CHAPTER 12

RADIATION PROTECTION

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RADIATION PROTECTION

12.1 ASSURING THAT OCCUPATIONAL RADIATION EXPOSURES ARE AS-LOW-AS-REASONABLY ACHIEVABLE (ALARA)

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

STD COL 12.1-1 This section incorporates by reference NEI 07-08, Generic FSAR Template Guidance for Ensuring That Occupational Radiation Exposures Are As Low As Is Reasonably Achievable (ALARA), Revision 0, which is currently under review by the NRC staff. See Table 1.6-201.

Add the following information at the end of DCD Subsection 12.1.2.3:

12.1.2.4.3 Equipment Layout

STD SUP 12.1-1 A video record of the equipment layout in areas where radiation fields are expected to be high following operations may be used to assist in ALARA planning and to facilitate decommissioning.

12.1.3 COMBINED LICENSE INFORMATION

STD COL 12.1-1 This COL item is addressed in NEI 07-08 and Appendix 12AA.

12.2 RADIATION SOURCES

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

12.2.1.1.10 Miscellaneous Sources

Add the following information at the end of DCD Subsection 12.2.1.1.10:

STD COL 12.2-1 Licensed sources containing byproduct, source, and special nuclear material that warrant shielding design consideration meet the applicable requirements of 10 CFR Parts 20, 30, 31, 32, 33, 34, 40, 50, and 70.

There are byproduct and source materials with known isotopes and activity manufactured for the purpose of measuring, checking, calibrating, or controlling processes quantitatively or qualitatively.

These sources include but are not limited to:

- Sources in field monitoring equipment.
- Sources in radiation monitors to maintain a threshold sensitivity.
- Sources used for radiographic operations.
- Depleted uranium slabs used to determine beta response and correction factors for portable monitoring instrumentation.
- Sources used to calibrate and response check field monitoring equipment (portable and fixed).
- Liquid standards and liquids or gases used to calibrate and verify calibration of laboratory counting and analyzing equipment.
- Radioactive waste generated by the use of radioactive sources.

Specific details of these sources are maintained in a database on-site following procurement. This database, at a minimum, contains the following information:

- Isotopic composition
- Location in the plant
- Source strength

- Source geometry

Written procedures are established and implemented that address procurement, receipt, inventory, labeling, leak testing, surveillance, control, transfer, disposal, storage, issuance and use of these radioactive sources. These procedures are developed in accordance with the radiation protection program to comply with 10 CFR Parts 19 and 20. A supplementary warning symbol is used in the presence of large sources of ionizing radiation consistent with the guidance in Regulatory Issue Summary (RIS) 2007-03.

Sources maintained on-site for instrument calibration purposes are shielded while in storage to keep personnel exposure ALARA. Sources used to service or calibrate plant instrumentation are also routinely brought on-site by contractors. Radiography is performed by the licensed utility group or licensed contractors. These sources are maintained and used in accordance with the provisions of the utility group's or contractor's license. Additional requirements and restrictions may apply depending on the type of source, use, and intended location of use. If the utility group or contractor source must be stored on-site, designated plant personnel must approve the storage location, and identify appropriate measures for maintaining security and personnel protection.

12.2.3 COMBINED LICENSE INFORMATION

STD COL 12.2-1 This COL item is addressed in Subsection 12.2.1.1.10.

12.3 RADIATION PROTECTION DESIGN FEATURES

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

12.3.4 AREA RADIATION AND AIRBORNE RADIOACTIVITY MONITORING INSTRUMENTATION

Add the following text to the end of DCD Subsection 12.3.4.

STD COL 12.3-2 Procedures detail the criteria and methods for obtaining representative measurement of radiological conditions, including in-plant airborne radioactivity concentrations in accordance with applicable portions of 10 CFR Part 20 and consistent with the guidance in Regulatory Guides 1.21-Appendix A, 8.2, 8.8, and 8.10. Additional discussion of radiological surveillance practices is included in the radiation protection program description provided in Appendix 12AA.

