

Princeton University Plasma Physics Laboratory

RADIOLOGICAL ALARA PLAN

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REVISION 5

PPPL ALARA Program

1. Purpose

The purpose of this document is to describe the Princeton Plasma Physics Laboratory (PPPL) program to reduce individual and collective exposures to ionizing radiation to as low as is reasonably achievable (ALARA) and to minimize the spread of radioactive contamination. A primary objective of this program is to provide guidance to line management, workers, and operational health physics personnel in the application of ALARA principles approved by PPPL senior management.

2. Scope

The ALARA program applies to all PPPL operations that involve ionizing radiation and radioactive materials. ALARA requirements are designed to effectively reduce radiation exposures to PPPL employees, contractors, and the public and to minimize the spread of radioactive materials to the environment.

3. References

- a. Title 10 Code of Federal Regulations, Part 835
- b. DOE Manual PNL-6577, Health Physics Manual of Good Practices for Reducing Radiation Exposure to Levels that are As Low As Reasonably Achievable (ALARA).
- c. ICRP Publication 37, Cost/Benefit Analysis in the Optimization of Radiation Protection.
- d. PPPL Organization/Mission Statement No. O-021, ES&H Executive Board Charter.
- e. PPPL Organization/Mission Statement No. O-024, ALARA Review Committee Charter.
- f. PPPL ESHD-5008, Environment, Safety and Health Manual.

4. THE PPPL ALARA PROGRAM

a. Organizational Structure

The Health Physics Division Head is assigned responsibility by the Head, Environment, Safety, Health & Security Department, for the operation of the ALARA program. The ALARA Coordinator operates the ALARA Program on a day-to-day basis.

Managers, line supervisors, radiation protection personnel, and workers involved in projects that utilize or produce radioactive materials and/or ionizing radiation are responsible for, and have direct authority from, the PPPL Director to minimize exposure to a level as low as is reasonably achievable.

b. Administration

The ALARA Program functions through the ALARA Review Committee (ALARARC) which is a resource subcommittee of the ES&H Executive Board. The ES&H Executive Board (ES&HEB) is a standing PPPL committee which reports directly to the Deputy Director for Operations on environment, safety, and health issues.

The ES&H Executive Board is chaired by the PPPL Deputy Director for Operations and has a multi-disciplined membership of senior Laboratory managers. With respect to the ALARA program it advises the PPPL Director on realistic exposure goals and provides program oversight to ensure that ALARA considerations are adequately included in PPPL operations and that radiation exposures are necessary and ALARA.

The ALARA Review Committee is chaired by a Planning and Control Officer from the Business Operations group, and includes various project representatives and the ALARA Coordinator as members. The committee also includes a representative of the Engineering and Infrastructure Department, a representative for Construction, and a representative appointed by the Laboratory Director (currently serving as chair).

5. POLICY AND MANAGEMENT COMMITMENT

PPPL policy with respect to the ALARA concept is described as follows:

"It is the policy of the Princeton Plasma Physics Laboratory to conduct its operations and research in a manner such that the health and safety of employees, the environment, and the public are protected. Consistent with PPPL P-003, ES&H Policy, is committed, in all its activities, to reduce any safety or health risks associated with ionizing radiation to levels that are as low as reasonably achievable (ALARA). Both individual and collective exposures shall be maintained as far below DOE and PPPL administrative limits as social, economic, practical, and public policy considerations permit. The Princeton Plasma Physics Laboratory Radiological ALARA Plan is the implementing document which shall be used by line management to ensure that worker and public exposures to ionizing radiation are consistent with this policy."

PPPL senior management demonstrates its commitment to the ALARA concept by ensuring that the authority and resources are provided to adequately implement the PPPL ALARA program.

