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MEMORANDUM TO: John P. Segala, Chief  
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Division of Advanced Reactors and Non-Power  
Production and Utilization Facilities  
Office of Nuclear Reactor Regulation

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SUBJECT: SUPPLEMENTAL INFORMATION TO SUPPORT  
SEPTEMBER 24, 2020, PUBLIC MEETING ASSOCIATED WITH  
ADVANCED REACTOR CONTENT OF APPLICATION PROJECT

The purpose of this memorandum is to provide supplemental information to support a September 24, 2020, public meeting associated with the Advanced Reactor Content of Application Project (ARCAP). The information in this document supplements the Nuclear Regulatory Commission's (NRC's) handouts that have been developed for the meeting.

The agenda for the September 24, 2020, ARCAP public meeting is available at the following link: <https://www.nrc.gov/pmns/mtg?do=details&Code=20201070>. The staff intends to provide additional thoughts on the use of a performance-based approach using draft ARCAP Chapter 8, "Liquid and Gaseous Radioactive Waste Requirements," and draft ARCAP Chapter 9, "Control of Occupational Dose," as an example. The enclosures to this memorandum provides additional material for consideration based on approach 3 of a model that was discussed at a June 12, 2020, and July 31, 2020, ARCAP public meeting. A description of approach 3 can be found in the June 12, 2020, ARCAP meeting summary dated July 15, 2020 available in the Agencywide Documents Access and Management System (ADAMS) at Accession No. ML20195B104.

The enclosed ARCAP Chapter 8 has been updated from the version discussed during the July 31, 2020, ARCAP public meeting. The July 31, 2020 ARCAP meeting summary dated August 21, 2020 (ADAMS Accession No. ML20233A990), provides a reference to the ARCAP Chapter 8 discussed during the meeting. The enclosed Chapter 8 is highlighted to show changes that have been made to this Chapter since the July ARCAP meeting. The enclosed Chapter 9 is new and was developed using the same methodology as that used to develop Chapter 8.

Enclosure:

1. ARCAP Chapter 8 - Control of Routine Plant Radioactive Effluents, Plant Contamination and Solid Waste
2. ARCAP Chapter 9 - Control of Occupational Dose

SUBJECT: SUPPLEMENTAL INFORMATION TO SUPPORT SEPTEMBER 24, 2020,  
PUBLIC MEETING ASSOCIATED WITH ADVANCED REACTOR CONTENT OF  
APPLICATION PROJECT: Dated September 16, 2020

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## 8. Control of Routine Plant Radioactive Effluents, Plant Contamination and Solid Waste

Nuclear power plants that generate liquid, gaseous and solid waste during normal operations must have processes to contain, store, and release these wastes in accordance with NRC regulations. 10 CFR 20 sets limits on the activity of liquid and gaseous waste which can be released into the environment as well as establishes requirements for contamination control. 10 CFR 50, Appendix A, General Design Criterion (GDC) 60 and GDC 64 establish design criteria for controlling and monitoring releases of radioactive materials to the environment for LWRs. 10 CFR 50, Appendix A, GDC 63 established design criteria for detecting conditions that may result in the loss of heat removal and excessive radiation levels in radioactive waste systems. Similar plant-specific design criteria may be identified for particular non-LWR technologies. 10 CFR 61 describes the classes of low-level waste and acceptable packaging for its disposal, as a function of its composition and activity level. Accordingly, each reactor design that generates radioactive wastes must have waste management systems that ensure the requirements of 10 CFR 20, 50 and 61 are met, or propose alternative requirements consistent with the technology of the proposed design.

Requirements described in 10 CFR 50.34, 50.34a, 52.47 and 52.79, specify that an application for a construction permit, an operating license (OL), a combined license (COL) or a design certification (DC) describe the radioactive materials expected to be produced in the operation, an estimate of the radionuclides expected to be released annually to unrestricted areas, and the means for controlling and limiting radioactive effluents and radiation exposures to within the limits set forth in the regulations. However, as discussed below, an alternative approach to demonstrating compliance with these requirements is for an applicant to describe in its application a performance monitoring program for effluent releases.

