved in the Environmental ALARA Program.

#### 3.1 Organizational Structure at Berkeley Lab

At Berkeley Lab, an institutional environmental ALARA program is in place. Berkeley Lab programs do not establish individual environmental ALARA programs within their research areas. Figure 1 presents the organizational structure of the Environmental ALARA Program.



**Figure 1.** Berkeley Lab Environmental ALARA Program Organizational Structure

### 3.2 Responsibilities and Authorities for Environmental ALARA

At Berkeley Lab, scientific investigators, supervisors, and workers are responsible for following environmental laws and regulations (including the ALARA policy) and must be fully aware of the environmental impact of their own activities (LBNL 2006). The Environmental Services Group of the Environment, Health, and Safety (EHS) Division has lead responsibility for the Berkeley Lab Environmental ALARA Program. Scientific investigators rely on the Environmental Services Group to assist them in accomplishing environmental compliance objectives, including implementation of the ALARA policy. The responsibilities and authorities for each environmental ALARA function are described below.

**Environment, Health, and Safety Division Director:** The division director has overall responsibility for the conduct of the environmental, health, and safety programs at Berkeley Lab, including the Environmental ALARA Program.

**Environmental Services Group Leader:** The group leader is responsible for environmental compliance and restoration activities at Berkeley Lab, including the Environmental ALARA Program. In addition to general oversight of the program, the group leader ensures that any necessary reports are generated and disseminated, and that staff in appropriate disciplines are available to support ALARA analyses and evaluations.

**Environmental ALARA Program Leader:** The program leader is responsible for managing the Environmental ALARA Program, which includes the following activities.

- Interface with the Radiation Protection Group to determine environmental emissions, source inventories, and external radiation requirements.
- Identify and evaluate site activities that have the potential for radiological impacts on the environment and the public.
- Support the Environmental Services Group Leader by maintaining this plan and implementing procedures.
- Establish and maintain records of environmental ALARA activities.

**Radiation Protection Group Leader/Radiation Control Manager:** The Radiation Protection Group Leader has responsibility for worker radiation protection programs at Berkeley Lab, filling the position of Radiation Control Manager as well. The Radiation Control Manager works with the Radiation Safety Committee to oversee facility and worker ALARA reviews.

**Radiation Work Authorization/Permit Program Staff:** These personnel staff several work authorization programs, including the Radiation Work Authorization Program and the Radiation Work Permit Program, and perform worker ALARA reviews. Analyses and information gathered are used by the Environmental Services Group to perform environmental ALARA evaluations.

## **4. ENVIRONMENTAL ALARA PROCESS**

This section describes the steps taken by the Environmental ALARA Program Leader to implement the environmental ALARA policy.

- 1) Identify site activities with the potential for environmental radiological impacts.
- 2) Review radiological impacts of activities.
- 3) Perform qualitative ALARA analyses to determine if quantitative ALARA analyses are required.
- 4) Perform quantitative ALARA analyses on activities with radiological impacts that warrant such review.

### **4.1 Identify Potential Radiological Impacts**

Through facility ALARA reviews, each new facility or operation using radiation is subjected to reviews before radiation work begins to ensure that radiation exposures to workers, the public, and the environment are ALARA. Through work authorization programs, worker ALARA reviews are conducted for all operations, practices, and procedures that have potential for high individual or collective dose to workers. Facility and worker reviews culminate in reports such as safety analysis documents, activity hazard documents, and radiological work authorizations and permits (LBNL 2006a).

These reports are used by the Environmental ALARA Program Leader to identify activities that have potential for radiological environmental impacts and that could require environmental ALARA analysis. All Class II and Class III (moderate- and high-hazard) authorizations issued by the Radiation Protection Group are reviewed by the Environmental ALARA Program Leader. In addition, Class III authorizations are routed to the program leader for review and approval (LBNL 2005a; LBNL 2005b). If the authorized activity impacts the environment significantly, the Environmental ALARA Program Leader communicates the results of the authorization review to the Radiation Protection Group and to the principal investigator responsible for the authorized work.

### **4.2 Review Radiological Impacts**

The Environmental Services Group reviews the radiological environmental impacts of the Laboratory and summarizes the results annually in the site environmental report, which is available to Berkeley Lab managers and employees, as well as members of the public (LBNL 2006c). Radiological impacts to the environment and public from Berkeley Lab operations are due to accelerator and irradiator operations, air emissions, and sewer discharges. The Environmental ALARA Program uses the results from monitoring accelerator and irradiator

operations, air emissions, soil, sediment, surface water, and sewer discharges to assess the radiological impacts of Berkeley Lab activities.