6. ASSIGNMENT OF RESPONSIBILITIES

a. The PPPL Director

The PPPL Director is responsible to ensure that clearly defined responsibilities are established to implement the ALARA program and ensures that adequate authority, commitment, and resources are provided to accomplish program objectives. He reviews the results of the program and approves exposure goals based on operational requirements. As the senior executive, he approves the ALARA Review Committee charter to oversee the effectiveness of the program.

b. ALARA Review Committee (ALARARC)

The ALARARC evaluates activities such as construction and design of facilities and systems, planned major modifications or work activities, as well as experimental test plans for radiological exposure, waste, and release minimization. The committee receives the results of radiological control reviews and audits, both internal and external, and reviews the overall conduct of the PPPL Radiological Control Program. In addition, the ALARARC is responsible for:

- Reviewing, for approval, plans for PPPL operations that may involve exposure to individuals of effective dose equivalents of one or more person rem.
- Reviewing radiation work permits for activities for which independent ALARA review is required as detailed in the PPPL ALARA Plan.
- Reviewing radiological control incidents and accidents that result in the initiation of Occurrence
- Reporting and recommending corrective measures to the ES&H Executive Board when requested.
- Recommending to management, via the ES&H Executive Board, realistic administrative radiological control levels and goals so that planned work can be accomplished both efficiently and with a minimum of exposure to workers and the public.
- Maintaining minutes of meetings, including approvals of any documentation.

c. PPPL Line Managers and Supervisors (including operations, construction, etc.)

PPPL Line Managers and Supervisors are responsible for the implementation of the ALARA program. This includes working to achieve assigned ALARA goals through preplanning of tasks that involve radiation and/or radioactive contamination to avoid unnecessary exposure and applying lessons learned from past major tasks so that future exposures can be reduced.

d. The ALARA Coordinator

The ALARA Coordinator or designee is responsible for providing technical support and assistance to management, staff, supervisors, planners, and design engineers for the implementation of the programmatic elements of the ALARA program. The ALARA Coordinator coordinates ALARA activities between line functions and the PPPL ALARARC and employs optimization methods to assure that occupational exposures are maintained ALARA when developing and justifying facility designs and physical controls. In addition, the ALARA Coordinator serves as a member of the ALARARC and maintains the documents that demonstrate compliance with ALARA policy and procedures that demonstrate the adequacy of the ALARA program implementation.

e. Head, Health Physics

The Head of the Health Physics Division (HHP) or his designee is responsible for interfacing with operations, maintenance, research, and other support group managers and supervisors to ensure that ALARA is implemented and the assigned goals are achieved. He recommends, through the ALARARC, radiological performance goals and administrative exposure control levels. He assists in the development and review of pertinent procedures and provides guidance to management and first line supervisors on program administration and achievement of their ALARA goals.

f. Health Physicists and HP Technicians

Health Physicists (HPs) and Health Physics Technicians (HPTs) are responsible for conducting radiological surveillances, establishing exposure and contamination controls, and prescribing protective requirements prior to and during radiological work to reduce occupational exposures and the spread of radioactivity. HPs and HPTs have the authority to prevent unsafe practices and to stop work and communicate to the appropriate level of management any unsafe conditions and associated corrective actions.

g. Design Engineers, Planners and Schedulers

Design Engineers, Planners and Schedulers are responsible for incorporating established ALARA design criteria into new facilities and modifications to existing facilities to reduce dose and control the spread of radioactivity to levels that are as low as is reasonably achievable.

h. Human Resources Division

The Human Resources staff is responsible for developing, maintaining, and providing appropriate training courses to instill an awareness and appreciation of the ALARA concept. Training includes: information on the biological effects of radiation; instruction in the relation of time, distance, and shielding to radiation protection; and the effects of ventilation, filtration, and containment on the spread of and exposure to radioactive contaminants.

i. Radiation Workers

Radiation workers are responsible for reducing their exposure and the spread of radioactivity as low as is reasonably achievable by strict adherence to approved procedures, compliance with PPPL radiological control requirements, reporting any radiological problems and following established good work practices.

7. ADMINISTRATIVE EXPOSURE LIMITS

The DOE occupational exposure limits for general employees, which are specified in 10 CFR 835.202, in part, require that exposures shall be controlled so as not to exceed an annual total effective dose equivalent of 5 rem whole body (external plus internal). At PPPL, the annual administrative exposure limit is 1 rem/calendar year. The quarterly limit is 600 mrem per calendar quarter. These levels are based on an evaluation of historical and projected radiation exposures, workload, and mission. Administrative exposure limits are meant to be challenging as well as realistic. In any case, they are established below the DOE administrative limit. Care is taken to avoid merely trading individual for collective exposure. The Administrative exposure limit system approved for use at PPPL is a graded approach designed to initiate management review of existing exposure conditions at reference levels established below DOE administrative limits. Once the PPPL exposure limit has been reached, review and approval by the HP Manager and the ES&HEB are required to exceed these levels.

