OFFICE OF NEW REACTORS

RESPONSE TO OKLO, INC. CONCERNS

REGARDING INFORMATION CONTAINED IN DRAFT NRC REPORTS

## I. Background

On April 3, 2019, the U.S. Nuclear Regulatory Commission (NRC) published a series of draft reports that identifies the work necessary to ensure that computer codes and other analytical tools are available to support reviews of non-light-water reactor (non-LWR) designs.

On April 8, 2019, Oklo, Inc. (Oklo) contacted the NRC and expressed concern that some of the information in the reports contained Oklo's proprietary information and export controlled information (ECI). In particular, Oklo was concerned with certain information contained in two reports:

- "NRC Non-Light Water Reactor (Non-LWR) Vision and Strategy, Volume 1—Computer Code Suite for Non-LWR Design Basis Event Analysis," dated April 1, 2019 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML19093B322), and

- "NRC Non-Light Water Reactor (Non-LWR) Vision and Strategy Volume 3: Computer Code Development Plans for Severe Accident Progression, Source Term, and Consequence Analysis," dated April 1, 2019 (ADAMS Accession No. ML19093B404).

The NRC staff and Oklo discussed Oklo's concerns during a conference call on April 11, 2019. During this call, the NRC staff asked Oklo whether its proprietary information had been included in the draft reports. At the time of the call, Oklo did not identify any proprietary information in either report. However, Oklo offered to send the NRC staff suggested revisions to the portions of the draft reports to clarify descriptions of Oklo's technology. Oklo also agreed to further consider and inform the NRC staff whether its proprietary information had been included in the draft reports. The NRC agreed to review any revisions and concerns provided by Oklo and determine whether any actions were necessary. On April 12, 2019, Oklo e-mailed the NRC staff a list of sections in the two NRC draft reports that it believes contain proprietary information and export controlled information (ECI) (ADAMS Accession No. ML19122A249).

This document reproduces and addresses the concerns identified by Oklo in its April 12, 2019 e-mail. For each concern, the NRC staff has provided a response that confirms the nature of the information included in the two draft reports and indicating any additional action to be taken.

## II. Proprietary Information and Export Controlled Information

The NRC staff reviews requests from persons for the withholding of submitted documents and portions of submitted documents containing trade secrets, privileged, or confidential commercial or financial information in accordance with the requirements of Title 10 of the *Code of Federal Regulations* (CFR) 2.390, "Public inspections, exemptions, requests for

withholding." On the basis of the statements made by a person in the affidavit accompanying the information sought to be withheld, the NRC staff makes a determination as to whether the submitted information sought to be withheld contains proprietary commercial information and should be withheld from public disclosure. To aid in its determinations, the NRC staff may also consider NRC Office Instruction LIC-204, "Handling Requests to Withhold Proprietary Information from Public Disclosure," dated January 24, 2007 (ADAMS Accession No. ML062200530), which provides the NRC staff guidance on performing proprietary review requests. Section 4.3, "Proprietary Determination," states the following:

> If the staff determines that the information contains trade secrets and commercial or financial information that is confidential or privileged based on the 10 CFR 2.390(b)(4), then, pursuant to 10 CFR 2.390(b)(5), it must be determined: (1) whether the right of the public to be fully apprised of the proposed action outweighs the demonstrated concern for protection of a competitive position; and (2) whether the information should be withheld.
>
> The PM should be able to answer "Yes" to each of the following questions to determine if the information should be withheld:
>
> 1. Was the information held in confidence by the owner?
> 2. Is the information of a type normally held in confidence?
> 3. Was the information sent to and received by the NRC in confidence?
> 4. Is the information not publicly available?
> 5. Is public disclosure likely to cause harm to the owner of the information?
>
> If any of the answers are "No," the withholding may be denied. If all of the answers are "Yes," the PM should prepare an approval letter addressed to the submitter.

Examples of information types not typically considered proprietary include information that is publicly available, common terminology, or general descriptions of technology. Consistent with 10 CFR 2.390 and the guidance in LIC-204, the NRC staff does not consider these types of information to be trade secret or confidential or privileged commercial or financial information that should be withheld from public disclosure.

