

# NRC Licensing of Small Modular Reactors (SMRs)

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# Purpose

- The purpose of this section is to provide an understanding of the differences that the NRC is encountering with licensing SMRs (small light-water reactor technology)
  - Modular designs
  - Nuclear safety review areas
  - Environmental review areas
  - SMR review challenges
  - SMR lessons-learned

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# Differences in Licensing SMRs

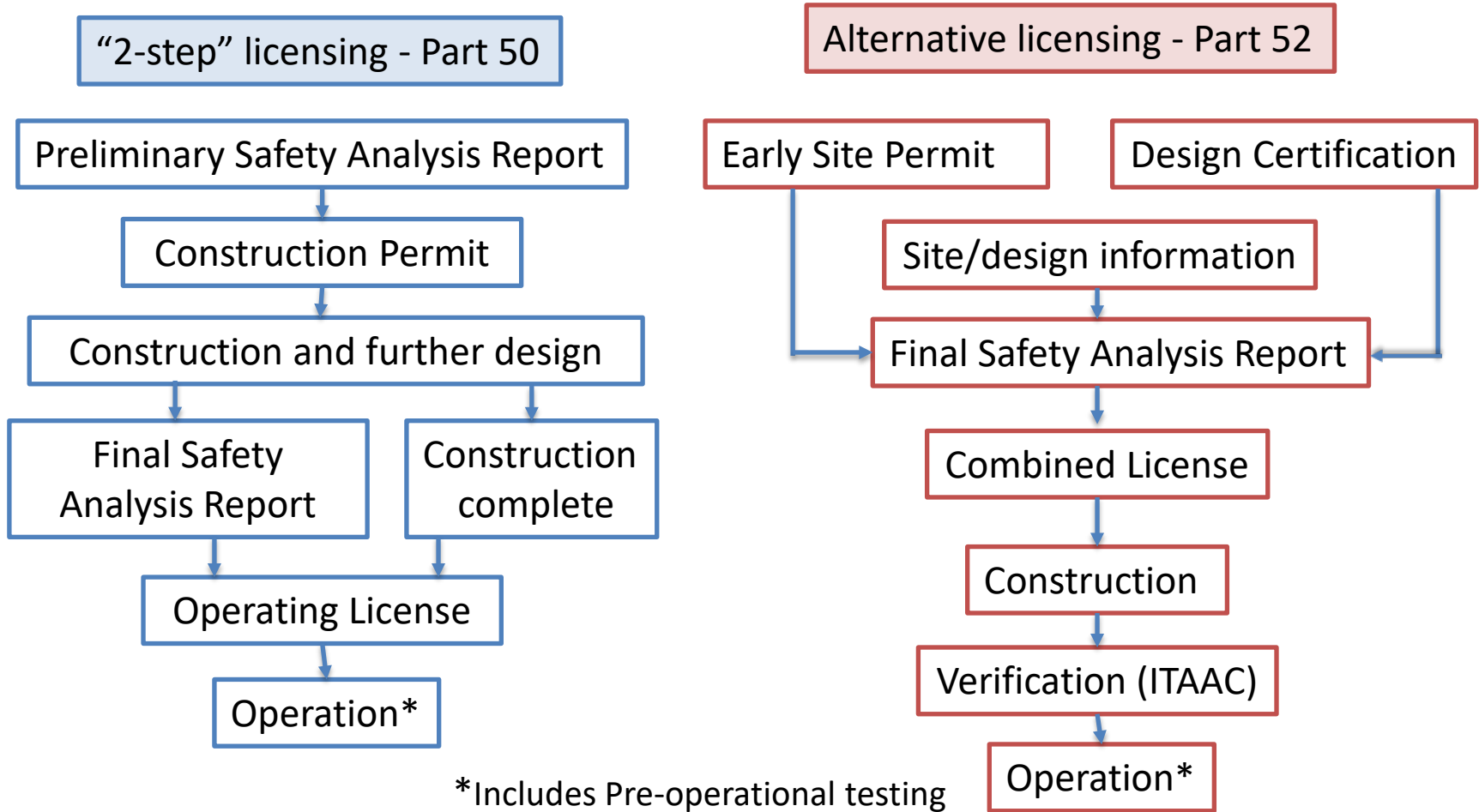
- In general, the same regulatory framework applies to SMRs as to large LWRs; however, gaps may exist
- Gaps in regulatory and guidance documents are a continually evolving challenge
- Gaps change according to changes in technologies and approaches
- Addressing gaps in a completely technology-neutral, meaningful way is difficult