The guidance in the chapter applies to non-LWR and small modular LWR applications for a Part 50 OL or a Part 52 COL or DC [although for a DC the design information may be conceptual (refer to Regulatory Guide 1.206, Rev 1) and the programmatic information may be deferred to the COL stage using COL action items]. Applications for construction permits (10 CFR 50.34(a), *preliminary safety analysis reports*) need only provide: (1) a commitment to have a radioactive effluents monitoring program to verify compliance with Part 20 and 50.34a requirements; (2) a commitment to include design provisions to minimize contamination and control and collect any spillage; and (3) a commitment to develop and implement a process control program for solid waste that meets 10 CFR 61. The additional information requested below can be provided by the applicant during the OL application review.

The guidance below summarizes the information that should be provided in the application regarding liquid and gaseous effluents, control of contamination, and solid waste using performance monitoring, to the extent practicable, and a risk-informed approach to demonstrate compliance with the applicable regulations.

Information being requested in this FSAR chapter may be described in the Radiation Protection Program or **Process Control Program (PCP)** document which may be part of a separate application document. Because the staff will rely on information in these documents **and the FSAR** to make its safety finding, information in these documents does not need to be repeated **in the FSAR**. However, the FSAR should incorporate this information by reference to ensure that future changes to this information are properly evaluated by the FSAR change process to determine the need for prior NRC approval.

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## 8.1. Liquid and Gaseous Effluents

The application must provide assurance that the limits on the release of radioactive liquid and gaseous effluents during normal operation (including expected operational occurrences) will meet the requirements in 10 CFR 20 and 10 CFR 50. Specifically

- a. 10 CFR 20.1101 requires the licensee to use engineering controls and procedures to achieve doses to members of the public that are ALARA.
- b. 10 CFR 20.1301(a) specifies the allowable annual dose and allowable hourly dose to members of the public from routine operation.
- c. 10 CFR 20.1301(e) specifies that a licensee subject to the provisions of **Environmental Protection Agency's** (EPA) generally applicable environmental radiation standards in 40 CFR part 190 shall comply with those standards.
- d. 10 CFR 20.1302(b) provides an alternative to 20.1301 by allowing the designer to show that the concentrations of radionuclides in liquid and gaseous effluents (contained in 10 CFR 20, Appendix B, Table 2) are not exceeded and specified annual and hourly doses to an individual in an unrestricted area are not exceeded.
- e. 10 CFR 20.1302(c) contains a provision allowing for adjustment of the concentrations contained in 10 CFR 20, Appendix B, Table 2, with Commission approval.
- f. 10 CFR 50.34a specifies design objectives for the release of radioactive material in effluents. For LWRs, reference is made to 10 CFR 50, Appendix I, for numerical guidelines for ALARA doses and Section IID of Appendix I for the use of cost-benefit analysis for further reductions in the numerical guidelines.
- g. 10 CFR 50, Appendix A, Criterion 60, specifies that the waste systems have sufficient holdup capacity for retention of gaseous and liquid effluents containing radioactive materials.
- h. 10 CFR 50, Appendix A, Criterion 64, specifies monitoring requirements for, in part, effluent discharge paths for radioactivity that may be released from normal operations.

As provided for in **[exemption XXXX]**, in lieu of providing detailed system descriptions and analysis of estimated effluent releases as required by 10 CFR 50.34, 50.34a, 52.47, and 52.79, an application may demonstrate compliance with the applicable regulations by describing a radiation protection program and an effluent release monitoring program that will ensure that effluent release limits will be met during normal operations for the life of the plant. Information related to physical systems can be limited to general descriptions of layout and technologies used to limit the release of the various inventories of radioactive materials within the plant. While the specific analysis of effluent releases is not required to be included in the application an applicant should develop such analysis for its internal engineering documents. These analyses could be the subject of audit by NRC staff reviewers at the time of application review or subsequently as part of inspections during plant construction or operation.

The description of the monitoring program should address monitoring the performance of the design features that control the liquid and gaseous effluents (e.g., release pathways, instrument coverage, instrument accuracy and equipment reliability) and by monitoring the releases themselves including frequency and methods.