Documents and portions of documents that are claimed to be proprietary must include proper information and page markings, as well as the basis for requesting that the information be withheld in either the document or affidavit. The specific procedures that must be followed by anyone submitting a document to the NRC who seeks to have the document, or a portion of it, withheld from public disclosure because it contains trade secrets, privileged, or confidential commercial or financial information are found in 10 CFR 2.390. Additional guidance is also available in LIC-204.

In general, when requesting that a document or portion of a document containing proprietary information be withheld from public disclosure, a public version of the document containing proprietary information should also be submitted to the NRC. However, NRC staff acknowledges that there are instances where a non-proprietary version of a document would be of no value to the public due to the extent of the proprietary information. In such instances, a non-proprietary version is not required to be submitted to the NRC. Absent

such a finding, the submitter should provide a version that could be made available to the public. The task of providing a public version rests on the submitter, not on the NRC staff.

Previously, the NRC staff has agreed to withhold substantial portions of documents containing proprietary and ECI submitted by Oklo, including Oklo's Draft Guide (DG)-1353, "Submittal to Support NRC Submittal and Implementation of DG-1353, A Guidance to Risk-Inform Application Development and Contents Including Event Selection and SSC Classification," issued September 2018 (DG-1353 Pilot Report) (ADAMS Accession No. ML18311A205, non-public). The NRC staff agreed to broadly withhold and protect this information based on the preliminary nature of the information and its use to support pre-application interactions. Withholding information in these circumstances is not an acknowledgement by the NRC staff that all information withheld was proprietary, but only that preparation of more specific redactions within a public version would be of no value to the public due to the extent of the proprietary information. When requesting the withholding of information in future submittals, Oklo should consider the requirements in 10 CFR 2.390 and guidance in LIC-204 when preparing documents.

Statutory and regulatory authorities for ECI provide designation authority to agencies other than NRC, including the U.S. Department of Energy (DOE), U.S. Department of Commerce, and U.S. Department of State. While the NRC does not have designation authority over ECI, the NRC staff considered whether any information identified by Oklo and contained within the draft reports had been previously withheld from public disclosure as ECI under 10 CFR Part 810, "Assistance to Foreign Atomic Energy Activities."

Based on its review, the NRC staff has determined that no proprietary information or ECI was released in the draft NRC reports. However, as the NRC staff develops the final versions of the reports, it will consider Oklo's proposed modifications to the draft NRC reports as requested in the e-mail attachment.

## III. Concerns Related to "NRC Non-Light Water Reactor (Non-LWR) Vision and Strategy, Volume 1—Computer Code Suite for Non-LWR Design Basis Event Analysis," Section 4.4, "Heat Pipe Cooled 'Micro' Reactors"

1. *Oklo-Identified Issue #1:* Paragraph 2, sentence 4, page 90 of digital PDF (printed page 89) reads as follows, "A supercritical $CO_2$ power cycle has been suggested for the secondary side of both designs."

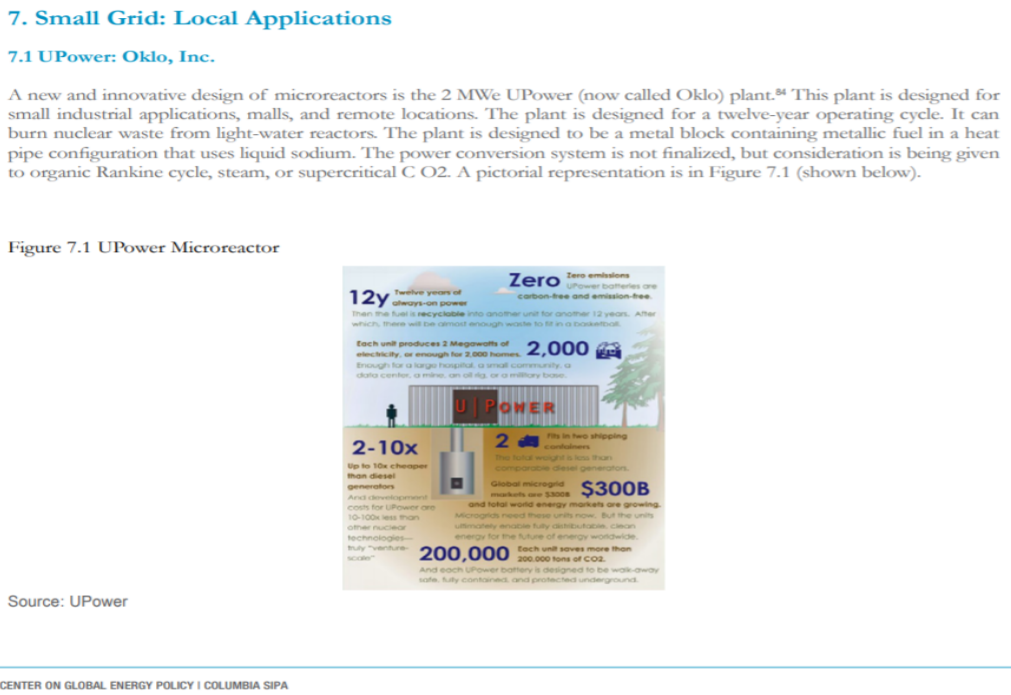
   *Oklo-Provided Suggestion*: Please rewrite as follows, "A supercritical $CO_2$ power cycle is one of the power cycles that have been suggested for both designs."

