TABLE OF CONTENTS

RADIATION PROTECTION DESIGN (Programmatic & Facility) 1
1.0 Application of Chapter 1
2.0 Responsibilities 2
3.0 Design Criteria 3
4.0 Acronyms and Definitions 7
5.0 Attachments 8

RECORD OF REVISIONS

Rev	Date	Description	POC	OIC
0	2/9/04	Initial issue.	William Eisele, *HSR-12*	Gurinder Grewal, *FWO-DO*
1	10/27/06	Administrative changes only. Updated references, other administrative changes.	Art Crawford, *RP-3*	Kirk Christensen, *CENG-OFF*
1 Chg 1	11/25/08	Revised 3.2.L and 3.2.Q on fluence-to-dose conversion factors and conditions requiring a formal radiological engineering analysis and design review.	Art Crawford, *RP-3*	Kirk Christensen, *CENG-OFF*
2	01/08/18	Revised scope, responsibilities, and design criteria; reordered, updated references. Appendix redesignated as Attachment. Formerly UniFormat F1030.2.	Steve Costigan, *RP-PROG*	Larry Goen, *ES-DO*

PLEASE CONTACT THE ESM RAD PROTECTION POC
for upkeep, interpretation, and variance issues

RADIATION PROTECTION DESIGN (PROGRAMMATIC & FACILITY)

1.0 APPLICATION OF CHAPTER

A. This chapter helps ensure that facilities with hazards from ionizing radiation are designed and constructed to prevent accidents and mitigate consequences; yet are efficient, convenient, and adequate for good service; minimize the generation of hazardous, radioactive, and mixed waste; and are maintainable, standardized, and adequate for future expansion.

B. This chapter contains requirements and guidance that applies to design and construction, both new construction and modification of existing installations for new efforts as

described by PD340, Conduct of Engineering and Configuration Management for Facility Work.

This chapter shall be used in conjunction with LANL Procedure P121, *Radiation Protection*, which outlines the requirements from the federal requirements of Title 10 CFR Part 835, *Occupational Radiation Protection*. Other drivers include DOE Order 420.1C, *Facility Safety*; DOE Order O 420.2C, *Safety of Accelerator Facilities*; ANSI N43.3, *Installations Using Non-Chemical X-Ray and Sealed Gamma-Ray Sources, Energies up to 10 MeV*; ANSI N43.2, *Radiation Safety for X-Ray Diffraction and Fluorescence Analysis Equipment;* ANSI N34.17, *Radiation Safety for Personnel Security Screening Systems using X-rays or Gamma Radiation;* and DOE O 458.1*, Admin Chg 3, Radiation Protection of the Public and the Environment.*

Note: DOE Order 420.1C is a document that incorporates the federal requirements of Title 10 Part 835 *Occupational Radiation Protection Requirements*. References to 10CFR835 herein cover the requirements of DOE Order 420.1C and its guide. Therefore, this chapter, along with other chapters of the Engineering Standards Manual, comprehensively implements requirements and guidance in *DOE O 420.1C, Facility Safety*, and its guide, *DOE G 420.1-1, Nonreactor Nuclear Safety Design Criteria and Explosive Safety Criteria Guide for use with DOE O 420.1 Facility Safety* along with providing additional requirements.

C. Use this chapter along with the ESM Chapter 1–General, Chapter 10–Hazardous Process, Chapter 12–Nuclear, and other ESM chapters as applicable.

D. Variances and Alternate Methods: In addition to the variance requirements in ESM Chapter 1 Section Z10, approval of the RP Division Leader is also required on the variance form 2137.

E. WARNING: Failure of nuclear facilities/activities to comply with the 10 CFR 835 requirements that are further promulgated by DOE O 420.1C could result in civil enforcement under PAAA. LANL cannot waive these requirements without going through a formal exemption process with NNSA/DOE approval in accordance with 10CFR820.

Note: Guidance statements are in *ITALICS* and generally follow the paragraph they support.

F. All new facility-related design, material, equipment, and installations shall comply with the requirements in this chapter and Chapter 1 of the ESM. This entire chapter is also applicable to programmatic structures, systems, and components (SSC) unless specifically noted otherwise.