The Environmental Services Group determines environmental radiological impacts from penetrating radiation produced by accelerator and irradiator operations using two methods: (1) a network of real-time environmental monitoring stations located around the site perimeter to track instantaneous gamma and neutron radiological impacts, and (2) a network of thermoluminescent detectors located near the site boundary and offsite to measure time-averaged doses from gamma radiation. The group estimates radiological impacts from accelerator and irradiator operations at Berkeley Lab annually and reports the results in the site environmental report (LBNL 2006c).

The Environmental Services Group monitors radionuclides in stack and ambient air. Several air-sampling stations at Berkeley Lab monitor radionuclides in the ambient air, and the Environmental Services Group reports the results of this monitoring annually in the site environmental report (LBNL 2006c). For facilities where radionuclides are handled, the group measures or calculates stack emissions and resulting doses to the public and reports them annually (LBNL 2006b). Throughout the year, the Environmental Services Group reviews work authorizations for operations that have the potential to emit airborne radionuclides. Operations that have the potential to emit radionuclides to the environment that could result in an annual effective dose equivalent of  $1 \times 10^{-2}$  mrem or greater to the public are monitored using stack air sampling and analysis procedures that comply with the National Emissions Standards for Hazardous Air Pollutants (EPA 1989).

The Environmental Services Group samples Berkeley Lab's wastewater at two sewer outfalls and analyzes the water for radionuclides. The Environmental Services Group also samples soil, stream sediment, and creek water at several locations onsite and analyzes for radionuclides. The group uses the results of these analyses to confirm that the Lab is in compliance with biota dose limits. Results of sampling and biota dose evaluation are reported annually in the site environmental report (LBNL 2006c).

The compliance evaluation is documented annually in file save Environmental Services Group files and summarized in the site environmental report.

#### **4.3 Perform Qualitative ALARA Analyses**

Annually, the Environmental ALARA Program assesses the qualitative radiological impacts from Laboratory operations by performing a collective dose assessment that is communicated to scientific investigators, managers, and workers through the annual site environmental report. Periodically throughout the year, radiological impacts of Laboratory operations are assessed when the Environmental ALARA Program Leader reviews Class II and III (moderate- to high-hazard)

work authorizations and determines individual dose to the public. The results of work authorization reviews are maintained in the NESHAP files. If the authorization has significant impact on the environment, the results are communicated to the Radiation Protection Group and to the principal investigator responsible for the authorized work.

#### **4.4 Perform Quantitative ALARA Analyses**

Based on qualitative ALARA analyses, individual projects that could cause the potential dose to the public to exceed 1 mrem (individual) or 10 person-rem (collective) are subjected to quantitative ALARA analyses using the steps described below. Since 1996, no operations or facilities at Berkeley Lab have resulted in an individual dose to the public greater than 1 mrem or a collective dose greater than 10 person-rem, the Department of Energy's thresholds for quantitative ALARA analysis (DOE 1997).

Quantitative ALARA analyses include societal, technological, economic, and public policy considerations. In addition, these ALARA analyses consider DOE guidance for performing the following environmental ALARA assessments (DOE 1997).

- Identify possible candidate radiation protection systems, such as alternative operating methods or controls, that are reasonably achievable. The options should range from the most rudimentary (base case) to the most technologically sophisticated systems.
- Quantify exposures and doses to individuals and populations in the vicinity of the activity for each candidate radiation protection system.
- Quantify the economic factors, including the costs of purchasing, installing, operating, and maintaining the radiological protection system equipment, and the potential health effects associated with the exposure of people and any other direct or indirect cost resulting from exposures to radiation.
- Identify and estimate other health and nonhealth detriments and benefits.
- Evaluate process alternatives using a quantitative cost-benefit analysis optimization, when possible. If evaluations include assumptions, judgments, and limitations that cannot be quantified, and potential doses are well below the dose limit, qualitative analyses can be used with full documentation.
- Select one of the candidate radiation protection systems.
- Implement recommendations of the ALARA analysis and monitor the results.

A checklist of the following specific factors is prepared for a quantitative ALARA analysis (DOE 1997).