   *Oklo Reasoning*: Oklo has not publicly stated that supercritical $CO_2$ will be used for the secondary-side coolant. It is understood that the NRC is developing models for supercritical $CO_2$, which is why the rewrite is slight.

   NRC Response:

   The NRC staff does not agree that this sentence contains non-public information. Oklo's possible use of supercritical carbon dioxide ($CO_2$) for its power conversion system can be found in the public domain. For example, page 90 of the publicly available report, "A Comparison of Advanced Nuclear Technologies," issued March 2017, by Andrew C. Kadak,

Ph.D., of Columbia University (https://energypolicy.columbia.edu/sites/default/files/A%20Comparison%20of%20Nuclear%20Technologies%20033017.pdf) notes that Oklo is considering supercritical $CO_2$ as an option for its power conversion system (see: Figure 1). Consistent with the guidance provided in LIC-204, the NRC staff has determined that references to Oklo's potential use of supercritical $CO_2$ for its power conversion system are publicly available information and should not be withheld from public disclosure. However, the NRC staff will consider Oklo's suggested revision in the final version of the report.



7. Small Grid: Local Applications

7.1 UPower: Oklo, Inc.

A new and innovative design of microreactors is the 2 MWe UPower (now called Oklo) plant.[84] This plant is designed for small industrial applications, malls, and remote locations. The plant is designed for a twelve-year operating cycle. It can burn nuclear waste from light-water reactors. The plant is designed to be a metal block containing metallic fuel in a heat pipe configuration that uses liquid sodium. The power conversion system is not finalized, but consideration is being given to organic Rankine cycle, steam, or supercritical C O2. A pictorial representation is in Figure 7.1 (shown below).

Figure 7.1 UPower Microreactor



Source: UPower



**Figure 1. Reproduction of Report Describing Oklo's Potential use of a Supercritical $CO_2$ Power Conversion Cycle**

2. *Oklo-Identified Issue #2:* Paragraph 4, sentences 5 and 6, page 91 of digital PDF (printed page 90) state the following, "This would include the sodium bond, the can and the supporting structures including the steel base, upper and lower reflectors, gas plenum, and insulator. Estimating the contact resistance between fuel cells may be a challenge, as will be the thermo-mechanical interaction as the fuel cells expand."

   *Oklo-Provided Suggestion*: Remove sentence 5 and rewrite sentence 6 as follows, "Estimating contact resistances between various core components and structures may be a challenge, as will be the thermo-mechanical interactions that arise from thermal expansion of these components and structures."

   *Oklo Reasoning*: Sentence 5 contains proprietary information and export-controlled information (ECI), such as the term "can"; the removal of this sentence does not take away from the message in this paragraph as it is extraneous design information. Sentence 6 contains proprietary information and ECI, such as the term "fuel cells." The proposed revision does not utilize this term.

NRC Response:

The NRC staff does not agree that the terms “can” and “fuel cells” are proprietary information.

