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10 Control of Occupational Dose

This chapter of the safety evaluation (SE) summarizes the NRC staff's review and evaluation of the Long Mott Generating Station (LMGS) preliminary safety analysis report (PSAR) chapter 10, "Control of Occupational Dose," which contains preliminary descriptions of the radiation protection program (RPP), the as low as is reasonably achievable (ALARA) program, design considerations and design features to maintain occupational radiation exposures ALARA, and the preliminary dose assessment for expected occupancy performed for the construction permit (CP) application.

The applicable regulatory requirements for the evaluation of the control of occupational dose are as follows:

- Title 10 of the *Code of Federal Regulations* (10 CFR) 50.34(a)(6); and
- Section 50.40, "Common standards," of 10 CFR.

The applicable guidance for the evaluation of the control of occupational dose is as follows:

- Division of Advanced Reactors and Non-Power Production and Utilization Facilities (DANU) Interim Staff Guidance (ISG) DANU-ISG-2022-01, "Review of Risk-Informed, Technology-Inclusive Advanced Reactor Applications - Roadmap," section 12 (ML23277A139);
- DANU-ISG-2022-04, "Advanced Reactor Content of Application Project, Chapter 10, 'Control of Occupational Dose'" (ML23277A142);
- NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," section 12.5 (ML13155A232).

The following principal design criteria (PDC), as defined in section 5.3 of the LMGS PSAR, apply to the evaluation of the control of occupational dose:

- PDC 19, "Control Room";
- PDC 61, "Fuel Storage and Handling and Radioactivity Control."

Paragraph 50.34(a)(6) of 10 CFR, requires that a CP application contain a preliminary plan for the applicant's organization, training of personnel, and conduct of operations. Consistent with this requirement, DANU-ISG-2022-04 states that a CP application should include: (1) a description of its plans to develop, at the operating license (OL) application stage, comprehensive worker protection programs, organizational structure, training, and monitoring to ensure the requirements are met in 10 CFR Part 19, "Notices, Instructions and Reports to Workers: Inspection and Investigations," and 10 CFR Part 20, "Standards for Protection Against

Radiation”; (2) a description of the design-specific PDC necessary to control occupational exposures; and (3) a preliminary description of design provisions necessary to control occupational exposure, including ensuring that occupational doses are ALARA, such as shielding, ventilation, area radiation and airborne radioactivity monitoring instrumentation, and dose assessment for expected occupancy.

The NRC staff’s evaluation of the requirements in 10 CFR Part 20, will be conducted during the OL application review consistent with 10 CFR 50.34(b)(3), which provides the OL application requirement to provide the kinds and quantities of radioactive materials expected to be produced during operation and the means for controlling and limiting radioactive effluents and radiation exposures within the limits set forth in 10 CFR Part 20.

Section 20.1101, “Radiation protection programs,” of 10 CFR, states that a “licensee” shall develop, document, and implement an RPP commensurate with the scope and extent of licensed activities and sufficient to ensure compliance with the provisions of 10 CFR Part 20 and shall use, to the extent practical, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses that are ALARA. As provided in 10 CFR 20.1002, “Scope,” the regulations in 10 CFR Part 20, apply to “persons licensed by the Commission to receive, possess, use, transfer, or dispose of byproduct, source, or special nuclear material or to operate a production or utilization facility....” Since Long Mott Energy, LLC (LME or the applicant) is not a licensee within the scope of 10 CFR Part 20, the NRC staff did not evaluate whether the requirements in 10 CFR Part 20 would be met in support of its review of the CP application. Instead, consistent with DANU-ISG-2022-04, the NRC staff assessed whether LME had identified the relevant requirements for an operating facility and provided descriptions of how the preliminary facility design will, to the extent practicable, meet the 10 CFR Part 20 requirements as discussed in the technical evaluation. This is consistent with 10 CFR 50.40(a), which provides that in determining whether a CP will be issued, the Commission will be guided by, among others, consideration of reasonable assurance that LME will comply with the NRC’s regulations, including the regulations in 10 CFR Part 20, and that the health and safety of the public will not be endangered. For the CP application review, the NRC staff ensures that LME has met 10 CFR 50.40, and has provided enough information to provide reasonable assurance that it will comply with the regulations in 10 CFR Part 20, at the OL stage.