Surveillance requirements are determined by the functional manager in charge of radiation protection based on actual or potential radiological conditions encountered by personnel and the need to identify and control radiation, contamination, and airborne radioactivity. These requirements are consistent with the operational philosophy in Regulatory Guide 8.10. Frequency of scheduled surveillance may be altered by permission of the functional manager in charge of radiation protection or their designee. Radiation Protection periodically provides cognizant personnel with survey data that identifies radiation exposure gradients in area resulting from identified components. This data includes recent reports, with survey data, location and component information.

The following are typical criteria for frequencies and types of surveys:

Job Coverage Surveys

- Radiation, contamination, and/or airborne surveys are performed and documented to support job coverage.
- Radiation surveys are sufficient in detail for Radiation Protection to assess the radiological hazards associated with the work area and the intended/ specified work scope.
- Surveys are performed commensurate with radiological hazard, nature and location of work being conducted.
- Job coverage activities may require surveys to be conducted on a daily basis where conditions are likely to change.

Radiation Surveys

- Radiation surveys are performed at least monthly in any radiological controlled area (RCA) where personnel may frequently work or enter. Survey frequencies may be modified by the functional manager in charge of radiation protection as previously noted.

- Radiation surveys are performed prior to or during entry into known or suspected high radiation areas for which up to date survey data does not exist.

- Radiation surveys are performed prior to work involving highly contaminated or activated materials or equipment.

- Radiation surveys are performed at least semiannually in areas outside the RCA. Areas to be considered include shops, offices, and storage areas.

- Radiation surveys are performed to support movement of highly radioactive material.

- Neutron radiation surveys are performed when personnel may be exposed to neutron emitting sources.

Contamination Surveys

- Contamination surveys are performed at least monthly in any RCA where personnel may frequently work or enter. Survey frequencies may be modified by the functional manager in charge of radiation protection as previously noted.

- Contamination surveys are performed during initial entry into known or suspected contamination area(s) for which up to date survey data does not exist.

- Contamination surveys are performed at least daily at access points, change areas, and high traffic walkways in RCAs that contain contaminated areas. Area access points to a High Radiation Area or Very High Radiation Area are surveyed prior to or upon access by plant personnel or if access has occurred.

- Contamination surveys are performed at least semiannually in areas outside the RCA. Areas to be considered include shops, offices, and storage areas.

- A routine surveillance is conducted in areas designated by the functional manager in charge of radiation protection or their designee likely to

indicate alpha radioactivity. If alpha contamination is identified, frequency and scope of the routine is increased.

Airborne Radioactivity Surveys

- Airborne radioactivity surveys are performed during any work or operation in the RCA known or suspected to cause airborne radioactivity (e.g., grinding, welding, burning, cutting, hydrolazing, vacuuming, sweeping, use of compressed air, using volatiles on contaminated material, waste processing, or insulation).

- Airborne radioactivity surveys are performed during a breach of a radioactive system, which contains or is suspected of containing significant levels of contamination.

- Airborne radioactivity surveys are performed during initial entry (and periodically thereafter) into any known or suspected airborne radioactivity area.

- Airborne radioactivity surveys are performed immediately following the discovery of a significant radioactive spill or spread of radioactive contamination, as determined by the functional manager in charge of radiation protection.

- Airborne radioactivity surveys are performed daily in occupied radiological controlled areas where the potential for airborne radioactivity exists, including containment.

- Airborne radioactivity surveys are performed any time respiratory protection devices, alternative tracking methods such as derived air concentration-hour (DAC-hr), and/or engineering controls are used to control internal exposure.

- Airborne radioactivity surveys are performed using continuous air monitors (CAMs) for situations in which airborne radioactivity levels can fluctuate and early detection of airborne radioactivity could prevent or minimize inhalations of radioactivity by workers. Determination of air flow patterns are considered for locating air samplers.