The NRC staff acknowledges that the word “can” is included in the broad redactions of information previously submitted to the NRC by Oklo, as noted above in Section II. However, the word “can” is a common term and is not descriptive enough to divulge the details of Oklo’s design. Common terms are not considered trade secret or confidential or privileged commercial or financial information that should be withheld from public disclosure. Consistent with the guidance provided in LIC-204, the NRC staff has determined that references to the term “can” as it relates to Oklo’s design are not proprietary information and should not be withheld from public disclosure. However, the NRC staff will consider Oklo’s suggested revision in the final version of the report.

The public version of Oklo’s DG-1353 Pilot Report (ADAMS Accession No. ML19038A473) contains several instances where Oklo used the term “cell.” Examples include “cell temperature,” page 36; “reactor cell,” pages 45 and 114; and “geometric cells,” pages 48 and 52. The word “cell” is a common term and is not descriptive enough to divulge the details of Oklo’s design. Common terms are not considered trade secret or confidential or privileged commercial or financial information that should be withheld from public disclosure. Additionally, Oklo has not used or requested withholding of the term “fuel cell” in its previous docketed submissions to the NRC, including the proprietary version of Oklo’s DG-1353 Pilot Report (ADAMS Accession No. ML18311A205). However, the NRC staff considers “fuel cell” a common term that is not descriptive enough to divulge the details of Oklo’s design. Consistent with the guidance provided in LIC-204, the NRC staff has determined that references to the term “fuel cell” as it relates to Oklo’s design are not proprietary information and should not be withheld from public disclosure. However, the NRC staff will consider Oklo’s suggested revision in the final version of the report.

## IV. Concerns Related to “NRC Non-Light Water Reactor (Non-LWR) Vision and Strategy Volume 3: Computer Code Development Plans for Severe Accident Progression, Source Term, and Consequence Analysis,” Section B.4, “Design Specific Models – Oklo Heat Pipe Reactor”

1. *Oklo-Identified Issue #3:* Paragraph 4, page 148 reads as follows:

   The OKLO fuel cell is designed as an annular fuel region, with a cylindrical core representing the heat pipe. This geometry would require a new fuel component (modification to existing fuel component) since the effective coolant channel is now internal to the fuel cell and the fuel region is not cylindrical and may be interspersed with a sodium bond. The duct surrounding the fuel cell and the heat pipe walls would also need to be represented by a new (or by a modified) COR component.

   *Oklo-Provided Suggestion*: Rewrite the paragraph as follows, “The Oklo fuel element geometry would require a new fuel component (modification to existing fuel component) since the effective coolant channels are not similar to the MELCOR code geometry and the fuel region is not cylindrical and may be interspersed with a sodium bond. The structures around the fuel region would also need to be represented by a new (or by a modified) COR component.”

*Oklo Reasoning*: This paragraph contains proprietary information and ECI, such as detailed information about Oklo's fuel design.

NRC Response:

The NRC does not agree that the information in this paragraph is proprietary. Information on Oklo's use of heat pipes as its heat transfer mechanism is in the public domain and included in documents such as page 40 of the public version of Oklo's DG-1353 Pilot Report.

The concept of using heat pipes surrounded by the fuel for reactor designs is also in the public domain and included in documents such as INL/EXT-17-43212, "Preliminary Assessment of Two Alternative Core Design Concepts for the Special Purpose Reactor," issued May 2018 by Idaho National Laboratory (https://www.osti.gov/servlets/purl/1413987). Page 34 of this document, reproduced below in Figure 2, shows a core design with individual heat pipes surrounded by an annular hexagonal-shaped fuel element. This design also suggests thermally bonding gaps using liquid metal potassium or sodium. The paragraph that Oklo cites above is general enough that it could also describe the "Special Purpose Reactor" in the Idaho National Laboratory report.

The NRC staff does not consider general descriptions of Oklo's use of heat pipes and fuel design geometry to be trade secret or confidential or privileged commercial or financial information that should be withheld from public disclosure. Consistent with the guidance provided in LIC-204, the NRC staff has determined that references to Oklo's use of heat pipes and general geometric fuel design information as it relates to Oklo's design are not proprietary information and should not be withheld from public disclosure. However, the NRC staff will consider Oklo's suggested revision in the final version of the report.