Alternatively, if a particular reactor design can be shown to not generate any normal radioactive effluent releases throughout its life cycle (e.g., a microreactor using a heat pipe design) then the application need only describe (1) sufficient information to substantiate this design attribute, (2) a description of controls to ensure the design will maintain this characteristic throughout the life

of the plant, and (3) a description of how the applicant will detect a unexpected radioactive effluent release.

When using this performance-based approach much system design information that historically has been provided in reactor FSARs is not required to be included in this chapter, such as:

- Detailed quality assurance (QA) provisions for radioactive waste management structures, systems, and components (SSCs) as described in Regulatory Guide 1.143.
- Types and characteristics of filtration, ion-exchange resins, and adsorbent media to treat liquid process and effluent streams, including expected removal efficiencies, decontamination factors, holdup or decay times, and the applications of these characteristics in estimating releases by specific waste streams and treatment methods.
- The information describing the types of proposed filtration and adsorption media should include details from the applicant or suppliers, as generic or plant-specific information, in characterizing removal efficiencies, decontamination factors, and holdup or decay times.
- Availability of standby equipment, alternate processing routes, and interconnections between permanently installed subsystems and skid-mounted processing equipment.

#### Acceptance Criteria

The application should include information sufficient to allow the staff reviewer to understand the general layout and technologies used for radioactive waste system design, the radioactive sources, the monitoring instrumentation to be used, and the applicable programmatic requirements for controlling effluent releases. The applicant should provide information of the following type for the NRC reviewer to be able to reach a safety finding and address the topic in the staff's safety evaluation report.

- a. A description of the sources of normal radioactive liquid and gaseous waste including the general quantities and composition of liquid and gaseous radioactive waste estimated to be contained in the systems. Include a high-level description of any mathematical models and parameters used for developing the source terms. This information will assist the staff in making independent conclusions regarding the feasibility of the reactor design meeting effluent release requirements.
- b. A reference to the Radiation Protection Program, which describes organizations, procedures, and other means to limit the release of radionuclides from or within the plant.
- c. The instrumentation to be used to monitor normal and potential liquid and gaseous effluent pathways including types, release points, approximate instrument locations, instrument alarm/trip setpoints, automatic control features, and provisions for calibration. The staff needs this information to determine that all liquid and effluent release paths are properly monitored.
- d. A description of any equipment performance requirements or quality standards that are considered necessary to ensure instrument accuracy and equipment reliability. The degree of instrument accuracy and equipment reliability need only be commensurate with the degree to which the equipment is being relied upon to meet Part 20 and 50.34a limits. The staff needs this information to evaluate the quality of the instruments monitoring effluent releases to ensure that release requirements will be met.

- e. A description of how the performance monitoring program will ensure that releases of radioactive liquid and gaseous effluents are consistent with the requirements in 10 CFR 20.1101, 1301 and 1302 and 10 CFR 50.34a (including 10 CFR 50 Appendix A, GDC 64, and Appendix I, if applicable). This description should include how effluent concentration limits have been established, what monitoring is to be done, how often it is to be done (e.g., sampling frequencies), and the process for reviewing the results and determining compliance with the applicable requirements. The performance monitoring should be consistent with the guidance contained in NUREG/BR-0303, "Guidance for Performance-Based Regulation", December 2002. Since the staff is relying on the performance monitoring program to make its safety decision, it is important that there be sufficient descriptive information regarding the program attributes to provide confidence that deviations from expected effluent release quantities are detected in sufficient time to ensure that release limits in Part 20 and ALARA design objectives specified in 50.34a will not be exceeded.

The level of detail in the application should be sufficient for the staff to conclude that the design includes the equipment and programmatic controls capable of controlling releases of radioactive materials in liquid and gaseous effluents in accordance with the requirements specified above. Information contained in the Radiation Protection Program may be incorporated by reference into the FSAR in lieu of repeating the information in this chapter. The staff may also rely on audits of applicant's internal effluent release analysis to provide further confidence that effluent release limits can be met during plant operation.