Administrative exposure limits are reviewed by the ALARARC whenever major changes in the PPPL experimental program occur, but at a minimum, once each calendar year. Recommendations designed to challenge or change exposure limits are presented by the ALARARC for approval to ES&HEB.

8. RADIOLOGICAL PERFORMANCE GOALS

At least once each calendar year, the ALARARC recommends and the PPPL ES&HEB approves radiological goals designed to improve overall PPPL radiation control performance. Goals are based on the PPPL experimental program and on data and recommendations supplied by the ALARARC. Quantitative radiological goals include:

- Annual collective dose for the facility. Actual doses received are tracked to improve the performance of non-routine and high exposure radiological tasks.
- Maximum individual dose.
- Square footage of facility contaminated areas.
- Radioactive waste volume and activity in cubic feet and Curies, respectively.

The goals established are motivators for improvement. Their purpose is to improve and monitor health protection performance. Goals are designed to be challenging, clear, achievable, and based on standards of excellence. PPPL senior management decides, with the assistance of the ALARARC, which areas need improvement. Line management evaluates existing conditions, determines the improvement needed, identifies the root causes for any deficiencies noted, and develops corrective action plans.

The ALARA Coordinator, together with the ALARA Chair, reviews goal achievement periodically and modifies action plans as necessary. At least annually, a formal summary of performance related to efforts in dose reduction and contamination minimization and in achieving the facility's radiological goals is developed for the ES&HEB by the ALARA coordinator in consultation with line management. This report includes a comparison of performance to established goals, an estimate of collective dose saved, the number of individuals that exceeded administrative exposure control levels together with the justification for the approval to exceed these levels, and recommendations for improvement.

9. ALARA Training

PPPL employees and PPPL contracted workers who may enter a radiologically controlled area receive an orientation on the PPPL ALARA policy and philosophy and their biological bases. Radiation workers and radiation protection technicians receive additional ALARA training in addition to the basic orientation. In this instance, ALARA training is combined with Radiation Worker training. Retraining is conducted at intervals not to exceed 2 years.

a. Radiological Workers

In addition to the basic orientation, radiological workers receive instruction in specific procedures that have been developed to control dose and the spread of radioactive materials for the type of work undertaken. Retraining for radiological workers is conducted at intervals determined by the Human Resources Division.

Specialized radiological worker training is completed for non-routine operations or for work in areas with changing radiological conditions. This training is required for personnel who plan, prepare, and perform jobs that have the potential for high radiological consequences. Such jobs may involve special containment devices, the use of mockups, and other ALARA controls.

b. Health Physics (Radiological Control) Technicians

In addition to the training given to radiation workers, Health Physics Technicians receive training in their responsibilities in implementing the ALARA program.

ALARA training is provided, as part of General Employee Training, to engineers, schedulers, procedure writers, planners, and other radiological support personnel who are responsible for implementing the PPPL ALARA program. To demonstrate compliance with regulatory requirements, training is documented and training lesson plans, attendance records, and examinations generated are maintained by the PPPL Human Resources Division.

10. Plans and Procedures

The PPPL ALARA Program described herein together with its supporting procedures are reviewed every two years to determine their applicability to the PPPL experimental program and their compliance with current DOE policy. Maintenance and modification of plans and operating procedures for activities involving the handling of radioactive materials, the potential for significant exposure rates, or the potential to spread radioactive materials are reviewed for their radiation safety implications.

The ALARA policy and procedures documents that reflect the scope and depth of the program are:

- The PPPL ALARA policy statement
- The PPPL ALARA organization and responsibilities statement
- Documentation of ALARA audits
- The ALARARC Charter
- The PPPL Radiation Work Permit procedure

11. Internal Audits

Documented internal audits of all functional elements of the PPPL Radiological Protection Program, including ALARA, are conducted every three years by PPPL QA. As part of their charters, oversight and reviews are also performed by the ES&H Executive Board and the ALARARC.