- Airborne radioactivity surveys are performed prior to use and monthly during use on plant service air systems used to supply air for respiratory protection to verify the air is free of radioactivity.

- Tritium sampling is performed near the spent fuel pit when irradiated fuel is in the pit and other areas of the plant where primary system leaks occur and tritium is suspected.

Appropriate counting equipment is used based on the sample type and the suspected identity of the radionuclides for which the sample is being done. Survey results are documented, retrievable, and processed per site document control and records requirements consistent with Regulatory Guide 8.2. Completion of survey documentation includes the update of room/area posting maps and revising area or room postings and barricades as needed.

Air samples indicating activity levels greater than a procedure specified percentage of DAC are forwarded to the radiochemistry laboratory for isotopic analysis. Samples which cannot be analyzed on-site are forwarded to a contractor for analysis; or, the DAC percentage may be hand calculated using appropriate values from 10 CFR Part 20, Appendix B.

The responsible radiation protection personnel review survey documentation to evaluate if surveys are appropriate and obtained when required, records are complete and accurate, and adverse trends are identified and addressed.

An in-plant radiation monitoring program maintains the capability to accurately determine the airborne iodine concentration in areas within the facility where personnel may be present under accident conditions. This program includes the training of personnel, procedures for monitoring, and provisions for maintenance of sampling and analysis equipment consistent with Regulatory Guides 1.21 (Appendix A) and 8.8. Training and personnel qualifications are discussed in Appendix 12AA.

A portable monitor system meeting the requirements of NUREG-0737, Item III.D.3.3, is available. The system uses a silver zeolite or charcoal iodine sample cartridge and a single-channel analyzer. The use of this portable monitor is incorporated in the emergency plan implementing procedures. The portable monitor is part of the in-plant radiation monitoring program. It is used to determine the airborne iodine concentration in areas where plant personnel may be present during an accident. Accident monitoring instrumentation complies with applicable parts of 10 CFR Part 50, Appendix A.

Sampling cartridges can be removed to a low background area for further analysis. These cartridge samples can be purged of any entrapped noble gases, when necessary, prior to being analyzed.

12.3.5.1 Administrative Controls for Radiological Protection

STD COL 12.3-1 This COL Item is addressed in Appendix 12AA.

12.3.5.2 Criteria and Methods for Radiological Protection

STD COL 12.3-2 This COL Item is addressed in Subsection 12.3.4.

12.3.5.3 Groundwater Monitoring Program

STD COL 12.3-3 This COL Item is addressed in Appendix 12AA.

12.3.5.4 Record of Operational Events of Interest for Decommissioning

STD COL 12.3-4 This COL Item is addressed in Appendix 12AA.

12.4 DOSE ASSESSMENT

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

Add the following new subsections after DCD Subsection 12.4.1.8:

BLN SUP 12.4-1

12.4.1.9 Dose to Construction Workers

This section evaluates the potential radiological dose impacts to construction workers at the Bellefonte Nuclear Station, Units 3 and 4 (BLN) resulting from the operation of the BLN Unit 3. Since a portion of the Unit 4 construction period overlaps operation of Unit 3, construction workers at Unit 4 would be exposed to direct radiation and gaseous radioactive effluents from Unit 3. Doses to construction workers during construction of Unit 3 are not evaluated since the only radiation sources prior to the start-up of Unit 3 are background sources.

12.4.1.9.1 Site Layout

The BLN power block areas are shown on FSAR Figure 2.1-201. Construction activity for Unit 4 is outside the protected area for Unit 3 but inside the owner controlled area.

12.4.1.9.2 Radiation Sources

Construction workers at a new facility on the BLN site are not be exposed to any radiation sources until Unit 3 becomes operational. Workers constructing Unit 4 may be exposed to direct radiation and to gaseous radioactive effluents emanating from the routine operation of Unit 3. Radiation dose to construction workers is from direct radiation and from airborne effluents from BLN Unit 3, and from background radiation.

