TerraPower

NATRIUM

Applicability of Regulations

SUBJECT TO DOE COOPERATIVE AGREEMENT NO. DE-NE0009054

Agenda

- Advanced Reactor Demonstration Program
- Natrium™ Safety Features
- Plant Overview
- Regulatory Engagement
- Licensing Approach
- Risk-Informed, Performance-Based Design Approach
- Principal Design Criteria
- 10 CFR Regulations Review

Advanced Reactor Demonstration Program

- Demonstrate the ability to design, license, construct, startup and operate the Natrium reactor within the Congressionally mandated seven-year timeframe
- Include improvements in safety, security, economics, and environmental impacts
- Utilize a simple, robust, reliable, and proven safety profile
- Lower emissions by initiating the deployment of a fleet of Natrium reactors – Demonstrate that the plants can be built economically and that they will be attractive for future owner/operators

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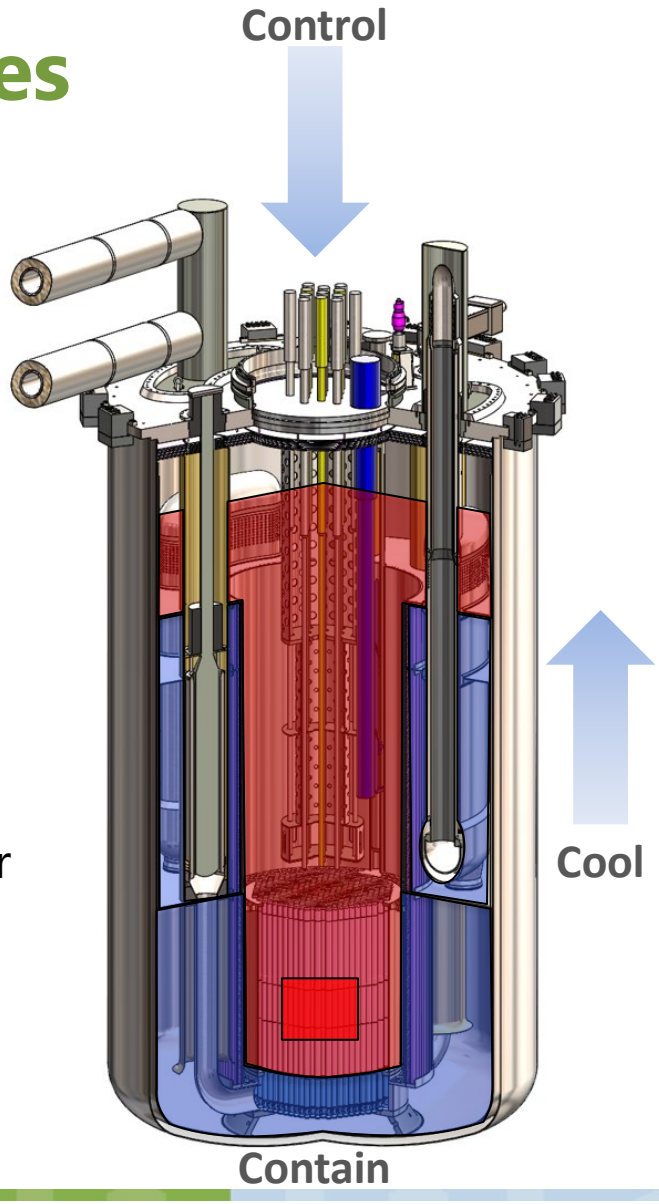
Natrium Safety Features

- Pool-type Metal Fuel SFR with Molten Salt Energy Island
  - Metallic fuel and sodium have high compatibility
  - No sodium-water reaction in steam generator
  - Large thermal inertia enables simplified response to abnormal events
- Simplified Response to Abnormal Events
  - Reliable reactor shutdown
  - Transition to coolant natural circulation
  - Indefinite passive emergency decay heat removal
  - Low pressure functional containment
  - No reliance on Energy Island for safety functions
- No Safety-Related Control Systems, Operator Actions, or AC power
- Technology Based on U.S. SFR Experience
  - EBR-I, EBR-II, FFTF, TREAT
  - SFR inherent safety characteristics demonstrated through testing in EBR-II and FFTF