Additionally, management assessments are performed periodically per QA-025.

12. OPTIMIZATION METHODOLOGY

A formal optimization methodology is used to assure that occupational exposure is maintained ALARA in developing and justifying facility design and physical controls. Decisions on the costs and benefits of reducing occupational doses include judgments on the relative value of social, technical, and economic factors.

The level of effort involved in documenting ALARA decisions is maintained commensurate with the costs and potential dose savings to be realized. A detailed optimization evaluation is not made if its cost, together with the cost of documentation, outweigh the potential value of the benefits realized. The evaluation process includes a cost/benefit methodology used to judge the appropriateness of dose reduction and contamination minimization decisions.

13. RADIOLOGICAL DESIGN REVIEW

At PPPL, during routine operations, design features and administrative controls are used for facilities and equipment to control exposure. This combination provides that the anticipated magnitude of the total effective dose equivalent shall not exceed 5 rem in a year; the anticipated magnitude of the committed dose equivalent to any organ or tissue,

plus any deep dose equivalent from external exposure, shall not exceed 50 rem in a year; and exposure levels are as low as reasonably achievable.

At PPPL, when new facilities are designed or old facilities are modified the following applies:

- In areas of continuous occupational occupancy (> 2000 hours per year), the design objective for controlling personnel exposure from external sources of radiation is to maintain exposure levels below an average of 0.5 mrem per hour and as far below this average as is reasonably achievable.
- In areas where occupational occupancy is non-continuous, the design objective for exposure rates for potential exposure to radiological workers does not exceed 20 percent of the applicable standards in 10 CFR 835.202 and as far below this limit as is reasonably achievable.
- In areas where airborne radioactivity can be generated, the design objective, under normal conditions, is to avoid releases to the workplace atmosphere and in any situation, to control the inhalation of such material by workers to levels that are ALARA, and to use confinement and ventilation to control airborne radioactive materials.
- In areas where ionizing radiation is to be used or stored, the design objective is to select materials that include features that facilitate operations, maintenance, decontamination, and decommissioning.

From early in the design phase and throughout, when appropriate, a representative of Health Physics is assigned as a member of the design team to ensure that radiological design criteria and practices are incorporated into major modifications of existing facilities and equipment and the construction or acquisition of new facilities and equipment. This individual assists to ensure that reasonable radiological considerations have been integrated into designs, construction, operating procedures, and in plans for decommissioning. In addition, an independent radiological safety review is made throughout the design process. The following tasks may be undertaken as part of this independent review:

- Review of the general configuration of the facility, the location of radiologically controlled areas, and adequacy of change rooms, personnel decontamination facilities, operational and maintenance space, and decommissioning plans.
- Verification that facility design and selection of materials include features that facilitate operation, maintenance, decontamination, and decommissioning.
- Verification that radiological design criteria are consistent with applicable federal and state regulations and with appropriate DOE directives relating to radiological safety in design.
- Verification that the design of confinement and ventilation systems provides the required level of protection from airborne contamination. Releases of radioactive material to the workplace atmosphere are avoided under normal conditions and inhalation of such materials by workers is controlled to the extent reasonably achievable.

- Evaluation of the adequacy of specific control devices for reducing occupational exposures, including shielding, hoods, glove boxes, containments, interlocks, barricades, shielded cells, decontamination features, and remote operations.
- Verification that external sources of radiation in areas of continuous occupational occupancy (> 2,000 hours/year) are maintained below an average of 0.5 mrem per hour and as far below this average as is reasonably achievable. For areas of non-continuous occupational occupancy, external exposure rates may not exceed 20% of the regulatory limit in 10 CFR 835.202.
- Verification that the design is able to maintain personnel entry control for each radiological area, commensurate with existing or potential radiological hazards within the area, by using one or more of the methods required by federal regulation (10 CFR 835.501).
- Verification that the entrance of each access point to high and very high radiation areas have the control features required by federal regulation (10 CFR 835.502).
- Assessment of the adequacy of planned radiation monitoring, including whether the proposed instrumentation is appropriate for the expected types and intensities of radiation, and whether it has sufficient redundancy and capability for operation under normal operating conditions and in emergencies.