10.1 Radiation Protection Program

As discussed in DANU-ISG-2022-04, the purpose of the NRC staff’s review of the RPP is to ensure that the CP application includes, among other things, in accordance with 10 CFR 50.34(a)(6), a description of LME’s plans to develop, at the OL stage, comprehensive worker protection programs, organizational structure, training, and monitoring to ensure that the relevant requirements are met in 10 CFR Parts 19 and 20. The NRC staff’s evaluation of the overall organization as required to meet 10 CFR 50.34(a)(6), is addressed in section 11.1 of this SE.

10.1.1 Technical Evaluation

The NRC staff reviewed the LMGS PSAR to determine whether, as required by 10 CFR 50.34(a)(6), the applicant for the CP adequately described its plans to develop an RPP. The NRC staff reviewed PSAR chapter 10, which states that the RPP will be developed and implemented, as required by 10 CFR 20.1101, prior to receiving radioactive materials on-site and that the RPP will ensure that 10 CFR 19.12, “Instruction to workers,” and 10 CFR Part 20 requirements are met. PSAR section 10.1 references Nuclear Energy Institute (NEI) 07-03A,

“Generic FSAR [Final Safety Analysis Report] Template Guidance for Radiation Protection Program Description,” and NEI 07-08A, “Generic FSAR Template Guidance for Ensuring that Occupational Radiation Exposures are as Low as is Reasonably Achievable (ALARA),” and states that the RPP will be consistent with the guidance in NUREG-1736, “Consolidated Guidance: 10 CFR Part 20 - Standards for Protection Against Radiation,” and states full conformance or partial conformance with Regulatory Guide (RG) 1.8, “Preoperational Testing of Instrument Air Systems,” RG 8.2, “Administrative Practices in Radiation Surveys and Monitoring,” RG 8.4, “Personnel Monitoring Device—Direct-Reading Pocket Dosimeters,” RG 8.7, “Instructions for Recording and Reporting Occupational Radiation Exposure Data,” RG 8.8, “Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations Will Be as Low as Is Reasonably Achievable,” RG 8.10, “Operating Philosophy for Maintaining Occupational Radiation Exposures as Low as Is Reasonably Achievable,” RG 8.15, “Acceptable Programs for Respiratory Protection,” RG 8.27, “Radiation Protection Training for Personnel at Light-Water-Cooled Nuclear Power Plants,” RG 8.34, “Monitoring Criteria and Methods To Calculate Occupational Radiation Doses,” and RG 8.38, “Control of Access to High and Very High Radiation Areas of Nuclear Plants,” which are also listed in PSAR table 1.4-2.

In addition, PSAR section 10.1 describes that the purpose of the RPP is to maintain occupational dose below regulatory limits and keep exposure ALARA; have a trained and qualified organization; and have adequate facilities, equipment, and procedures to effectively implement the program for various functional areas. This PSAR section also describes other areas that the RPP will encompass. In PSAR section 10.1.1, LME describes that the RPP meets the requirements outlined in 10 CFR Part 20, Subpart F and RG 8.2, Rev. 1, and states that additional details on radiation monitor locations will be provided at the OL stage. In PSAR section 10.1.2, LME describes the controls for access to high and very high radiation areas and states that they will conform with RG 8.38, Revision 1. PSAR table 10.5-2 describes the zoning designations that will be applied to the LMGS.

