“The Road Less Traveled: Blazing a Trail Customized for Your Vehicle”

Ross Moore - Oklo

GAIN Gateway for Accelerated Innovation in Nuclear

Ross Moore

Director of Regulatory Affairs, Oklo

Ross Moore is currently the Director of Regulatory Affairs for Oklo, where he manages the licensing activities for Oklo's advanced reactor designs, including the Aurora-INL combined license application, currently under review by the Nuclear Regulatory Commission.

Previously, Ross served as Control Room Supervisor at Salem Nuclear Power Plant, where he provided oversight of control room and field activities for two commercial nuclear power reactors. Ross was responsible for managing daily operations at Salem Nuclear Power Plant including, supervision of power operations, management of surveillance testing for various plant systems, and coordination of work control activities.

Prior to that, Ross held several roles at the Nuclear Regulatory Commission, from ensuring proper management of operating reactor license renewal activities, preparing the regulatory framework for advanced reactor design reviews, and performing on-site inspections at the operating reactor fleet.

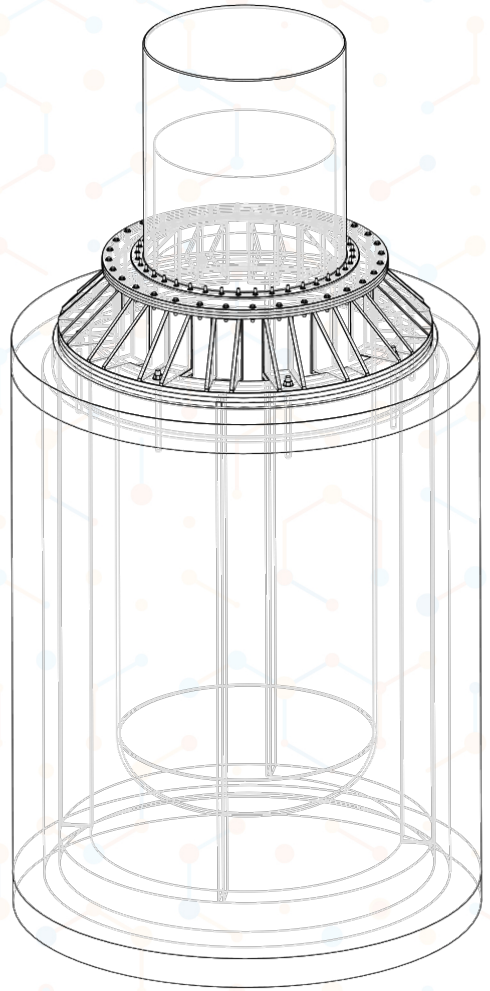
Ross earned his B.S. in Mechanical and Nuclear Engineering from Pennsylvania State University.

Introduction

- Oklo develops clean energy generation sources, such as the Aurora, to mitigate the social and environmental impacts of pollution as well as energy poverty.
- The Aurora combined license application was the first ever for advanced fission and the first received by the NRC at all in over a decade.
- The application is different from traditional applications in a number of ways in order to bring a new technology and a new operational model, as well as novel safety, to reality.

Aurora design

Electric capacity	**1.5MWe**
Thermal capacity	**4MWt**
Fuel type	**Metallic fuel**
Heat transportation	**Heat pipes**
Capacity factor	**>90%**
Licensed operating life	**20 + years**
Frequency of refueling	**None**
Land footprint	**<20,000 ft^2**



Broad applications

- A broad array of applications need what our plant can provide:
  - Off-grid and remote communities
  - Data centers
  - Campuses, hospitals, resorts and military bases
  - Industrial facilities
  - Mines and other resource extraction areas
  - Developing areas

The regulatory challenge

- Decades of regulatory guidance predicated on old technology and large light water reactors
- Costs and requirements have increased over decades and would disproportionately make advanced and very small plants a “non-starter”
- Lack of thousands of reactor-years of data for advanced fission like what light water reactors have means that probabilistic risk analysis has some challenges compared with LWR experience (even with decades of operating advanced fission experience)

The novel licensing approach

- The combined license application (COLA) structure is built from the regulations for COLA application content, in the approximate order as the regulations in 10 CFR 52.77, 79, and 80
- This final COLA structure has additionally employed unique methods to ensure safety metrics are tracked and upheld from design and analysis through programmatic controls