During design review the following may be considered to implement ALARA considerations:

- Dose assessment.
- Comparison of radiological conditions with management established radiological Goals
- Identification of the applicable radiological design criteria
- Review of previous similar jobs to select optimum alternatives
- Incorporation and documentation in the design package of features to reduce dose and the spread of radioactive materials
- Post construction review of effectiveness of engineering features to reduce dose and the spread of radioactive materials.

14. RADIOLOGICAL WORK/EXPERIMENT PLANNING

During routine PPPL operations, the administrative control used as a supplement to facility design to limit workers' exposures and the spread of radioactivity to as low as can be reasonably achieved is the Radiation Work Permit.

a. The Radiation Work Permit (RWP)

Radiation Work Permits are issued to control work activities and thereby limit exposures in radiologically controlled areas that are not controlled by a specific, approved radiation protection procedure. RWPs are initiated by the organization that wishes to enter and/or work in a radiologically controlled area. The HHP, after a

review of the radiological conditions that will be encountered, determines and lists the radiation control requirements and restrictions for the proposed entry and/or work. RWP's are reviewed by the ALARA coordinator or his designee to ensure that exposures received will be ALARA. The Project Supervisor signs each RWP so that work can be coordinated with operational requirements and schedules.

ALARA reviews take into account not only radiological conditions under which the work will be performed, but also the work itself. ALARA recommendations include alternative methods to reduce exposures ALARA and accomplish work activity. As the potential for greater exposure increases, the ALARA review becomes more substantial. Work that entails only slight potential for exposure receives less ALARA attention.

b. Job/Experiment Review (JER)

JER is not a formal process at PPPL. However, the ALARA aspects of work that involves the potential for exceeding radiological thresholds established by PPPL management is considered during the normal planning of work tasks. The need for such a review is integrated with the RWP process. The ALARA aspects of a job or experiment are considered in three phases: (1) pre-job planning and dose assessment; (2) implementation of ALARA controls and dose tracking; and (3) post-job review.

Pre-job planning consists of estimation of the collective dose equivalent for the job/experiment and comparison to an established threshold. Controls needed to reduce exposures and/or the spread of contamination ALARA are developed and imposed. Before planned special exposures, the individuals involved are instructed in measures to be taken to keep dose ALARA, considering other risks that may be present.

During the work or experiment phase, periodic inspections are made by the Health Physics Division to ensure that ALARA controls are being implemented and are effective. In addition, collective dose and contamination levels caused by ongoing work are tracked by the HP Division and periodically compared to pre-job dose and contamination estimates to determine if intervention is needed.

An ALARA post-job review is held when:

- The job results in a collective dose equivalent of 1 person-rem or greater
- Actual job doses fall above 50% of pre-job estimates
- Stop work authority was used during the course of the work
- The work resulted in the issuance of a radiological occurrence report
- Significant lessons learned are identified

Post-job reviews compare actual person-hours and person-rem with original estimates, evaluate the effectiveness of the ALARA controls imposed, document the lessons learned, and provide recommendations to reduce dose for future, similar activities. Records of post-job reviews are maintained so that they can be readily retrieved.

15. ALARA Records

Records of major actions taken to maintain occupational exposures as low as is reasonably achievable are retained until final disposition is authorized by the DOE. This program and the related procedures and instructions describe the generation and retention of those records which document actions considered or taken to maintain occupational doses and the spread of radioactive material ALARA. All documents and legal records utilized to demonstrate ALARA program adequacy and implementation are checked and approved by the HP Division. The records and documents normally considered as part of this program are:

- Dose and intake authorizations to exceed administrative control levels
- Exposure investigation forms
- Radiological goals, status, and annual performance records
- Pre-job exposure estimates, along with actual exposure received
- Collective doses received by the total facility, by specific work groups, and for specific high dose jobs
- ALARA audit findings and responses
- ALARARC meeting minutes
- Radiation Work Permits