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# Differences in Licensing SMRs

- Not all gaps warrant the same amount of NRC focus or resources
  - Safety or security significance
  - Likelihood of guidance in that area actually being needed
  - Timing of the need
- The NRC is always scanning the horizon for future gaps and prioritizing them

# Part 50 vs. Part 52 Licensing



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# Nuclear Safety Review Areas

- Site Characteristics and Site Parameters
- Systems, Structures, Components, and Equipment Design
- Reactor Internals
- Reactor Coolant and Connected Systems
- Engineered Safety Features
- Digital Instrumentation and Controls/Electrical Power
- Auxiliary Systems
- Steam and Power Conversion Systems
- Radioactive Waste Management and Radiation Protection
- Conduct of Operations
- Initial Test Program and ITAAC
- Transient and Accident Analysis
- Technical Specifications
- Quality Assurance Program
- Human Factors Engineering
- Severe Accidents

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# Environmental Review Areas

- Seismology
- Geology
- Hydrology
- Meteorology
- Geography
- Demography (population distribution)
- Site Hazards Evaluation
- Radiological Effluent Releases
- Radiological Dose Consequences
- Emergency Preparedness (with FEMA)
- Security Plan Feasibility

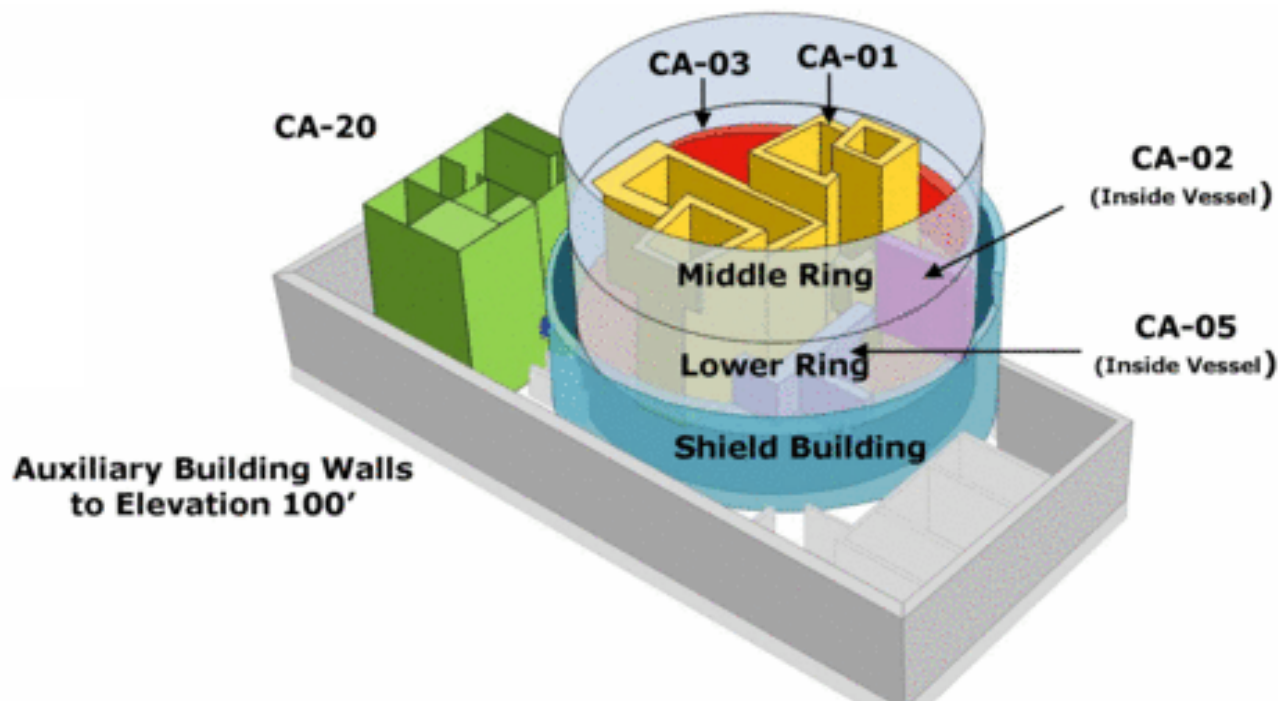
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# SMR Review Challenges