DANU-ISG-2022-01 references NUREG-0800, section 12.5, which provides additional guidance for an RPP and includes a list of RGs that an RPP should consider. Although NUREG-0800, section 12.5 is specific to light-water reactors (LWR) applications, it may provide useful insights for the NRC staff’s review of non-LWR applications. Consistent with the guidance in NUREG-0800, section 12.5, the NRC staff’s review determined that the high-level description of the LMGS RPP and LME’s commitments to follow applicable guidance are appropriate at the CP stage. This approach is acceptable because LME has identified those elements of an RPP that are considered at the CP stage and has committed to following additional RGs, which will be evaluated at the OL stage. The NRC staff’s review of PSAR table 1.4-2, determined that LME has either stated that LMGS is in full conformance with or will address conformance with applicable RGs that are a part of an RPP in any OL application.

The NRC staff’s review of PSAR section 10.1, finds that LME provided a high-level overview of the RPP and that the references to various RGs are appropriate for the CP stage because they demonstrate areas that an RPP should include for future consideration in an OL application, and the information provided in the CP application is consistent with the review guidance specified by DANU-ISG-2022-01, and the RGs listed in NUREG-0800, section 12.5.

Radiation protection training is addressed by the contents of PSAR table 1.4-2, which provides that conformance with RG 8.27, Revision 0, will be addressed at the OL stage. RG 8.27, Revision 0 describes a method to develop a radiation protection training program consistent

with ALARA objectives that is acceptable to the NRC staff for meeting 10 CFR 19.12. This is acceptable because LME is not required to address the operational training program for radiation protection during the CP stage, and the NRC staff will review the details of radiation protection training during the review of any OL application.

The radiation protection organizational structure is addressed by LME's commitments to RG 8.8, Revision 3 and RG 8.10, Revision 2. RG 8.8, Revision 3 and RG 8.10, Revision 2 describe methods of meeting 10 CFR Part 20 requirements, which include aspects of an organization that address ALARA, that are acceptable to the NRC staff. In addition, PSAR table 1.4-2 and PSAR section 10.1, describe that LME will address compliance with RG 1.8, Revision 4, during the OL stage for the qualification of radiation protection personnel. RG 1.8, Revision 4 describes a method acceptable to the NRC staff for complying with regulations associated with the organizational structure under 10 CFR 50.34(b)(6)(i), which would address the requirements in 10 CFR 50.34(a)(6) for a CP application. Based on this information, the NRC staff finds that LME has included sufficient information about its radiation protection organizational structure for the CP stage, which includes providing preliminary commitments to RG 8.8, Revision 3 and RG 8.10, Revision 2, and that it is appropriate to leave the remaining details to the OL stage. The NRC staff's review of the overall organization, including the radiation protection organization, is summarized in SE section 11.1.

10.1.2 Conclusion

The NRC staff's review of the RPP determined that the high-level description of the RPP and the commitments to address compliance with the RGs discussed above, are sufficient because LME referenced RGs for the RPP consistent with DANU-ISG-2022-01 and NUREG-0800, section 12.5. The NRC staff's review of the RPP can be reasonably deferred to the OL stage because details regarding specific aspects of the RPP and procedures are not required at the CP stage. The NRC staff will review LMGS RPP information at the OL stage to ensure compliance with 10 CFR 19.12, 10 CFR Part 20, and 10 CFR 50.34(b)(6)(i).

The NRC staff determined that referencing RGs 1.8 and 8.27, provides the NRC staff with approved methods that LME will use to qualify and train personnel for nuclear power plants and radiation protection training for personnel at nuclear power plants and is, therefore, acceptable. Accordingly, the NRC staff determined that the applicant has provided sufficient information for a CP application to describe the preliminary plan for the applicant's RPP organization, training of personnel, and conduct of operations as required by 10 CFR 50.34(a)(6).

10.2 ALARA Program

As discussed in DANU-ISG-2022-04, the purpose of the NRC staff's review of the ALARA program is to ensure that the CP application includes, among other things, in accordance with 10 CFR 50.34(a)(6), a description of LME's plans to develop, at the OL stage, comprehensive worker protection programs, organizational structure, training, and monitoring to ensure that the relevant requirements are met in 10 CFR Part 20.