The radiation exposure at the site boundary is considered in DCD Section 12.4.2. As stated in that section, direct radiation from the containment and other plant buildings is negligible. Additionally, there is no contribution from refueling water since the refueling water is stored inside the containment instead of in an outside storage tank.

Small quantities of monitored airborne effluents are normally released through the plant vent or the turbine building vent. The plant vent provides the release path for containment venting releases, auxiliary building ventilation releases, annex building releases, radwaste building releases, and gaseous radwaste system discharge. The turbine building vents provide the release path for the condenser air removal system, gland seal condenser exhaust and the turbine building ventilation releases. The ventilation system is described in DCD Section 9.4. The

expected radiation sources (nuclides and activities) in the gaseous effluents are listed in DCD Table 11.3-3.

Exposure of Unit 4 construction workers to radioactive liquid effluents is not evaluated because the discharge structure and blowdown piping is completed during Unit 3 construction. The only exposure of Unit 4 construction workers to liquid effluents is due to the tie-in of Unit 4 pipeline. The exposure from this activity is minimal.

12.4.1.9.3 Construction Worker Dose Estimates

The determination of construction worker dose due to Unit 3 operation depends on the airborne effluent release and the atmospheric transport to the worker location. The atmospheric dispersion calculation used the guidance provided in Regulatory Guide 1.111, meteorological data for the year beginning April 1, 2006 and ending March 31, 2007, and downwind distances to the construction worker locations. The XOQDOQ computer code (NUREG/CR-2919) was used to determine the χ/Q and D/Q values for the nearest location along the Unit 3 protected area fence in each direction as well as the nearest point of the Unit 4 shield building construction area.

Construction worker doses are conservatively estimated using the following information:

- The estimated maximum dose rate for each pathway.
  - External exposure to contaminated ground.
  - External exposure to noble gas radionuclides in the airborne plume.
  - Inhalation of air.
- A construction worker exposure time of 2080 hours per year.
- A peak loading of 2100 construction workers per year for Unit 4 construction.

The use of 2080 hours assumes the worker works 40 hours per week for 52 weeks per year.

The methodology used to calculate the doses to construction workers from normal effluent releases complies with the guidance provided in Regulatory Guide 1.109. Construction worker doses were estimated by use of GASPAR computer code (NUREG/CR-4653). The Total Effective Dose Equivalent (TEDE), which is the sum of the Deep Dose Equivalent (DDE) and the Committed Effective Dose Equivalent (CEDE), was determined based on the GASPAR results. The annual

TEDE dose was corrected for the actual time the construction workers are onsite by multiplying by a ratio of hours worked per year to hours in a year.

12.4.1.9.4 Compliance with Dose Regulations

BLN Unit 4 construction workers are, for the purposes of radiation protection, members of the general public. This means that the dose to the individual does not exceed 100 mrem per year, the limit for a member of the public. The construction workers do not deal with radiation sources.

Dose limits to the public are provided in 10 CFR 20.1301 and 10 CFR 20.1302. Because the construction workers are considered members of the public, the requirements of 10 CFR 21.1201 through 20.1204 do not apply.

The 10 CFR 20.1301 limits annual doses from licensed operations to individual members of the public to 100 mrem TEDE. In addition, the dose from external sources to unrestricted areas must be less than 2 mrem in any one hour. This applies to the public both outside and inside access controlled areas. The maximum dose rates are given in Table 12.4-201. For an occupational year, dose at the Unit 4 construction area is 0.54 mrem TEDE. The maximum dose anywhere onsite that is accessible to a construction worker is 7.1 mrem per year in the NNE sector at the Unit 3 fence line. This assumes the worker stands at this point on the fence line for all working hours for the entire year. This value is less than the limits specified for members of the public. Therefore, construction workers can be considered to be members of the general public and do not require radiation monitoring.