2.0 RESPONSIBILITIES

2.1 The Project Engineer shall ensure that:

- Projects receive radiological engineering design input from a Radiological Engineer as defined, as early as possible during the design process.
- Input from a Radiological Engineer is implemented in the design.
- The Radiological Engineering Design Analysis of the design is performed before actual construction or modification begins.
- Documentation is maintained on all actions taken to maintain exposures ALARA, including facility design and controls.

2.2 The RP-PROG Group Leader shall:

- Ensure that Radiological Engineering Program members are qualified.
- Authorize those not in the Radiological Engineering Program to perform a Radiological Engineering Design Analysis and require that the analysis be peer reviewed by a Radiological Engineer.
- Identify radiological subject matter experts to ensure appropriate design features and considerations are incorporated in the design through the design and design review process.
- Qualify Radiological Engineers

2.3 The Radiological Engineer shall:

- Perform a design analysis determination to ensure the necessity of a Radiological Engineering Design Analysis.
- Perform a formal radiological design review at appropriate design phases. The formal radiological engineering and operational review of the design shall be performed before actual construction or modification begins.
- Ensure deployed management are informed of activities that may affect operations
- Review and submit comments, when required, during formal design reviews as part of the engineering process.
- Peer review Radiological Engineering Design Analysis by other Radiological Engineers.
- Be authorized by the RP-PROG Group Leader.

3.0 DESIGN CRITERIA[1]

3.1 Regulatory Requirements

The following requirements are derived from P121 and the LANL Radiation Protection Program. 10CFR835 and other supporting documents help to implement these requirements.

A. When a new facility or modification to an existing facility is planned, the design project management team shall notify and coordinate with RP-PROG Radiological Engineering Team for radiological engineering design support and/or review of the project design.[2]

1. A radiological design and design review must be performed if any of the following conditions are expected to prevail for a new facility/equipment or modification of existing facility/equipment:

   a. Dose rate exceeds 0.5 mrem per hour at 30 cm from any surface in the facility or areas occupied by radiological workers during routine operations.

   b. A reasonable potential for inhaling airborne radioactive material in the facility during routine operation is present.

[1] DOE G 420.1-1

[2] P121-12.1221

c. A reasonable potential for contamination exceeding Table 14-2, Chapter 14, P121-5, contamination values in the facility during normal operations is present.

d. A reasonable potential for public or non-radiological worker exposure worker exposure during routine operation is present.

2. A determination shall be performed, using RP-Form 068.3, by a radiological engineer. The design drawings and written design documents must be reviewed and approved by a RP-PROG Radiological Engineering as designated by the RP-PROG Group Leader.[3]

C. Measures shall be taken to maintain radiation exposure in controlled areas as low as reasonably achievable (ALARA) through physical features and administrative control.[4]

ALARA is the approach to radiological control that manages and controls exposures (individual and collective) to the work force and to the general public to levels that are as low as reasonably, taking into account social, technical, economic, practical, and public policy considerations. ALARA is not a dose limit but a process that has the objective of attaining doses as far below the applicable controlling limits as is reasonably achievable

1. The primary methods used shall be physical features (e.g., confinement, ventilation, remote handling, and shielding).[6]
2. Administrative controls shall only be employed as supplemental methods to control radiation exposure.[6]
3. For specific radiological activities, where design features have been demonstrated to be impractical, administrative controls shall be used to maintain radiation exposure ALARA.[5]
4. The combination of engineered and administrative controls must be sufficient to ensure that, during routine operation, the Table 4-2 of P121 dose limits for each type of worker are not exceeded and occupational doses are maintained ALARA [see 835.1003(a), .1003(b)]; and[6] [7]
5. The use of administrative controls instead of physical controls shall be documented and approved by the Project Lead and the Project Radiological Engineering Coordinator.