Gaps 1 and 4 could also be thermally bonded using a small amount of liquid metal potassium or sodium, although this would complicate the design.

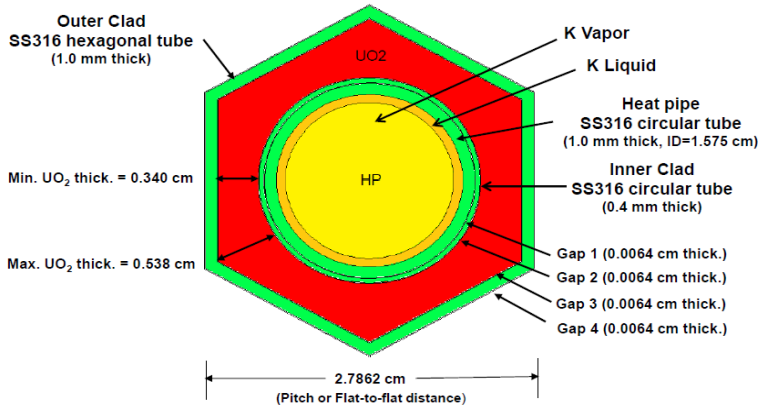



Figure 7. Nominal dimensions and materials for the Design A fuel element.

**Figure 2. Fuel Element Presented in INL/EXT-17-43212**

2. *Oklo-Identified Issue #4:* Paragraph 1, sentence 2, page 149 reads as follows, "These new fuel cell components could be extended using the existing multi-rod model for assessment of propagation from localized failures."

*Oklo-Provided Suggestion*: Replace “fuel cell” with “fuel element” when discussing Oklo fuel structures.

*Oklo Reasoning*: The term “cell” as it relates to an Oklo fuel structure is considered proprietary information and ECI by Oklo.

NRC Response:

The NRC staff does not agree that the term “cell” as it relates to an Oklo fuel structure is proprietary information.

The public version of Oklo’s DG-1353 Pilot Report (ADAMS Accession No. ML19038A473) contains several instances where Oklo used the term “cell.” Examples include “cell temperature,” page 36; “reactor cell,” pages 45 and 114; and “geometric cells,” pages 48 and 52. The word “cell” is a common term and is not descriptive enough to divulge the details of Oklo’s design. Common terms are not considered trade secret or confidential or privileged commercial or financial information that should be withheld from public disclosure. Additionally, Oklo has not used or requested withholding of the term “fuel cell” in its previous docketed submissions to the NRC, including the proprietary version of Oklo’s DG-1353 Pilot Report (ADAMS Accession No. ML18311A205). However, the NRC staff considers “fuel cell” a common term that is not descriptive enough to divulge the details of Oklo’s design. Consistent with the guidance provided in LIC-204, the NRC staff has determined that references to the term “fuel cell” as it relates to Oklo’s design are not proprietary information and should not be withheld from public disclosure. However, the NRC staff will consider Oklo’s suggested revision in the final version of the report.

3. *Oklo-Identified Issue #5:* Paragraph 2, sentence 1, page 149 states the following, “The OKLO reactor uses metallic U-10wt%Zr fuel in a steel alloy heat pipe wall and is surrounded by a steel alloy duct.”

   *Oklo-Provided Suggestion*: Rewrite as follows, “The Oklo reactor uses metallic U-10wt%Zr fuel and stainless steel structural materials.”

   *Oklo Reasoning*: This statement is hard to read but is an issue, taken in the context of the preceding paragraphs mentioned above. It could be describing detailed design information about the Oklo fuel that is inaccurate. Additionally, this statement taken at face value could be describing a design by a different vendor and could be interpreted as patent infringement.

   NRC Response:

   The NRC staff agrees that the statement is inaccurate and will make appropriate revisions in the final version of the report, taking into consideration Oklo’s suggested revision.