10.2.1 Technical Evaluation

The NRC staff reviewed PSAR section 10.2, which states that as part of the LMGS RPP and in accordance with 10 CFR Part 20, maintaining occupational doses below regulatory limits and ALARA is a key focus of the LMGS plant structures, systems, and components and

programmatic design and implementation activities. PSAR section 10.1 references RG 8.10, which provides guidance for establishing an ALARA program that is acceptable to the NRC staff, and PSAR table 1.4-2 states that LMGS is in partial conformance with RG 8.10, Revision 2, because the guidance that is only applicable to LWRs, is not applicable to LMGS. In PSAR section 10.2, LME states that additional details of the ALARA program will be provided in any OL application. The NRC staff finds that the applicant's use of RG 8.10, Revision 2 is appropriate because it is the applicable guidance and it will be followed with the exception of its guidance that is only applicable to LWRs. The NRC staff also finds that that LWR-specific guidance relates to application-specific guidance that would be otherwise met through the use of DANU-ISG-2022-04.

10.2.2 Conclusion

The NRC staff determined that the description provided in the CP application of LME's plan to develop an ALARA program at the OL stage is acceptable because LME states that the ALARA program will be in partial conformance with RG 8.10, as described above. The NRC staff will review the LMGS ALARA program as part of the review of any OL application to ensure compliance with relevant regulations.

10.3 Design Considerations

As discussed in DANU-ISG-2022-04, one purpose of the NRC staff's review is to ensure that a CP application provides a description of the design-specific PDCs necessary to control occupational exposures and a preliminary description of design provisions necessary to control occupational exposure, including ensuring that occupational doses are ALARA. As discussed in SE section 1.3.3, the NRC staff's review includes evaluating compliance of the LMGS design with the technically relevant portions of 10 CFR 50.34(f), which are identified in PSAR table 1.4-1. With respect to the LMGS CP application and the control of occupational dose, the applicant identified the technically relevant portions of 10 CFR 50.34(f)(2) as (vii), (xxvii), and (xxviii). As specified in 10 CFR 50.34(f)(2)(vii), an applicant shall perform radiation and shielding design reviews of spaces around systems that may, as a result of an accident, contain accident source term radioactive materials, and design as necessary to permit adequate access to important areas and to protect safety equipment from the radiation environment. As specified in 10 CFR 50.34(f)(2)(xxvii), an applicant shall provide, for monitoring of in-plant radiation and airborne radioactivity as appropriate, for a broad range of routine and accident conditions. As specified in 10 CFR 50.34(f)(2)(xxviii), an applicant shall evaluate potential pathways for radioactivity and radiation that may lead to control room habitability problems under accident conditions resulting in an accident source term release and make necessary design provisions to preclude such problems. The regulation at 10 CFR 50.34(f)(2) states that to satisfy these requirements, CP applications must provide sufficient information to demonstrate that the required actions will be satisfactorily completed by the OL stage.

10.3.1 Technical Evaluation

The NRC staff reviewed PSAR section 10.3.1, which cites the relevant radiation protection aspects of PDCs 19 and 61, which are the design-specific PDCs necessary to control occupational exposures. The PDCs for LMGS are provided in the PSAR and details on the PDC development process and basis are in the topical report, "Xe-100 Licensing Topical Report Principal Design Criteria," Revision 3 (ML24319A155). The NRC staff's review of PDCs is summarized in SE section 5.3. PSAR section 10.3.2 and table 10.3-1, provide preliminary

information on the major radiation sources expected at the facility. PSAR table 1.4-1 provides that 10 CFR 50.34(f)(2)(vii), (xxvii), and (xxviii), are addressed in full compliance.