- **New first-of-a-kind designs**
  - Modular construction
  - Completeness of the design
  - Applicability of existing regulations
  - Verification and validation of computer codes
  - Applicability of prior operating experience
- **Smaller applicant organizations in some cases**
  - Important that they have experience with nuclear licensing requirements
  - Important that they are adequately staffed to address regulator questions in a timely manner during reviews



# Modular Designs - AP1000 Modules



CA01	Steam Generator / Refueling Channel
CA02	In-Containment Refueling Water Storage Tank (IRWST) Interior Wall
CA03	IRWST Perimeter Wall
CA04	Reactor Vessel Cavity
CA05	Access Tunnel / Passive Core Cooling and Volume Control System Equipment Room Wall
CA20	Aux Building

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# SMR Lessons-Learned

- A rigorous safety basis and understanding is still essential for new designs
- If an organization is mostly familiar only with large light water reactors (LWRs), a mindset change may need to occur
- Sustained focus on the most safety-significant aspects of the design is important
- Complete understanding of the design as a whole assists the applicant and the regulator
- Successful completion of first-of-a-kind reviews will result in streamlined N<sup>th</sup>-of-a-kind reviews
- Early and frequent communication with applicants is crucial, both prior to and during the regulator's review

# NRC Licensing of Advanced Reactors

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# Purpose

- The purpose of this section is to provide an understanding of the differences that the NRC is encountering with licensing Advanced Reactors (small non-light water reactor technology)
  - Advanced Reactor design landscape
  - Ensuring readiness for licensing Advanced Reactor designs

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# New Non-Light Water Licensing