4. *Oklo-Identified Issue #6*: Figure B-23, page 150, is replicated below (Figure 3):

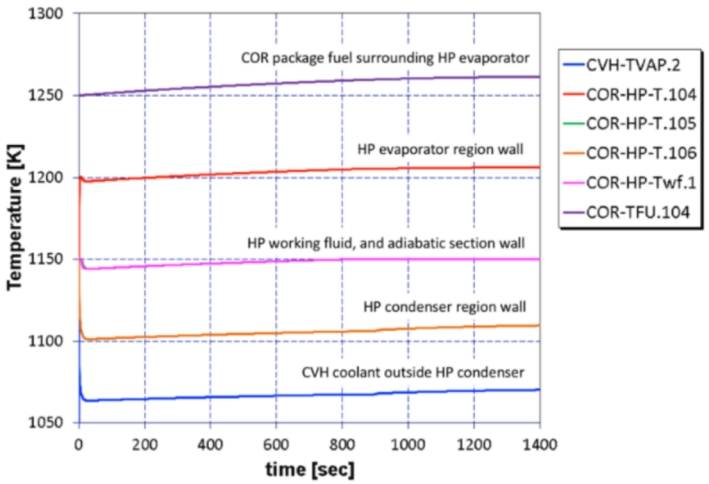



*Figure B-23. MELCOR heat pipe temperatures for a transient-equilibrium test problem*

**Figure 3. Replication of Figure B-23, "MELCOR Heat Pipe Temperature for a Transient-equilibrium Test Problem"**

*Oklo-Provided Suggestion*: Delete this figure.

*Oklo Reasoning:* This figure discloses detailed fuel design information that Oklo usually considers proprietary information and ECI. Additionally, the removal of this figure from the report does not take away from the message conveyed in this report.

NRC Response:

The NRC staff does not agree that the referenced MELCOR heat pipe temperature figure contains Oklo's proprietary information.

The information in this figure does not represent data specific to the Oklo design. The information displayed is theoretical and was developed to test the accuracy of the general MELCOR heat pipe model. The NRC staff does not consider general descriptions of heat pipe performance be trade secret or confidential or privileged commercial or financial information that should be withheld from public disclosure. Consistent with the guidance provided in LIC-204, the NRC staff has determined that information contained in Figure B-23 (Figure 3 above) of "NRC Non-Light Water Reactor (Non-LWR) Vision and Strategy Volume 3: Computer Code Development Plans for Severe Accident Progression, Source Term, and Consequence Analysis," is not proprietary and should not be withheld from public disclosure. However, the NRC staff will consider whether it is appropriate to clarify the nature of the information presented in this figure in the final version of the report.

5. *Oklo-Identified Issue #7*: Throughout Section B.4 of the document, it is repeatedly stated that the heat pipes will be filled with sodium.

*Oklo-Provided Suggestion*: Modify the wording such that Oklo is using liquid metal heat pipes and that the NRC has specifically selected sodium as the working fluid for their models.

*Oklo Reasoning*: Given that the title of this section is explicitly named as, "Design Specific Models—Oklo Heat Pipe Reactor," it is thus implied that this is the material that Oklo will be using in its heat pipes. Oklo is generally reticent to discuss the specific material employed in its heat pipes, preferring instead to say, "liquid metal." This decision is both for proprietary reasons and because multiple liquid metal working fluids are currently under evaluation.

NRC Response:

The NRC staff does not agree that the use of sodium in a heat pipe is proprietary information.

The concept of using heat pipes surrounded by the fuel for reactor designs is in the public domain and included in documents such as INL/EXT-17-43212, "Preliminary Assessment of Two Alternative Core Design Concepts for the Special Purpose Reactor," issued May 2018 by Idaho National Laboratory (https://www.osti.gov/servlets/purl/1413987) and "Solid-Core Heat-Pipe Nuclear Battery Type Reactor," by Ehud Greenspan of the University of California, issued September 2008 (https://www.osti.gov/servlets/purl/940911). Both of these documents suggest using liquid metal potassium or sodium.

The NRC staff used sodium as a nominal working fluid in its MELCOR models and did not intend to imply that Oklo had made a definitive selection of a working fluid in its design. Since the use of sodium as a working fluid in liquid metal heat pipes is publicly available information and Oklo has not selected a specific fluid for its heat pipes, the NRC staff does not consider this information to be trade secret or confidential or privileged commercial or financial information that should be withheld from public disclosure. Consistent with the guidance provided in LIC-204, the NRC staff has determined that references to the use of sodium in the staff's MELCOR models are not proprietary information and should not be withheld from public disclosure. However, the NRC staff will consider appropriate revisions in the final version of the report to clarify that the nominal selection of sodium as a working fluid in its heat pipe models does not necessarily reflect specific design choices made by Oklo.