The NRC staff reviewed PSAR section 10.3, which describes that a key objective of the LMGS design is to reduce radiation fields in operating areas and that ALARA principles are applied throughout design processes via methodologies and design decisions. In PSAR section 10.3, LME provides that the radiation protection design approach includes overarching design approaches, system level considerations, plant features, and mitigation efforts to minimize dose and maintain ALARA in accordance with, but not limited to, 10 CFR 20.1101. LME also provides that detailed design information will be available during the review of any OL application. PSAR section 10.3.2 provides a list of preliminary radiation sources in PSAR table 10.3-1. PSAR section 10.3.2 also states that the sources in this table range from major radiation sources, such as spent fuel, to more limited sources, such as filters and dust. Additional details of the radiation sources for the LMGS needed to demonstrate compliance with 10 CFR Part 20, will be provided to support any OL application.

The NRC staff reviewed the information in PSAR section 10.3.2 and table 10.3-1 to understand the locations of potential radiation sources. To support its understanding of these radiation sources, the NRC staff conducted an audit of the facility's preliminary estimates for dose (ML audit summary). During the audit, LME provided the NRC staff with insights into its high-level planning for anticipated radiation zoning levels consistent with the information provided in PSAR table 10.3-1.

For the LMGS CP application, the NRC staff verified that LME has committed to the methods contained in RG 8.8, Revision 3 and other RGs applicable to the RPP. RG 8.8 describes information relevant to attaining goals and objectives for planning, designing, constructing, operating, and decommissioning an LWR to meet the ALARA criteria, but also contains information applicable to non-LWR designs. Commitments to this RG along with the other RGs discussed above with respect to the RPP, provide reasonable assurance that ALARA design considerations will be included as the LMGS design is being finalized. The NRC staff's assessment of the preliminary information provided to meet 10 CFR 50.34(f)(2)(xxvii) is in SE section 9.4. Additional information to support the NRC staff's review of ALARA design considerations and dose assessments would be evaluated as part of the review of any OL application. For example, an OL application review would include evaluating the ALARA design considerations against the requirements of 10 CFR Part 20, 10 CFR 50.34(b)(3), 10 CFR 50.34(f)(2)(vii), 10 CFR 50.34(f)(2)(xxvii), 10 CFR 50.34(f)(2)(xxviii), PDC 19, and PDC 61.

10.3.2 Conclusion

Given PDCs 19 and 61 and the commitments to follow the RGs described above for the RPP and the ALARA program and to fully comply with 10 CFR 50.34(f)(2)(vii), (xxvii), and (xxviii), the NRC staff has reasonable assurance that LME will be able to incorporate design considerations such as shielding into the final design to ensure that dose estimates and radiation zones are maintained at appropriate levels for the LMGS facility. The NRC staff would review the design considerations, radiation sources, and dose assessments at the OL stage to ensure compliance with 10 CFR Part 20, 10 CFR 50.34(b)(3), 10 CFR 50.34(f)(2)(vii), 10 CFR 50.34(f)(2)(xxvii), 10 CFR 50.34(f)(2)(xxviii), PDC 19, and PDC 61.

10.4 Design Features

As discussed in DANU-ISG-2022-04, one purpose of the NRC staff's review is to ensure that a CP application provides a preliminary description of design provisions necessary to control occupational exposure, including ensuring that occupational doses are ALARA.

10.4.1 Technical Evaluation

The NRC staff reviewed PSAR section 10.4, which states that plant design features, such as ALARA considerations during shielding design and remote operations where feasible, are considerations made during the design phase and maintain occupational radiation exposure ALARA. PSAR section 10.4.1 states that the design of the plant considers adequate shielding design to support occupational radiation exposure ALARA and within the limits of 10 CFR Part 20. In this PSAR section, the applicant also highlights the regulatory requirements, regulatory guidance, and applicable codes and standards considered during the shielding design process for the plant. PSAR table 1.4-2 further provides that LMGS will be in full conformance with RG 1.69, "Concrete Radiation Shields and Generic Shield Testing for Nuclear Power Plants," Revision 1 and RG 8.8, Revision 3. PSAR section 10.4.2 states that the design considers remote operation activities where available, such as remote monitoring and controlling of various plant parameters and autonomous or remotely operated special tooling for inspection, service, and maintenance to minimize dose to plant staff to achieve ALARA. This section also provides some examples of remotely operated tooling operations and manipulations, which are installing and removing components, turning valves, manipulating switches, racking breakers, connecting and disconnecting connectors, and using hand-tools.

