



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

November 17, 2020

Ms. Caroline Cochran
Co-Founder, Chief Executive
Officer Oklo, Inc.
230 E. Caribbean
Dr. Sunnyvale, CA 94089

SUBJECT: OKLO POWER LLC EXTENSION OF STEP 1 TECHNICAL
REVIEW OF KEY SAFETY AND DESIGN ASPECTS OF THE
AURORA POWERHOUSE

Dear Ms. Cochran:

By letter dated March 11, 2020 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML20075A000), Oklo Power LLC (Oklo), submitted a combined license (COL) application for its Aurora micro-reactor to be located at the Idaho National Laboratory. By letter dated June 5, 2020 (ADAMS Accession No. ML20149K616), the U.S. Nuclear Regulatory Commission (NRC) informed Oklo of its decision to accept the application for docketing and that a two-step approach will be used in order to achieve understanding of four key safety and design aspects of the licensing basis prior to establishing a schedule for the licensing review. The period for engagement on the four key aspects is referred to as Step 1 and the balance of the full detailed review will be Step 2. The four key aspects are discussed below, identifying which Step 1 issues are completed and which require further information and evaluation before the NRC staff can complete Step 1 and establish a schedule for the full detailed review.

The purpose of Step 1 is to achieve mutual understanding of four key safety and design aspects of the licensing basis: Maximum Credible Accident (MCA); Classification of Structures, Systems and Components (SSCs); Applicability of Regulations; and the Quality Assurance Program (QAP). At the end of Step 1, the NRC staff expects to have defined the scope of the full, detailed technical review so that it is possible to develop a schedule to efficiently perform the detailed review of the design in Step 2. During Step 1, the NRC staff issued requests for additional information (RAIs) related to MCA, SSC classification, and QAP scope. In addition, staff conducted audits and held public meetings related to MCA, SSC classification, and the applicability of regulations.

Oklo's RAI responses (ADAMS Accession No. ML20305A582), audit documents, and audit discussions enhanced staff's understanding of Oklo's novel approach to the Aurora safety case but did not provide sufficient information to define the scope of the full technical review. During the course of interactions with Oklo, the staff has determined that Oklo's licensing approach closely aligns its QAP with the SSC classification strategy. Because Oklo's QAP is closely tied to its SSC classification, these two issues will no longer be tracked separately. The NRC staff has completed its Step 1 review of the Applicability of Regulations and is issuing a separate letter documenting the Step 1 closure of this topic. Since the purpose of

Step 1 has not been fully satisfied for the remaining key safety and design aspects of the Aurora licensing basis, Step 1 is being extended to allow time to reach alignment on the MCA and SSC classification. This is essential to prepare a schedule for a predictable, timely, and risk-informed Step 2 review that will include the review of exemption requests in the areas of emergency planning, security, and postulated fission product release.

Discussion of Key Topics

Oklo has proposed a novel approach to determining the spectrum of potential accidents deemed credible to the Aurora design and the selection of the MCA. Similarly, Oklo has applied a new methodology for determining the classification of SSCs within its design. Both topics are foundational to the safety case for reasonable assurance of adequate protection of public health and safety for the Aurora design and will significantly shape the scope and depth of other areas of the NRC staff's review. As such, it is essential that the NRC staff understand Oklo's approaches and evaluate their reasonableness prior to expending resources elsewhere. The following discussion identifies some specific needs from Oklo that are critical for Oklo to demonstrate that its safety case is adequately supported.

MCA

The Step 1 closure criteria for the MCA is for staff to issue "a letter documenting mutual agreement on the methodology used in the analysis and evaluation of the MCA." Thus far during the Step 1 review, staff has gained an understanding of Oklo's definition of credible as used in the application, the methodology for and implementation of the MCA selection process, and Oklo's reliance on the fuel matrix to retain fission products such that the reactor cell can is not credited in the MCA analysis. In its response to MCA RAI 9774 (ADAMS Accession No. ML20305A584), Oklo committed to add in the application a design commitment and three programmatic controls for the efficacy of the measurement system used to infer fuel temperature. Reasonable assurance of the adequacy of the MCA is essential because it establishes the basis for Oklo's licensing basis assumption of zero radioactivity release. Exemption requests for emergency planning, postulated fission product release, and portions of the environmental review are dependent on the MCA. For the staff to better understand Oklo's selection of the MCA, resolution is needed on the following aspects:

- Oklo needs to provide its systematic search for initiating events, particularly related to Oklo-specific SSCs, and more information is needed on what was considered in the scope of certain events. In performing this search, all impacts from initiating events should be considered. This was recently recommended by the Advisory Committee on Reactor Safeguards,¹ who noted the staff, in their view, "should ensure that applicants compensate for novel designs with uncertainties due to incompleteness in the knowledge base by performing systematic searches for hazards, initiating events, and accident scenarios with no preconceptions that could limit the creative process." Methods such as a failure modes and effects analysis, a hazard and operability study, a master logic diagram method, and/or an independent challenge review board are acceptable examples that can produce thorough evaluations.
- In Oklo's definition of "credible" related to event selection, Oklo includes the term "not mechanistically possible." A description of the criteria used by Oklo to characterize a

¹ Letter from Matthew Sunseri to Chairman Svinicki, "10 CFR Part 53 Licensing and Regulation of Advanced Nuclear Reactors" dated October 21, 2020 (ADAMS Accession No. ML20295A647)

failure as “not mechanistically possible” is needed to demonstrate that Oklo used a justifiable and consistent screening process. For each instance where Oklo used the criteria in screening events from the MCA, justification should be provided, including the basis for assumed system reliabilities. Additionally, Oklo only considers event sequences that result from a single initiating event to be “credible.” A justification is needed for how this approach sufficiently addresses the spectrum of conditions of normal operation, external events, natural phenomena, and accident scenarios for which the plant must be designed.