A novel application

Putting the unique safety case into a structure based on regulatory requirements

COLA requirements

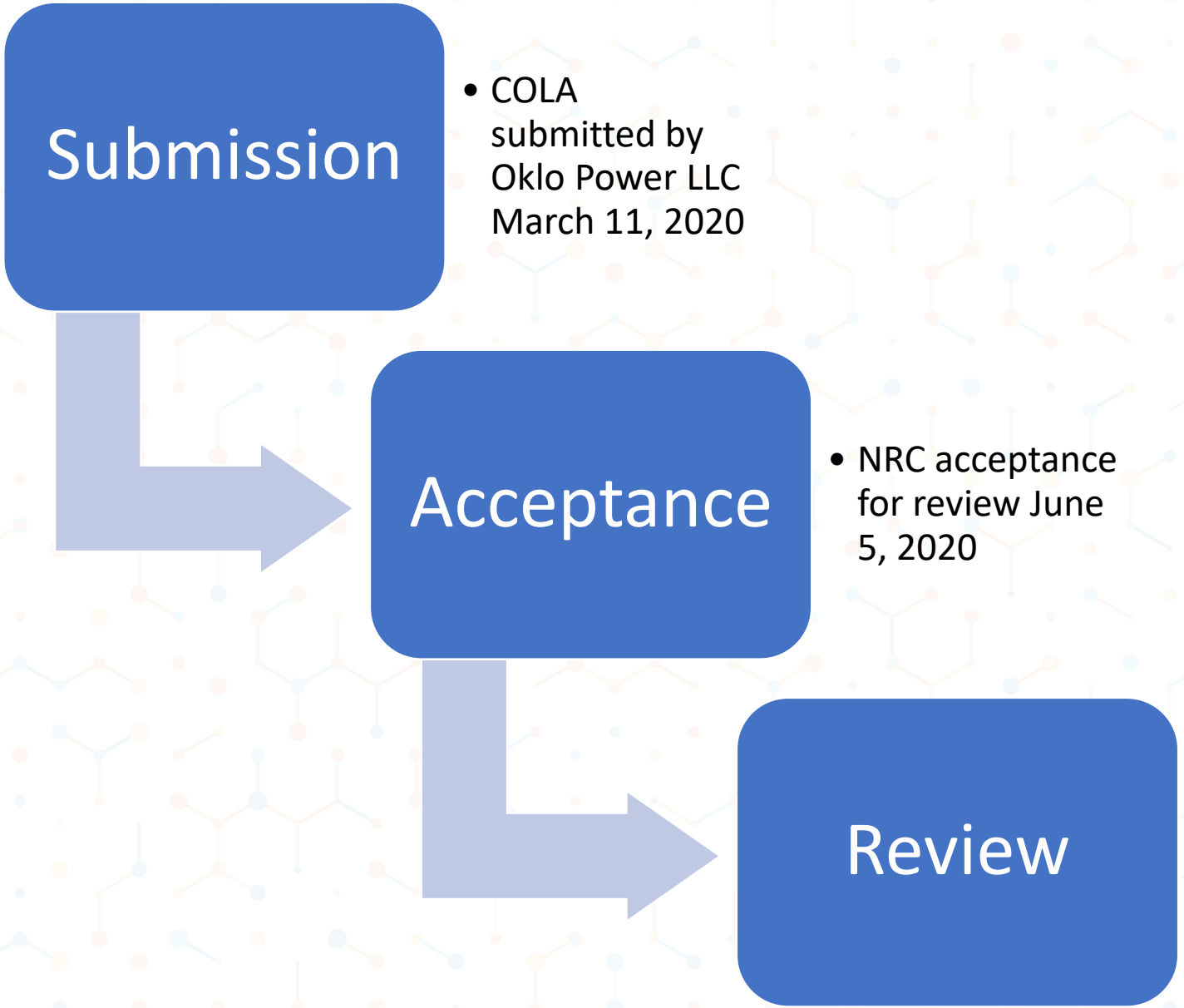
- The requirements for the items to be included in a COLA are included in the following:
  - 10 CFR 52.77
  - 10 CFR 52.79
  - 10 CFR 52.80
- The Aurora COLA follows the structure of these regulations and not any regulatory guidance
- If a requirement (1) does not apply to the Aurora, or (2) if it does apply, but has a related requested exemption, it is a part of Part V, “Nonapplicabilities and requested exemptions”

Parts of the COLA

I. Company information and financial requirements
II. Final safety analysis report
III. Environmental Report
IV. Technical Specifications
V. Nonapplicabilities and requested exemptions
VI. Proposed license conditions
VII. Enclosures

Application summary

- The first combined license application ever accepted for an advanced fission reactor
- Pioneered an application structure that builds from the regulations and is ultimately more streamlined, allowing for a clearer focus on the safety case
  - Ties specifically to requirements, so each regulation is clearly demonstrated
  - COLA entire application less than 1,000 pages
  - Spent less than $10 million in total costs to reach COLA acceptance
- Next steps?