Control

- Motor-driven control rod runback
- Gravity-driven control rod scram
- Inherently stable with increased power or temperature

Cool

- In-vessel primary sodium heat transport (limited penetrations)
- Intermediate air cooling natural draft flow
- Reactor air cooling natural draft flow – always on

Contain

- Low primary and secondary pressure
- Sodium affinity for radionuclides
- Multiple radionuclides retention boundaries

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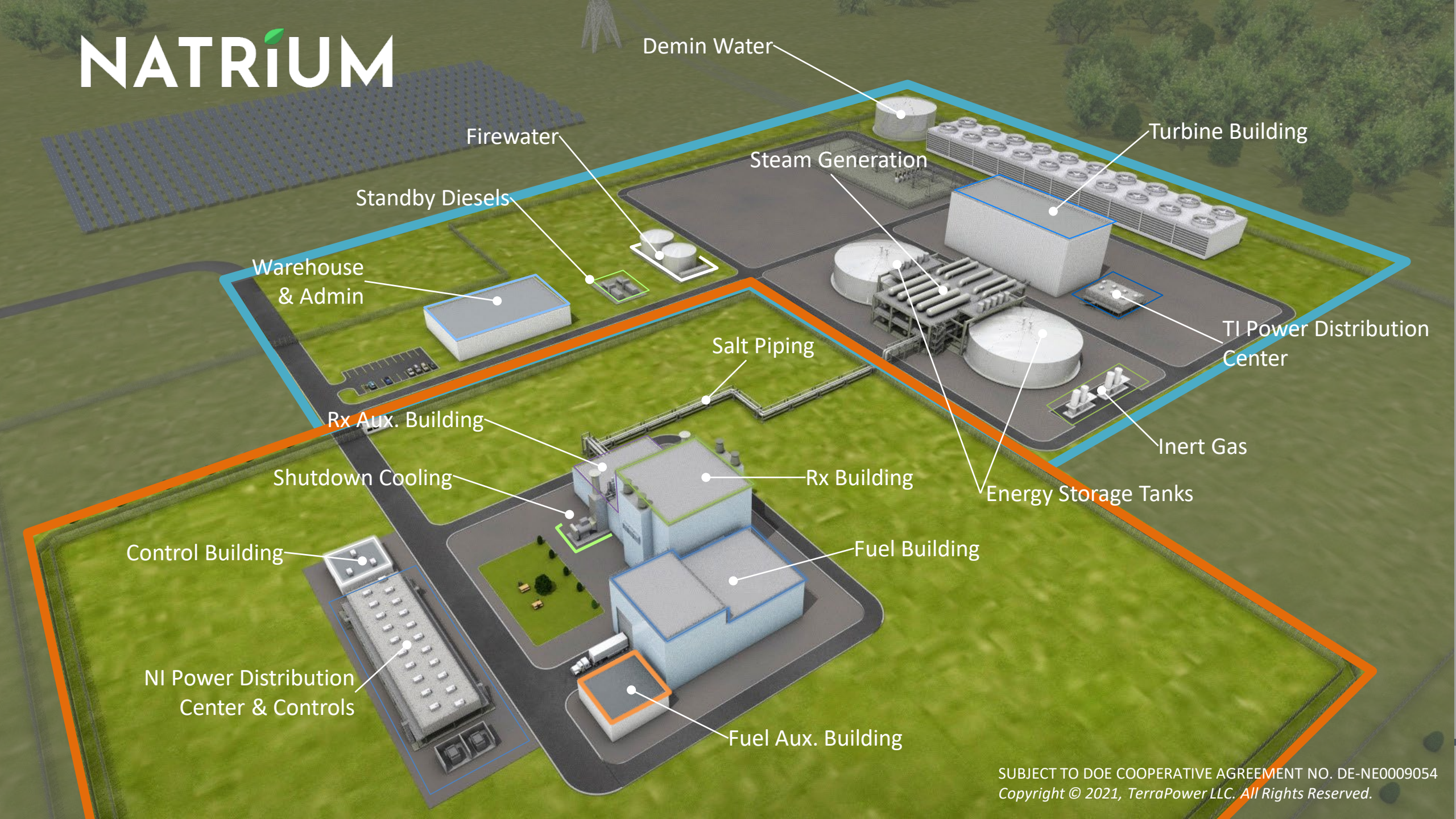