For applications utilizing the guidance in NEI 18-04, Revision 1, *Risk-Informed Performance-Based Technology Inclusive Guidance for Non-Light Water Reactor Licensing Basis Development*, it is expected that abnormal events involving the radioactive liquid and gaseous effluents and waste systems will be analyzed as part of licensing basis event (LBE) analysis to determine their risk significance and contribution to LBE identification. Specifically, as stated in NEI 18-04, Section 3.2.1:

"The LBEs identified in the PRA can identify important events that have the potential to release radioactivity to the public. Thus, LBEs can inform the determination of the limiting source terms and potential releases to be considered for operational protection in normal operations as well as AOOs and DBEs that can then be used to identify design-specific shielding, filtering capability of the heating, ventilation, and air conditioning system, monitoring, and other requirements for different types of non-LWRs."

As part of the LBE analysis, applicants will show that anticipated operational occurrences are unlikely to result in a plant exceeding the dose limits defined in 10 CFR 20.1301(a)(1). Therefore, evaluations addressing this dose requirement as well as analysis of risk significance of the radioactive waste systems performed as part of the LBE analysis do not need to be repeated in this chapter.

## 8.2. Contamination Control

The application should describe sufficient design and programmatic information to address the following regulation:

- a. 10 CFR 20.1406 requires that the design and operation minimize contamination of the facility and the environment.

The principles regarding contamination control that should be embodied in the applicant's design and operating philosophy are threefold: (1) prevention of unintended releases; (2) early detection, if there is unintended release of radioactive contamination; and (3) prompt assessment to support a timely and appropriate response. The application content in this area should be developed using a risk-informed approach that considers the magnitude of the hazard involved. Licensee activities do not all reflect the same potential for contamination of a facility and the environment, or for the generation of radioactive waste. Therefore, the applicant should use judgment to determine the extent of the information provided.

However, even applications that do not deal with large or significant amounts of radioactive material need to address the minimization and facilitation provisions of the regulations, but they should do so using common sense and good judgment. Refer to guidance in Regulatory Guide 4.21, *Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning*.

### Acceptance Criteria

The application should include information sufficient to allow the NRC reviewer to understand how contamination in the plant will be minimized. The applicant should provide information of the following type for the NRC reviewer to be able to reach a safety finding and address the topic in the staff's safety evaluation report.

- a. Design provisions to minimize contamination and control and collect any spillage. This should include how the facility design and procedures for operation will minimize, to the extent practicable, contamination of the facility and the environment; facilitate eventual decommissioning; and minimize, to the extent practicable, the generation of radioactive waste. The staff needs to understand the applicant's design provisions to control contamination to make a judgement that the plant meets 10 CFR 20.1406.

### 8.3. Solid Waste

The application should describe the sources of solid waste and design capacities of the solid waste management system (SWMS). If a vendor-supplied process for solidification or dewatering is used then the applicant should commit to provide the Topical Report or other certification documenting appropriate approval of the process and associated containers to be used.

Additionally, the applicant should describe the methods and controls, process parameters, sampling and surveillance requirements that are necessary for the interim storage, solidification or dewatering, packaging and final disposal of radioactive wastes in order to meet the following regulations:

- a. 10 CFR 20.1302 and 10 CFR 20.1301(e), as they relate to radioactive materials released in gaseous and liquid effluents to unrestricted areas. These criteria apply to releases resulting from SWMS operation during normal plant operations and anticipated operational occurrences.
- b. 10 CFR 20.1406, as it relates to the design and operational procedures for minimizing contamination, facilitating eventual decommissioning, and minimizing the generation of radioactive waste.