Submission
• COLA submitted by Oklo Power LLC March 11, 2020
Acceptance
• NRC acceptance for review June 5, 2020
Review
• Two step review to be completed by June 5, 2023

Current review status

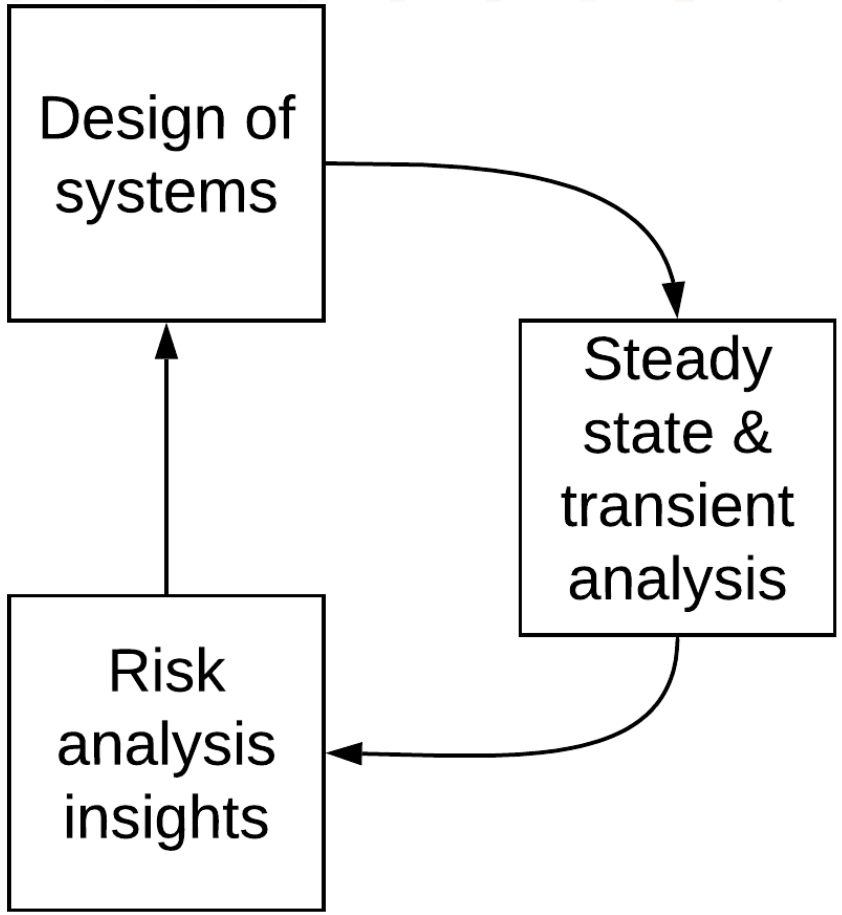
- Two step safety review process, currently in Step 1
- Four key areas of Step 1:
  1. Maximum Credible Accident methodology
  2. SSC classification
  3. Role of QA
  4. Non-applicabilities
- Oklo submitting two topical reports to outline the role of the Maximum Credible Accident and the Performance-based licensing methodologies to complement understanding key areas 1 through 3

Maximum Credible Accident + Performance-based licensing

A simpler, more flexible, performance-based approach to licensing

Design and analysis methodology overview

- **Iterative and systematic process**
  - Systems are designed to safety goals
  - Their performance is analyzed under many different event types:
    - Historical event types for non-LWRs
    - Event categories in NUREG 0800
    - External hazards
- Key parameters are called **design bases**
- Design bases, design commitments, and programmatic controls are developed to **ensure as-analyzed performance**