- Maximum dose to members of the public
- Collective dose to the population
- Doses to workers
- Applicable alternative processes (treatments, operating methods, or controls)

- Doses for each alternative evaluated
- Costs for each alternative evaluated
- Changes in costs among alternatives
- Societal and environmental (positive and negative) impacts associated with alternatives

Additional information, checklists, or analyses may be required in accordance with DOE guidance for performing environmental ALARA evaluations (DOE 1997). Results of a quantitative ALARA analysis are provided to the scientific investigators leading the project. If the potential dose from a chosen ALARA alternative exceeds 10 mrem effective dose equivalent to any member of the public in a year or a collective effective dose equivalent of 100 person-rem in a year, DOE will be notified.

## 5. TRAINING

Based on recent estimates of dose to the public from Berkeley Lab operations, only qualitative ALARA analyses are normally required. Much of the data and analysis used for environmental ALARA evaluations is developed and documented by the Radiation Protection Group as part of their routine work authorization processes.

The Environmental ALARA Program Leader is required to have the expertise to review and evaluate work authorizations for their application to the Environmental ALARA Program. In addition to expertise in radiation physics, the program leader must have knowledge of laboratory operations, radiological material handling, emission source characterization, radiation protection procedures, and dose modeling. These staff skills and qualifications for ALARA analyses are documented by Berkeley Lab's system of job classifications, which stipulates minimum personnel qualifications and experience levels.

If a quantitative ALARA analysis were to be performed, a broad array of disciplines might be required: computer modeling, dose and risk assessment, environmental monitoring and surveillance, engineering, environmental sciences, and others. Since one or two individuals may not have all of the requisite expertise for quantitative ALARA evaluations, discipline specialists should be available to support the Environmental ALARA Program Leader. In addition to Environmental Services Group staff, the following organizations may be requested to provide support: Facilities Department, Radiation Protection Group, and Waste Management Group.

The Environmental Services Group Leader and the Environmental ALARA Program Leader determine which areas of expertise will be required for a quantitative ALARA evaluation before the project is begun. If it is anticipated that staff with the required disciplines are not available, the Environmental Services Group Leader determines if supplemental training in specific technical areas is required.

## 6 RECORDS

Records will be kept to demonstrate that sufficient information was assembled and considered to support ALARA decisions. Records will be kept of actions taken to implement the ALARA policy in regulating exposures to the environment and members of the public, such as cost-benefit or other analyses performed for a quantitative ALARA assessments, and other factors that were important to the ALARA decision-making process. Qualitative and quantitative environmental ALARA analysis records are filed by the Environmental Services Group. Radiological work authorization and radiation work permit files are kept by the Radiation Protection Group.

Information used and generated by the Environmental ALARA Program will be documented and stored according to Berkeley Lab's records management policies and procedures. Records will be retained in an organized file system so that they are protected and easily accessed when needed. Records created by this procedure are reviewed after three years for transfer to the Berkeley Lab archives as described in the Laboratory's *Regulations and Procedures Manual* (LBNL 2000).

## 7 REFERENCES

- DOE 1991 U.S. Department of Energy, *DOE Guidance on the Procedures in Applying the ALARA Process for Compliance with DOE 5400.5*, Interim DOE Guidance (March 1991).
- DOE 1993 U.S. Department of Energy, *Radiation Protection of the Public and the Environment*, DOE Order 5400.5 (January 1993).
- DOE 1997 U.S. Department of Energy, *Applying the ALARA Process for Radiation Protection of the Public and Environmental Compliance with 10 CFR 834 and DOE 5400.5 ALARA Program Requirements*, draft DOE standard (April 1997).
- EPA 1989 U.S. Environmental Protection Agency, *National Emission Standards for Hazardous Air Pollutants*, 40 CFR Part 61, Subpart H (1989, as amended).
- LBNL 2000 Lawrence Berkeley National Laboratory, *Regulations and Procedures Manual*, Section 1.16, PUB-201 (April 2000).
- LBNL 2005a Lawrence Berkeley National Laboratory, *Radiological Work Authorization Program*, EHS Procedure 707, Revision 5, Radiation Protection Group (July 2005).
- LBNL 2005b Lawrence Berkeley National Laboratory, *Radiation Work Permit Program*, EHS Procedure 705, Revision 8, On-the-Spot Change 705-1, Radiation Protection Group (May 2005).
- LBNL 2006a Lawrence Berkeley National Laboratory, *Health and Safety Manual*, PUB-3000 (May 2006).

LBNL 2006b Lawrence Berkeley National Laboratory, *Radionuclide Air Emission Report for 2005*, Environmental Services Group (May 22, 2006).

LBNL 2006c Lawrence Berkeley National Laboratory, *Site Environmental Report for 2005, Volume I*, LBL-27170 (in preparation).