- c. 10 CFR 50.34a, as it relates to the provision of sufficient information to demonstrate that design objectives for equipment necessary to control releases of radioactive effluents to the unrestricted areas are kept as low as reasonably achievable.
- d. For LWRs, 10 CFR Part 50, Appendix I, Sections II.A, II.B, II.C, and II.D, as they relate to the numerical guides for dose design objectives and limiting conditions for operation to meet the ALARA criterion.
- e. 40 CFR Part 190, generally applicable environmental radiation standards, as implemented under 10 CFR 20.1301(e)), as it relates to limits on total annual doses from all sources of radioactivity and radiation from the site (with single or multiple units).
- f. 10 CFR 50, Appendix A, Criterion 60, as it relates to the design of the SWMS to control the release of radioactive materials in liquid effluents from the SWMS and to handle solid wastes produced during normal plant operation, including anticipated operational occurrences.
- g. 10 CFR 50, Appendix A, Criterion 61, as it relates to providing assurance that releases of radioactive materials during normal operation and anticipated operational occurrences, including adverse conditions on system components, will not result in radiation doses that exceed the 10 CFR Part 20.
- h. 10 CFR 50, Appendix A, Criterion 63, as it relates to the ability of the SWMS to detect conditions that may result in excessive radiation levels and to initiate appropriate safety actions.
- i. 10 CFR 61.55 and 10 CFR 61.56, as they relate to classifying, processing, and disposing of dry solid and wet wastes at approved low-level radioactive waste disposal sites.
- j. 10 CFR 20.2006 and Appendix G to 10 CFR Part 20, as they relate to the requirements for transferring and manifesting radioactive materials shipments to authorized facilities (e.g., disposal sites, waste processors).
- k. 10 CFR 20.2007, as it relates to compliance with other applicable Federal, State, and local regulations governing any other toxic or hazardous properties of radioactive wastes, such as mixed wastes characterized by the presence of hazardous chemicals and radioactive materials, that may be disposed under 10 CFR Part 20.
- l. 10 CFR 20.2108, as it relates to the maintenance of waste disposal records until the NRC terminates the pertinent license requirements.
- m. 10 CFR Part 71 and 49 CFR Parts 171–180, as they relate to the use of approved containers and packaging methods for the shipment of radioactive materials.
- n. 49 CFR 173.443, as it relates to methods and procedures used to monitor for the presence of removable contamination on shipping containers, and 49 CFR 173.441, as it relates to methods and procedures.

The application should also identify any waste streams with the potential for having the presence of hazardous chemicals and radioactive materials, mixed waste, that will need to be processed and disposed in accordance with applicable Federal, State and local regulations.

#### Acceptance Criteria

The application should include information sufficient to allow the staff to conclude that the design of the SWMS (either as a permanently installed system or in combination with mobile systems), which includes the equipment necessary to process liquid, wet, and dry solid wastes and to control releases of radioactive materials associated with the

operation of the SWMS, is acceptable and meets the above stated requirements. The applicant should provide information of the following type for the NRC reviewer to be able to reach a safety finding and address the topic in the staff's safety evaluation report.

- a. Provide a high-level description of the solid waste management system (SWMS) that includes:
  - i. Expected sources of waste (e.g. resins, sludge, filters, charcoal), waste composition (e.g. mixed waste), chemical make-up, dry or wet and other important factors.
  - ii. The equipment design capacities for expected waste volumes and radioactivity inventories of Class A, B and C waste associated with normal operation and anticipated operational occurrences.
- b. Describe design provisions to control and collect any solid waste spillage from equipment malfunction or puncture of waste containers.
- c. Provide a description of operational controls for waste processing and surveillance requirements which assure that:
  - i. Allowable doses to members of the public remain within required levels.
  - ii. The final waste product meets the requirements of applicable Federal, State and disposal site waste form requirements for burial at a 10 CFR 61 licensed Low-Level Waste (LLW) disposal site.
  - iii. As an option to address this criterion, the applicant may refer to NEI 07-10A, *Generic FSAR Template Guidance for Process Control Program (PCP)*. If the applicant chooses to reference this template there is no need to replicate text in the FSAR. Note that this template was written for LWRs and may need to be updated to reflect the specific technology. For example, Section 3.5 of the template describes a set of "waste types" typically generated at LWRs. Depending on the specific technology, non-LWRs may need to address other "waste types" not typically generated at an LWR.

## 9. Control of Occupational Dose

This chapter should provide information on facility and equipment design, radiation sources, and operational programs that are necessary to ensure that the occupational radiation protection standards set forth in 10 CFR Part 20 are met. The applicant should provide commitments to develop the management policy and organizational structure necessary to ensure occupational radiation exposures are ALARA.