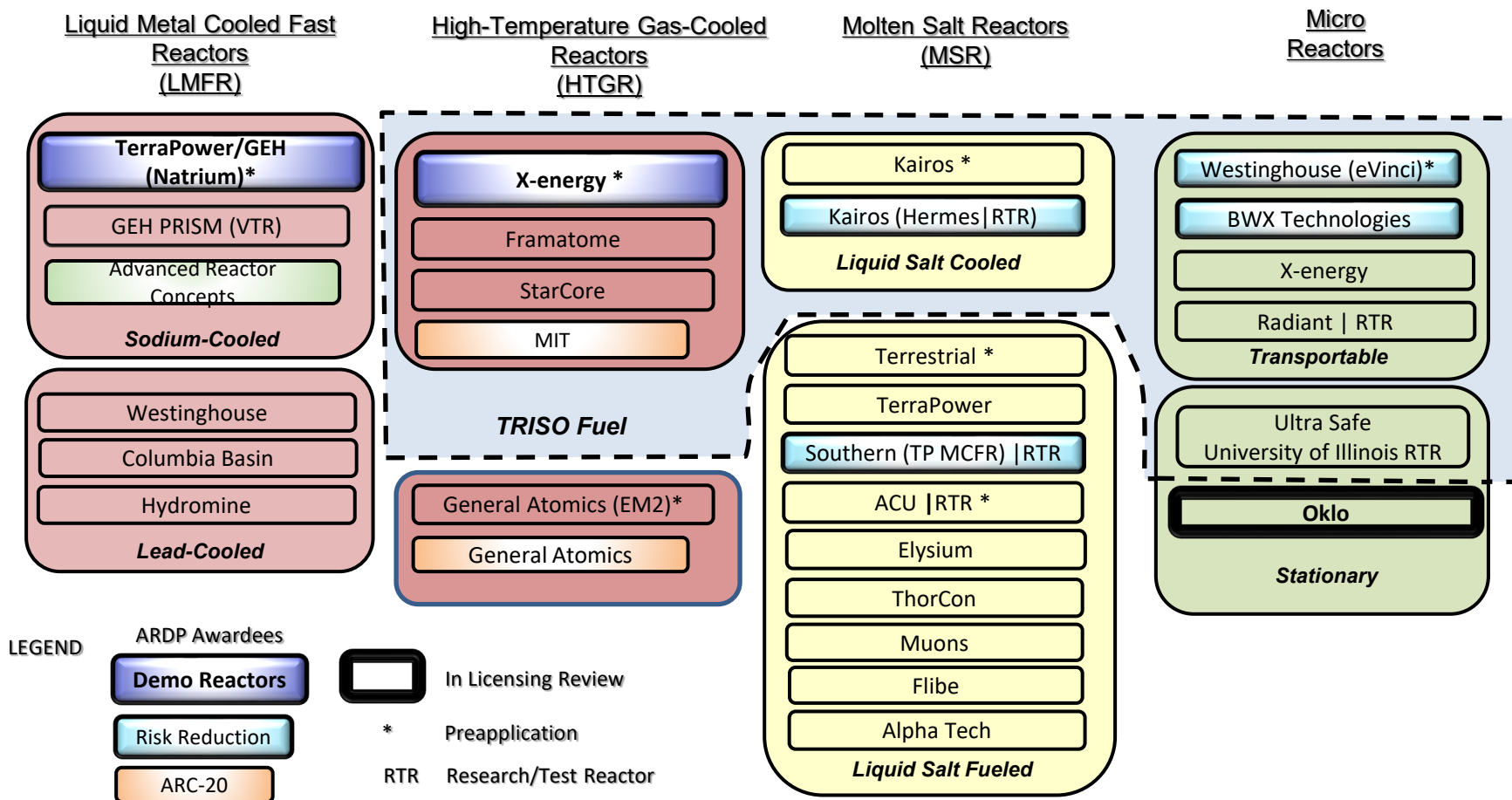


Oklo Aurora – first advanced reactor licensing application submitted March 2020. Microreactor – 1.5 MWe

## Companies in active pre-application engagement:

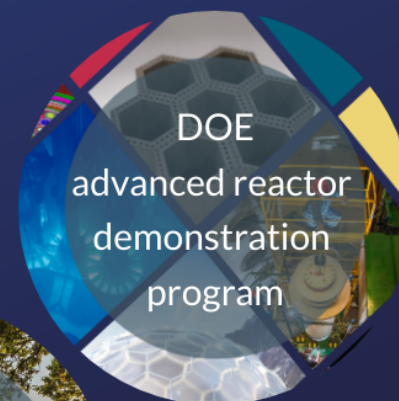
- X-Energy
- TerraPower & GE-Hitachi
- Kairos Power
- Terrestrial Energy USA
- General Atomics Energy
- Westinghouse Electric Company

# Advanced Reactor Landscape



# Ensuring Readiness for Licensing

## Ensuring Readiness for Licensing and Safe Deployment of Advanced Reactors in the United States



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# Ensuring Readiness for Licensing

- Risk-Informed Performance-Based Licensing Approaches
  - Draft Regulatory Guide (DG) 1353
- Technology Inclusive Policy Issues
  - Functional Containment
  - Security
  - Emergency Preparedness
- Nuclear Energy Innovation and Modernization Act (NEIMA)



Questions?

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