6. *Oklo-Identified Issue #8:* Section 2, "MELCOR Development Plans for Non-LWRs" Table 2-1, row 2, column 3, page 27 is replicated, in part, below (Figure 4):

*Table 2-1. MELCOR Non-LWR Development Plan Start Dates.*

| Reactor Type/ Development Item (DI) | Phenomenological Area (MELCOR) | Description of Tasks (needs) | FY18 | FY19 | FY20 |
|---|---|---|---|---|---|
| SFR (M1.1) | Development of core components | 3 new components (fuel region, fuel cell duct, heat pipe walls) need to be added to COR package. Radiation use existing models. (Applies to HPR designs) | ✓ | | |

**Figure 4. Excerpt from Table 2-1, "MELCOR Non-LWR Development Plan Start Dates"**

*Oklo-Identified Suggestion*: Omit the word “cell” in row 2, column 3, such that it reads as follows, “3 new components (fuel region, fuel duct, heat pipe walls) need to be added to COR package. Radiation use existing models. (Applies to HPR designs)

*Oklo Reasoning*: Oklo considers the term “fuel cell” both proprietary information and ECI.

NRC Response:

The NRC staff does not agree that the term “fuel cell” as it relates to an Oklo fuel structure is proprietary information.

The public version of Oklo’s DG-1353 Pilot Report (ADAMS Accession No. ML19038A473) contains several instances where Oklo used the term “cell.” Examples include “cell temperature,” page 36; “reactor cell,” pages 45 and 114; and “geometric cells,” pages 48 and 52. The word “cell” is a common term and is not descriptive enough to divulge the details of Oklo’s design. Common terms are not considered trade secret or confidential or privileged commercial or financial information that should be withheld from public disclosure. Additionally, Oklo has not used or requested withholding of the term “fuel cell” in its previous docketed submissions to the NRC, including the proprietary version of Oklo’s DG-1353 Pilot Report (ADAMS Accession No. ML18311A205). However, the NRC staff considers “fuel cell” a common term that is not descriptive enough to divulge the details of Oklo’s design. Consistent with the guidance provided in LIC-204, the NRC staff has determined that references to the term “fuel cell” as it relates to Oklo’s design are not proprietary information and should not be withheld from public disclosure. However, the NRC staff will consider Oklo’s suggested revision in the final version of the report.

7. *Oklo-Identified Issue #9*: Paragraph 1, sentence 4, page 42 read as follows, “Failure of one or two heat pipes may be tolerable but propagation of failure to adjacent fuel cells must be calculated to adequately calculate source term.”

   *Oklo-Provided Suggestion*: Rewrite as follows, “Failure of one or two heat pipes may be tolerable but propagation of failure to adjacent fuel elements must be calculated to adequately calculate source term.”

   *Oklo Reasoning*: Oklo considers the term “fuel cell” both proprietary information and ECI.

   NRC Response:

   The public version of Oklo’s DG-1353 Pilot Report (ADAMS Accession No. ML19038A473) contains several instances where Oklo used the term “cell.” Examples include “cell temperature,” page 36; “reactor cell,” pages 45 and 114; and “geometric cells,” pages 48 and 52. The word “cell” is a common term and is not descriptive enough to divulge the details of Oklo’s design. Common terms are not considered trade secret or confidential or privileged commercial or financial information that should be withheld from public disclosure. Additionally, Oklo has not used or requested withholding of the term “fuel cell” in its previous docketed submissions to the NRC, including the proprietary version of Oklo’s DG-1353 Pilot Report (ADAMS Accession No. ML18311A205). However, the NRC staff considers “fuel cell” a common term that is not descriptive enough to divulge the details of Oklo’s design. Consistent with the guidance provided in LIC-204, the NRC staff has determined that references to the term “fuel cell” as it relates to Oklo’s design are not proprietary information

and should not be withheld from public disclosure. However, the NRC staff will consider Oklo's suggested revision in the final version of the report.