The NRC staff reviewed the information cited as applicable guidance for shielding considerations and finds that the references to RG 1.69 for the design and construction of shielding and to RG 8.8 for ALARA design considerations, are appropriate for discussing design features that will be considered at the LMGS because RGs 1.69, Revision 1 and 8.8, Revision 3, describe acceptable methods for meeting shielding design requirements and ALARA shielding design features.

10.4.2 Conclusion

The NRC staff determined that the radiation protection design features and commitments to conform with RG 1.69, Revision 1 and RG 8.8, Revision 3, are appropriate because LME has committed to use NRC-approved methods for determining applicable design features to consider at the LMGS and has provided the NRC staff with a preliminary description of the design provisions necessary to control occupational exposure that would address the guidance for CP applications in DANU-ISG-2022-04.

10.5 Preliminary Dose Assessment for Expected Occupancy

As discussed in DANU-ISG-2022-04, one purpose of the NRC staff's review is to ensure that a CP application provides a preliminary description of design provisions necessary to control occupational exposure, including ensuring that occupational doses are ALARA.

10.5.1 Technical Evaluation

The NRC staff did not conduct a detailed review of PSAR section 10.5, which provides preliminary dose estimates for occupational workers, because this information is not required for a CP application. This section states that the estimated radiation exposure to plant staff was not

based on expected source terms and does not represent the actual dose rates anticipated at the LMGS. PSAR section 10.5 also states that detailed task-based dose assessments for plant staff, considering plant radiation zoning where plant staff would be expected to perform normal duties and staff occupancy information, and information similar to the tables presented in RG 8.19, "Occupational Radiation Dose Assessment in Light-Water Reactor Power Plants -- Design Stage Man-Rem Estimates," would be provided to support any OL application. Thus, initial radiation zones were developed to provide a basis for the preliminary design of the plant. The NRC staff reviewed the design considerations and design features as discussed in SE sections 10.3.1 and 10.4.1, respectively, which provide information on the preliminary design considerations and features that would inform the occupational dose assessment that would be performed at the OL stage.

10.5.2 Conclusion

With LME's commitment to follow RG 8.8 to manage dose, as discussed in SE sections 10.1 through 10.4, and the identification of major radiation sources, the NRC staff has determined that LME has identified the major radiation sources and will consider design considerations and design features as appropriate to ensure that occupational exposures are within regulatory limits and maintained ALARA. The commitments to follow the RGs discussed in this SE chapter, provide the preliminary description of design provisions necessary to control occupational exposure, including ensuring that occupational doses are maintained ALARA.

The NRC staff would review the occupational dose assessment at the OL stage when the details required to assess dose, such as radiation sources, would be provided, as required by 10 CFR 50.34(b)(3). The NRC staff would also review the LMGS occupational dose assessment at the OL stage to ensure compliance with 10 CFR Part 20.

10.6 Conclusion

Based on its findings above, the NRC staff concludes that the information in PSAR chapter 10 is sufficient and meets the applicable guidance and regulatory requirements identified in this chapter for the issuance of a CP in accordance with 10 CFR 50.34(a)(6) and 10 CFR 50.40.

10.7 References

1. Nuclear Energy Institute, NEI 07-03A, "Generic FSAR Template Guidance for Radiation Protection Program Description," May 2009.
2. Nuclear Energy Institute, NEI 07-08A, "Generic FSAR Template Guidance for Ensuring that Occupational Radiation Exposures are as Low as is Reasonably Achievable (ALARA)," October 2009.
3. Nuclear Regulatory Commission (U.S.), NUREG-1736, "Consolidated Guidance: 10 CFR Part 20 – Standards for Protection Against Radiation," October 2001.