D. Occupational exposure is maintained ALARA by using optimization methods in developing and justifying facility design and engineered controls.[8]

E. Continuously Occupied Areas for Radiological Workers – The design objective shall be to maintain exposure levels ALARA and below an average of 0.5 mrem per hour. Continuous occupancy (2000 hours/year) must be assumed unless the occupancy for the

[3] Ibid.
[4] 10CFR835.1001(a)
[5] 10CFR835.1001(b)
[6] 10CFR835.1003(a)
[7] 10CFR835.1003(b)
[8] 10CFR835.1002(a)

activity and area has been well-established, documented, and committed to by the line management and Project Design Team.[9]

F. Non-Continuously Occupied Areas for Radiological Workers – The design objective shall be to maintain exposure levels ALARA and below 20% of the applicable standard in 10CFR835.202 in areas not continuously occupied (less than 2000 hours per year) as outlined in Table 1.[10]

Table 1. Occupational and Design Dose Limits

Type of Dose Limit	**Annual Dose Limit** ISD 121-1/ 10CFR835.202 **(rems)**	**Design Dose Limit** 20% of Annual Dose Limit **(rem)**	**(mrem)**
Total Effective Dose Equivalent	5	1	1,000
Deep Dose Equivalent	50	10	10,000
Lens of Eye Dose Equivalent	15	3	3,000
Shallow Dose Equivalent (skin and any extremity)	50	10	10,000

G. Nonradiological Workers - For areas occupied by nonradiological workers and members of the public, the design objective must be to maintain the average exposure level ALARA and below 0.1 rem per year by use of physical and/or administrative controls.

H. Airborne Radioactive Material - Design shall ensure that, under normal conditions, the design avoids the release of airborne radioactive material to the workplace and, in any situation, the design must control the inhalation of such material by workers to levels that are ALARA. Confinement, ventilation, and cascading airflow are the primary means to accomplish this design requirement.[11]

I. Selected Material for Radiological Area – Design objective shall be to select appropriate materials in facility construction or modification to facilitate operations, maintenance, decontamination, and decommissioning.[12]

J. Workplace Monitoring – The design shall incorporate appropriate radiation monitoring devices to demonstrate the occupational/LANL on-site radiation exposure levels are ALARA.

K. Startup Surveys - After construction of new facilities/equipment or modification of facilities/equipment, radiological surveys must be performed during startup through full operations to ensure that established design objectives have been met.

L. Area for Radiological Operations - Sufficient areas must be properly designed and provided for access to radiological operations, to include donning and doffing of protective clothing, instrumentation, change rooms and showers, and storage of equipment, personal protective equipment (PPE), and supplies.

[9] 10CFR835.1002(b)
[10] Ibid.
[11] 10CFR835.1002(c)
[12] 10CFR835.1002(d)

M. Traffic Flow - New facilities and facility modifications must be designed to optimize traffic flow, contamination control, and ALARA practices, while minimizing commingling.

N. Support Areas – Support areas must be provided and be adequately sized and located for DESH personnel, activities, and equipment.

O. Engagement - When a new facility/equipment or modifications to an existing facility/equipment are planned, the design project team must engage and obtain radiological design support from the RP-PROG Radiological Engineering Team at the earliest practicable time in the design process and retain this support through design, review cycles, construction, and startup.

P. Design Documents - The design drawings and written design documents relating to radiological design must be reviewed and approved by an RP-PROG Radiological Engineering Team professional as designated by the RP-PROG Group Leader.

Q. Dose conversion factors (DCF) used in radiation protection calculations (such as fluence and inhalation DCFs) shall be approved by the RP-PROG Radiological Engineering Program. DCFs shall be selected based on the application of the results and shall be formally documented as part of the calculation write up.

R. Temporary Modifications - For temporary modifications to facilities/equipment, design criteria of this section may be achieved through the New Activity ALARA Review and work controls as required in P121, Chapter 11, Radiological Work Control.[13]

3.2 Design Considerations and Features (Guidance)

A. Attachment A has a list of radiological functional and design considerations and features to ensure the above mentioned design objectives and requirements are met. The radiological design considerations and features provided in Attachment A are not inclusive and not every item is required for every radiological design due to the type of operation or facility. The project shall have a radiological engineer to assist in the design process and determine the design features needed to be considered by the project and which items do not. Additional design items might need to be considered based on the design of a new or modified operation or facility. *The functional and design criteria areas in Attachment A are:*

1. *Function Requirement Document (FRD) and Radiological Design Criteria*
2. *Safety Analysis*
3. *ALARA and Radiological Design Plan*
4. *Radiological Design Scope*
5. *Radiological Condition*
6. *Facility/Operational Layout*
7. *Installation and Setup Considerations in an Active Radiological Area*
8. *Maintenance and Operations*
9. *Shielding and Dose Rate Determination*
10. *Contamination Control*

[13] Temp mod of configuration management SSCs in many LANL operating facilities is controlled by CoE AP-341-504, *Temporary Modification Control (it generally limits such mods to 6 months duration*).