12.4.1.9.5 Collective Doses to BLN Unit 4 Workers

The collective dose is the sum of all doses received by all workers. It is a measure of population risk. The total worker collective dose is 1.13 person-rem. This estimate is based upon the construction workforce of 2100 and assumes 2080 hours per year occupancy for each worker.

BLN SUP 12.4-1

TABLE 12.4-201
CONSTRUCTION WORKER DOSE COMPARISON TO
10 CFR 20.1301 CRITERIA

Type of Dose	Dose Limits[1] (TEDE)	Estimated Dose[2]
Annual total effective dose equivalent	100 mrem	0.54 mrem
Maximum dose in any hour	2 mrem	2.6E-04 mrem

Notes:

1. 10 CFR 20.1301 criteria.

2. Estimated dose is at Unit 4 shield building construction area. Total body dose calculated using the methodology in Regulatory Guide 1.109.

12.5 HEALTH PHYSICS FACILITIES DESIGN

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

12.5.2.2 Facilities

Revise the first sentence of DCD Subsection 12.5.2.2 to read:

STD DEP 18.8-1 The ALARA briefing room is located off the main corridor immediately beyond the main entry to the annex building.

12.5.5 COMBINED LICENSE INFORMATION

STD COL 12.5-1 This COL Item is addressed in Appendix 12AA.

Add the following Appendix after Section 12.5 of the DCD.

APPENDIX 12AA RADIATION PROTECTION PROGRAM DESCRIPTION

STD COL 12.1-1
STD COL 12.3-1
STD COL 12.5-1

This appendix incorporates by reference NEI 07-03, Generic FSAR Template Guidance for Radiation Protection Program Description, Revision 3, which is currently under review by the NRC staff. See Table 1.6-201. The numbering of NEI 07-03 is revised from 12.5# to 12AA.5# through the document, with the following revisions and additions as indicated by strikethroughs and underlines. Table 13.4-201 provides milestones for radiation protection program implementation.

Revise the first paragraph of NEI 07-03 Section 12.5 as follows:

A Radiation Protection Program is developed, documented, and implemented through plant procedures that address quality requirements commensurate with the scope and extent of licensed activities, sufficient to comply with the provisions of 10 CFR Parts 19, 20, 52, and 71 and consistent with the guidance in Regulatory Guides 1.8, 8.2, 8.4, 8.5, 8.6, 8.7, 8.8, 8.9, 8.10, 8.13, 8.15, ~~8.20, 8.26,~~ 8.27, 8.28, 8.29, ~~8.32,~~ 8.34, 8.35, 8.36 8.38 and the consolidated guidance in NUREG-1736.

Revise the first paragraph of NEI 07-03 Subsection 12.5.2 as follows:

Qualification and training criteria for site personnel are consistent with the guidance in Regulatory Guide 1.8 and are described in FSAR Chapter 13. Specific radiation protection responsibilities for key positions within the plant organization are described in Section 13.1 ~~below~~.

Subsections 12.5.2.1 through 12.5.2.5 of NEI 07-03 are not incorporated into Appendix 12AA.

Subsections 12.5.3, 12.5.3.1 and 12.5.3.2 of NEI 07-03 are not incorporated into Appendix 12AA. Facilities, instrumentation and equipment are described in DCD Subsection 12.5.2.

Add the following text after the first paragraph of NEI 07-03 Subsection 12.5.3.3.

If circumstances arise in which NIOSH tested and certified respiratory equipment is not used, compliance with 10 CFR 20.1703(b) and 20.1705 is maintained.

The following headings and associated material are described in DCD Subsection 12.5.3, and are therefore not incorporated into Appendix 12AA:

- Radwaste Handling
- Spent Fuel Handling

- Normal Operation
- Sampling

Add the following text to the end of the discussion on normal operation in NEI 07-03 Subsection 12.5.4.2.