- Oklo’s licensing basis presumes that all fission products are retained in the fuel matrix during normal and off-normal conditions and does not credit other SSCs, such as the reactor cell can, with performing any holdup or retention of fission products. In contrast, publicly available Experimental Breeder Reactor-II data appears to show that some fission product release from the metal fuel matrix is expected for burnups of 1 atom percent.² Oklo needs to provide data to justify its licensing basis assumption.

The staff is preparing RAIs related to the MCA. As Oklo provides information for these needs, the staff anticipates its review may identify additional questions related to Oklo’s MCA methodology and its application to scenarios and events screened. The staff will provide timely communications when raising these questions so that they may be discussed and closed as part of Step 1. Oklo may propose other approaches with appropriate justification to support resolution of these issues.

SSC Classification

The Step 1 closure criteria for SSC classification is for staff to issue “a letter documenting the process to be used for classifying SSCs in the Aurora design and the treatment for each classification of SSCs.” Thus far during the Step 1 review, staff understands that Oklo has not applied the regulatory definition of safety-related SSCs in Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.2 and instead classifies functions or inherent features as safety-related only if they are needed to meet the offsite dose consequence limit for siting per 10 CFR Part 100.

Oklo relies on design commitments to demonstrate that design bases—the characteristics of systems that ensure safe operation of the reactor—meet the appropriate level of quality. No design or construction standards are included in the design commitments. In addition, the Aurora application contains no design commitments for defense-in-depth systems because Oklo states that they are not credited in the safety analysis.

Proper classification and treatment of SSCs provides reasonable assurance that the SSCs will perform the safety-significant functions credited in the design basis. For staff to better understand the classification and treatment of SSCs, additional information is needed on the following aspects:

- A technical basis and supporting analyses are needed to support Oklo’s approach to designate as safety related only those features necessary to meet offsite dose requirements. Oklo needs to justify its definition of safety related given the role of some SSCs in limiting the release of radionuclides over a wide range of possible

² C.B. Lee, D.H. Kim, and Y.H. Jung, “Fission gas release and swelling model of metallic fast reactor fuel,” *Journal of Nuclear Materials*, 288 (2001) 29-42.

unplanned events. The additional information should demonstrate how no features are safety related and how Oklo's approach to SSC classification has been consistently and systematically applied across the design.

- Oklo needs to show that the design bases, design commitments, and programmatic controls specified in the application provide appropriate rigor in the lifecycle of an SSC including analysis, design, procurement, construction, repair, maintenance, etc., considering Oklo does not commit to any consensus design and construction codes and standards.
- In response to RAI 9773 (ADAMS Accession No. ML20305A585), Oklo clarified that quality assurance is applied to functions and inherent features rather than physical components as a whole. Oklo needs to revise its QAP description to clearly explain this approach and provide additional details regarding how its internal control procedures demonstrate a consistent implementation across the design.

The staff is preparing RAIs related to the items above. As Oklo provides information for these needs, the staff anticipates its review may identify additional questions related to Oklo's classification of SSCs. The staff will provide timely communications when raising these questions so that they may be discussed and closed as part of the Step 1 review. Oklo may propose other approaches with appropriate justification to support resolution of these issues.

QAP

The Step 1 closure criteria for the QAP scope is for staff to issue "a letter documenting understanding of the scope and application of the Quality Assurance Program to the Aurora." Because resolution of this item is dependent on how the classification of SSCs is resolved, it will no longer be tracked separately. Instead, the items needed for resolution of this Step 1 item will be captured in Step 1 with the SSC Classification or deferred to Step 2 of the review.

Applicability of Regulations

The Step 1 closure criteria for regulatory applicability to the Aurora design is for staff to issue "a letter documenting which, if any, of the regulations identified as non-applicable in the original application are actually applicable and require either compliance or exemptions." A letter on regulatory applicability is being transmitted separately and closes this key topic for Step 1.

Schedule and Resources

The NRC's application reviews are focused on ensuring safe and secure use of radioactive materials. The NRC is committed to conducting a safety-focused, timely, and risk-informed review of the Aurora design. In order to achieve this goal, the NRC will engage with Oklo on MCA and SSC classification through RAIs, audits, and public meetings to understand and document these key safety and design aspects of the licensing basis and bring Step 1 to closure. The NRC looks forward to working constructively with Oklo on these topics and will establish the remaining schedule for Step 1 closure after such engagement occurs. For the environmental review, staff will continue activities geared toward maintaining awareness of Step 1 safety review activities to support a prompt initiation of the full environmental review once a Step 1 closure date is determined. The staff previously estimated that Step 1 could be

completed within 2,500 hours. Step 1 activities to date are within this estimate. The staff will continue to work with Oklo to efficiently resolve the outstanding issues within the current estimate, however, the accuracy of this estimate will depend on the level of effort necessary to reach resolution of the Step 1 items.

If you have any questions, I can be reached by phone at (301) 415-0498 or by email at Jan.Mazza@nrc.gov.

Sincerely,

/RA/

Jan Mazza, Project Manager
Advanced Reactor Licensing Branch
Division of Advanced Reactors and Non-Power
Production and Utilization Facilities
Office of Nuclear Reactor Regulation

Docket No. 52-049

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SAFETY AND DESIGN ASPECTS OF THE AURORA POWERHOUSE
DATED: NOVEMBER 17, 2020

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