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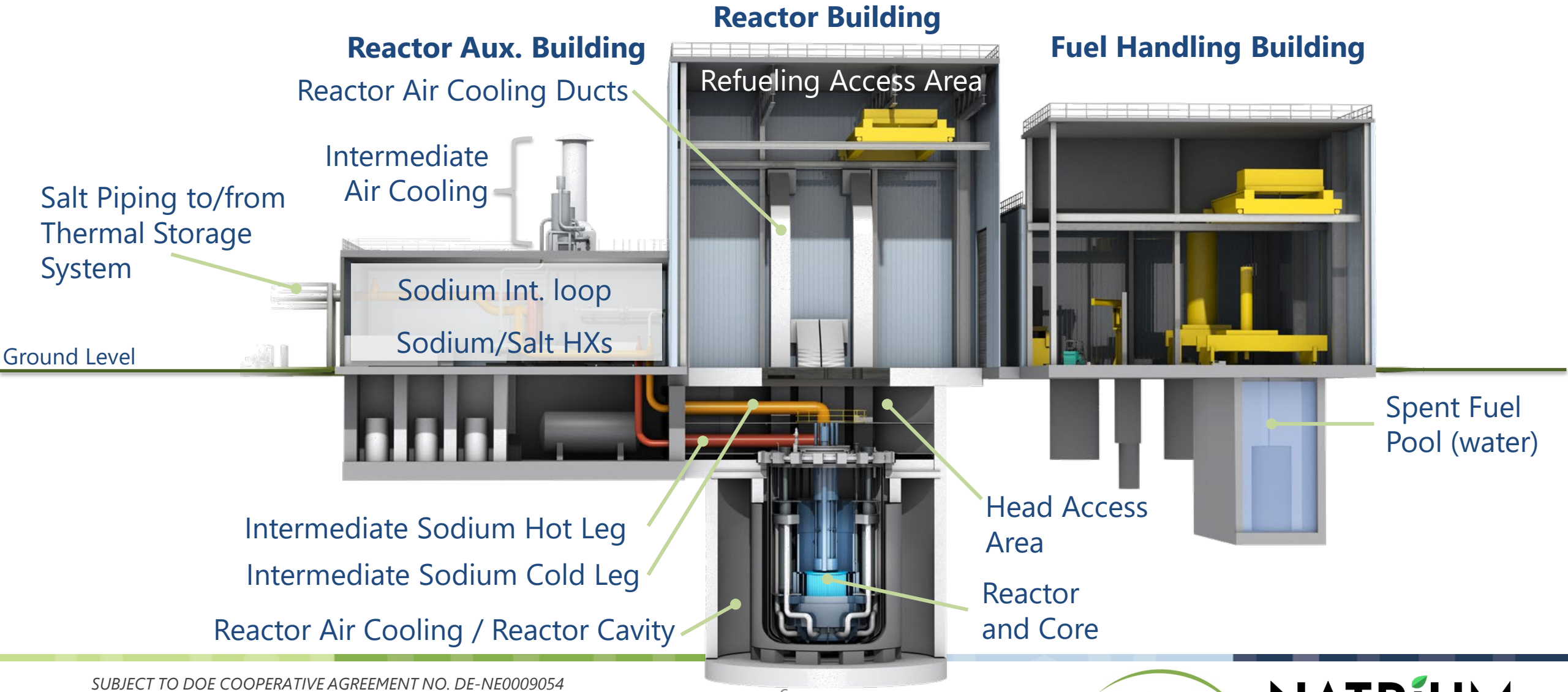
Plant Overview



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Regulatory Engagement

- Regulatory Engagement Plan submitted 6/8/2021
  - Numerous pre-application interactions are planned to reduce regulatory uncertainty and facilitate the NRC's understanding of Natrium technology and its safety case
  - Topical Reports, Technical Reports, and White Papers will be submitted to the NRC as part of Pre-Application activities
- Construction Permit Application Submittal– August 2023
- Operating License Application Submittal – March 2026