STD COL 12.3-1 A closed circuit television system may be installed in high radiation areas to allow remote monitoring of individuals entering high radiation areas by personnel qualified in radiation protection procedures.

Add the following text after the second paragraph of NEI 07-03 Subsection 12.5.4.4.

STD COL 12.3-1 In addition to the access control requirements for high radiation areas, the following control measures are implemented to control access to very high radiation areas in which radiation levels could be encountered at 500 rads or more in one hour at one meter from a radiation source or any surface through which the radiation penetrates:

- Sign(s) conspicuously posted stating GRAVE DANGER, VERY HIGH RADIATION AREA.
- Area is locked. Each lock shall have a unique core. The keys shall be administratively controlled by the functional manager in charge of radiation protection as described in Section 13.1.
- Plant Manager's (or designee) approval required for entry.
- Radiation Protection personnel shall accompany person(s) making the entry. Radiation Protection personnel shall assess the radiation exposure conditions at the time of the entry.

The locations and radiological controls of the radiation zones on plant diagrams are located in DCD Section 12.3.

Revise the first paragraph of NEI 07-03 Subsection 12.5.4.6 as follows.

STD COL 12.1-1
STD COL 12.3-1
STD COL 12.5-1 Personnel monitoring procedures are sufficient to comply with 10 CFR Parts 19 and 20 and are consistent with the guidance in Regulatory Guides 8.2, 8.7, 8.9, 8.13, ~~8.20, 8.26, 8.32,~~ 8.34, 8.35, and 8.36.

Revise the third paragraph of NEI 07-03 Subsection 12.5.4.7 as follows.

As described in Sections 12.1, ~~12.5.1~~Appendix 12AA and ~~12.5.2~~ 13.1, management policy is established, and organizational responsibilities and authorities are assigned to implement an effective program for maintaining occupational radiation exposures ALARA. Procedures are established and implemented that are in accordance with 10 CFR 20.1101 and consistent with the guidance in Regulatory Guides 8.8 and 8.10. Examples of such procedures include the following:

Revise the second bullet of NEI 07-03 Subsection 12.5.4.7 as follows.

II. Radiation Protection will assure that procedures and methods for operation, maintenance, repair, surveillance, refueling, and other activities that may involve significant exposures are reviewed prior to initial use and periodically thereafter to assure measures are considered to minimize occupational and public radiation exposures. Significant exposures are defined by the functional manager in charge of radiation protection in procedures.

Add the following Subsection to the information incorporated from NEI 07-03.

STD COL 12.3-3

12AA.5.4.13 Groundwater Monitoring Program

A groundwater monitoring program beyond the normal radioactive effluent monitoring program is developed. If and as necessary to support this groundwater monitoring program, design features will be installed during the plant construction process. Areas of the site to be specifically considered in this groundwater monitoring program are:

- West of the auxiliary building in the area of the fuel transfer canal.
- West and south of the radwaste building.
- East of the auxiliary building rail bay and the radwaste building truck doors

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STD SUP 12.5-1

Groundwater monitoring program implementation considerations include:

- Impacts on the foundation support if ground water or leaked liquids are extracted,
- Re-evaluation of the location and sampling frequency if contaminant is detected,

- Site specific models of contaminant migration, if contaminants are detected,
- Methods to isolate and collect liquid radioactive contaminants escaping to the subsurface to prevent abnormal release to ground water.

Add the following Subsection to the information incorporated from NEI 07-03.

STD COL 12.3-4

12AA.5.4.14 Record of Operational Events of Interest for Decommissioning

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Procedures are established to document the operational events that are deemed of interest for decommissioning, beyond that required by 10 CFR 50.75. These documented operational events assist in developing a historical assessment of the nuclear facilities, thereby reducing time, effort, and hazards to personnel during decommissioning planning. This documentation will include identification of the remediation of any leaks, which have the potential to contaminate groundwater.