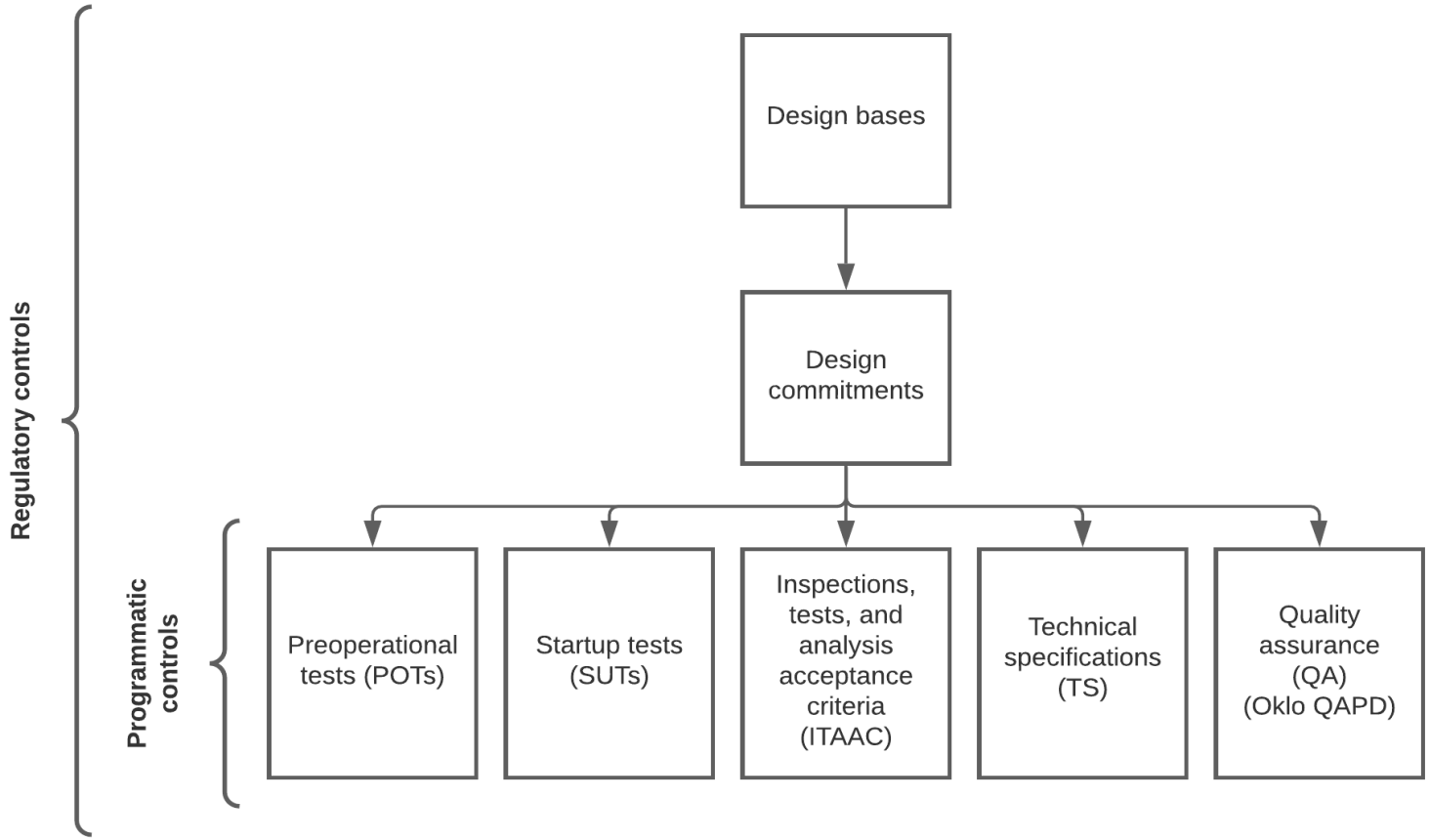
Maximum credible accident methodology

- History of conceptual use for ~70 years
- The worst credible accident(s) caused by any single event or failure
- We performed broad review and analysis of events as categorized in NUREG 0800, historical non-LWR event methodology, and events particular to the Aurora
- Reliance on worst-case deterministic analysis removes uncertainties introduced through reliance on risk analysis for a FOAK reactor
  - Oklo still incorporated insights from advanced probabilistic risk analysis
- Further precedent for safety case and EPZ/site boundary for reactors of this size regulated by the NRC is shown through existing non-power reactors

Performance-based licensing

- Make clear, explicit commitments to uphold the characteristics of the system that have importance to safety
- Scope licensing actions to include the information required to evaluate the sufficiency of these commitments, while including only a limited amount of information about system characteristics that do not have an effect on safety
- Tie these commitments to specific programmatic controls, including quality, which ensure they are met at all phases of construction, pre-operational testing, throughout the life of the plant

Performance-based licensing



The characteristics of a system that ensure the safe operation of the reactor.

The specific commitments made to ensure that a design basis is met.

Administrative controls used to ensure that the design commitments are met.

Conclusion

- Aurora combined license application first ever for advanced fission
- New structure focused on specific requirements, allowing for a streamlined application
- Safety assurance in a more holistic and integrated methodology
- Specific, regulatorily controlled, performance goals ensure design bases are met while allowing greater flexibility
- Maximum Credible Accident and Performance-based licensing methodology topical reports to be submitted as non-proprietary, for use by any reactor designer