Requirements described in 10 CFR 50.34, 52.47, 52.79 and 52.179, specify that an application for a construction permit (CP), an operating license (OL), a combined license (COL), a design certification (DC) or a Standard Design Approval (SDA) describe, in part, the kinds and quantities of radioactive materials expected to be produced in the operation and the means for controlling and limiting radiation exposures within the limits set forth in Part 20.

The guidance in the chapter applies to non-LWR (including microreactors) and small modular LWR applications for a Part 50 OL or a Part 52 COL, SDA or DC [although for a DC the design information may be conceptual (refer to Regulatory Guide 1.206, Rev 1) and the programmatic information may be deferred to the COL stage using COL action items]. Applications for construction permits (10 CFR 50.34(a), *preliminary safety analysis reports*) need only provide: (1) a commitment to develop comprehensive worker protection programs, organizational structure, training and monitoring to ensure 10 CFR 19 and 10 CFR 20 requirements are met; (2) a commitment to include in the OL application design provisions to ensure that occupational doses are ALARA. The additional information requested below can be provided by the applicant during the OL application review.

This guidance summarizes the information that should be provided in the application regarding control of occupational dose. Information being requested in this FSAR chapter may be described in the Radiation Protection Program (RPP) document which may be part of a separate application document. Because the staff will rely on information in the RPP document and the FSAR to make its safety finding, information in the RPP document does not need to be repeated in the FSAR. However, the FSAR should incorporate the RPP information by reference to ensure that future changes to this information are properly evaluated by the FSAR change process to determine the need for prior NRC approval.

The application must provide assurance that occupational doses will be controlled and meet the requirements in 10 CFR 20. Specifically:

- a. 10 CFR 19.12, as it relates to keeping workers informed who receive occupational radiation exposure (ORE).
- b. 10 CFR 20, Subpart C, *Occupational Dose Limits* (20.1201 – 20.1208).
- c. 10 CFR 20.1101 and the definition of ALARA in 10 CFR 20.1003, as they relate to those measures that ensure that radiation exposures resulting from licensed activities are below specified limits and ALARA.

Acceptance Criteria

The application should include information sufficient to allow the staff reviewer to understand the general design and operational controls that will be used to control occupational doses. The applicant should provide information of the following type for the NRC reviewer to be able to reach a safety finding and address the topic in the staff's safety evaluation report:

- a. Describe important equipment and facility design features used to ensure that occupational radiation exposures are ALARA such as, shielding, ventilation, area radiation and airborne radioactivity monitoring instrumentation and dose assessment.
- b. Describe major radiation sources including sources that require (1) shielding, (2) special ventilation systems, (3) special storage locations and conditions, (4) traffic or access control, (5) special plans or procedures, and (6) monitoring equipment. Information regarding sources terms used in license basis event analysis need not be described in this chapter as this information should be provided elsewhere in the application.
- c. Describe the design features provided to control access to radiologically restricted areas (including potentially very high radiation areas) and describe each very high radiation area and indicate physical access controls and radiation monitor locations for each of these areas.
- d. Describe those features that reduce the need for maintenance and other operations in radiation fields, reduce radiation sources in areas where operations may be performed, allow quick entry and easy access, provide remote operation capability, or reduce the time spent working in radiation fields, as well as any other features that reduce radiation exposure of personnel.
- e. Describe methods for reducing the production, distribution, and retention of activation products through design, material selection, water chemistry, decontamination procedures, and so forth.
- f. Provide commitments to develop comprehensive worker protection programs, organizational structure, training and monitoring to ensure 10 CFR 19 and 10 CFR 20 requirements are met. Include a description of the important elements of these programs. Include commitments to any relevant regulatory guides, NEI templates, or standards.
  - i. As an option, applicant may refer to NEI 07-08A, *Generic FSAR Template Guidance for Ensuring that Occupational Radiation Exposures are as Low as is Reasonably Achievable (ALARA)*. If an applicant chooses to reference this template to address the above acceptance criteria there is no need to replicate text in the FSAR. An applicant may need to update/revise template to reflect operation of the specific non-LWR.
  - ii. These criteria for operational controls could also be addressed in the Radiation Protection Program with a reference in the FSAR.