11. *Access Control*
12. *Liquid Systems (Tanks, Pumps and Sumps, and Slurry Systems)*
13. *Piping*
14. *Instrumentation*
15. *Ventilation*
16. *Filters and Demineralizers*
17. *Supplied Personnel Breathing Air*
18. *Implementation or Modification Design Considerations*
19. *Waste Minimization*
20. *DOE Standards*

Note: Additional requirements and guidance on some topics above are contained in other ESM chapters. In the case of conflict, requirements elsewhere take precedence over this guidance; conflicting guidance shall be resolved by the Radiation Protection POC and the POC of the respective discipline. Decision and outcome shall be documented and approved by both POCs.

3.3 Assistance for Radiological Engineering Design of Operations and Facilities

A. Contact the RP-PROG Radiological Engineering Team Leader if you have any questions, concerns, clarification or need assistance for any radiological design effort. If unavailable, others on the Radiological Engineering Team are available. The phone number for the RP-PROG Group Office is (505) 667-7171.

4.0 ACRONYMS AND DEFINITIONS

ALARA	An approach to radiological control to manage and control exposures (individual and collective) to the work force and to the general public at levels that are as low as is reasonable, taking into account social, technical, economic, practical, and public policy considerations. ALARA is not a dose limit but a process which has the objective of attaining doses as far below the applicable limits of 10 CFR 835 as is reasonably achievable.
CAM	Continuous air monitor.
commingling	The ability of an individual in or from a radiologically controlled area and an individual in an uncontrolled area to come in contact with each other.
design agency	The organization performing the detailed design and analysis of a project or modification.
ESM	Engineering Standards Manual (STD-342-100)
facility	Normally at LANL, facility is a synonym for Real Property and Installed Equipment. RP&IE is the land, improvements on the land such as buildings, roads, fences, bridges, and utility systems and the equipment installed as part of the basic building construction that is essential to normal functioning of a building space, such as plumbing, electrical and mechanical systems. This property/equipment is also referred to as institutional or plant and was formerly known as Class A. [from DOE Order 4330.4B, archived] **In the context of this chapter, facility follows the definition of nuclear facility in 10 CFR 830 which includes process (programmatic) systems and activities.**

FRD	The Functions & Requirements document (FRD, if present), along with the Requirements and Criteria Document (RCD), establishes the tasks, activities, operations, support facility or system process requirements, and specific operations and facility characterization data in sufficient detail to permit the project to quantify and qualify project design requirements.
mixed waste	MW contains both hazardous waste (as defined by RCRA and its amendments) and radioactive waste (as defined by Atomic Energy Act and its amendments). It is jointly regulated by NRC or NRC Agreement States and EPA or EPA's RCRA Authorized States. The fundamental and most comprehensive statutory definition is found in the Federal Facilities Compliance Act (FFCA) where Section 1004(41) was added to RCRA: "The term 'mixed waste' means waste that contains both hazardous waste and source, special nuclear, or byproduct material subject to the Atomic Energy Act of 1954."
ML	Management level, defined in AP-341-502, Management Level Determination
optimization	To demonstrate the expense (e.g., money, person-rem, dose to install and maintain, etc.) of a project or feature of a project is justified in terms of the benefit received. This is in accordance with the idea of balancing ALARA considerations against technological, social, operational, and economic considerations.
POC	Point of contact. For the ESM discipline POCs see http://engstandards.lanl.gov/POCs.shtml
Project Lead	Project manager (assigned by organization), project leader (assigned by PM Division) or other designated individual responsible for the management and overall design effort of the project.
Project Manager	Individual assigned by the User/Program Office and is responsible for the project.
programmatic	A synonym for Personal Property and Programmatic Equipment. PP&PE is equipment used purely for programmatic purposes, such as reactors, accelerator machinery, chemical processing lines, lasers, computers, machine tools, etc., and the support equipment dedicated to the programmatic purpose. This property/equipment is also referred to as organizational, research, production, operating or process and was formerly known as Class B. [DOE Order 4330.4B, archived]
SSC	Structures, systems, and components.

5.0 ATTACHMENTS

Attachment A, Radiation Protection Design Considerations and Features (Guidance)