Licensing Approach

- 10 CFR 50 will be utilized for the Natrium Reactor
- The PSAR will follow the draft PSAR outline and guidance provided by "Updated Draft Outline for Licensing Modernization Project Advanced Reactor License Applications," (NRC letter dated April 15, 2020)
- The LMP (NEI 18-04), as endorsed by RG 1.233, will inform the content of applications
- Ongoing ARCAP and TICAP activities will be monitored and incorporated as appropriate into the content of applications

Risk-Informed, Performance-Based Design Approach

- Use of LMP for the Natrium design
  - Risk-informed approach for LBE selection, SSC classification and DID evaluation
  - Highly iterative between PRA, deterministic analyses, design
  - Final, PRA-informed confirmation of classification and DID adequacy comes later in project
- Iteration management
  - An Events List database (common to PRA, deterministic analyses, design) being used to maintain alignment and consistency
  - Each discipline 'owns' certain attributes of each event in the Events List
- Managing risk associated with timing of PRA-informed classification and DID adequacy
  - Defense Lines explicitly used in the design basis
  - Good alignment between Defense Lines and LMP safety classifications

Principal Design Criteria

- Design Criteria will be reviewed, based on ARDCs (Regulatory Guide 1.232) and informed by LMP (NEI 18-04)
  - Initial PDCs are in development
  - The Natrium design will utilize a Risk-Informed, Performance-Based process
  - Final PDCs will reflect the final Natrium design
- Comparison between the PDCs developed using the RIPB approach and ARDCs will be discussed through engagement with the staff

10 CFR Regulations Review

- A thorough review of all 10 CFR Regulations is being performed
- The review is informed by "Updated NRC Staff Draft White Paper Analysis of Applicability of NRC Regulations of Non-Light Water Reactors," dated July 2021
- A graded approach will be applied across all 10 CFR Parts

10 CFR Regulations Review

Categories:

1. Applicable to SFR – Design compliance to be confirmed
    a) Design compliance with compliance documented
    b) Exemption requested
2. Applicable to SFR – Entry condition and compliance to be confirmed
    a) Entry condition met with compliance documented
    b) Entry condition met with exemption requested
    c) Entry condition not met and documented
3. Applicable to SFR – No design requirement imposed
4. Not-Applicable – No further action
5. Not-Applicable to SFR – Underlying regulatory basis to be addressed and documented

10 CFR 50 Review Examples

- Category 1a:
  - 10 CFR 50.43(e) requirements for demonstrating performance of safety features
    - Enclosure 2 of SECY-91-074, "Prototype Decisions for Advanced Reactor Designs," reprinted as Appendix A of "A Regulatory Review Roadmap for Non-Light Water Reactors" will be utilized to understand the NRC needs and expectations for testing requirements

10 CFR 50 Review Examples

- Category 2, Applicable to SFR – Entry condition and compliance to be confirmed:
  - 10 CFR 50.34(f)(2)(xiv), Containment Isolation
    - Entry condition for designs using a traditional containment

- Category 3, Applicable to SFR – No design requirement imposed:
  - 10 CFR 50.2, Definitions
  - 10 CFR 50.74, Notification of change in operator or senior operator status

10 CFR 50 Review Examples

- Category 4, Not-Applicable – No further action:
  - 10 CFR 50.64, Limitations on the use of highly enriched uranium (HEU) in domestic non-power reactors
  - 10 CFR 50.49(g), Sub-part of Environmental qualification of electric equipment important to safety for nuclear power plants

- Category 5, Not-Applicable to SFR – Underlying regulatory basis to be addressed and documented:
  - 10 CFR 50.62, Requirements for reduction of risk from anticipated transients without scram (ATWS) events for light-water-cooled nuclear power plants
  - 10 CFR 50.46, Acceptance criteria for emergency core cooling systems for light-water nuclear power reactors

Conclusion

- Lessons learned are being reviewed and incorporated
- Related Planned Pre-Application interactions include:
  - PDCs and SSC Classifications
  - Potential Exemptions
- An additional proposed Pre-Application interaction:
  - Results of the 10 CFR Regulations Review

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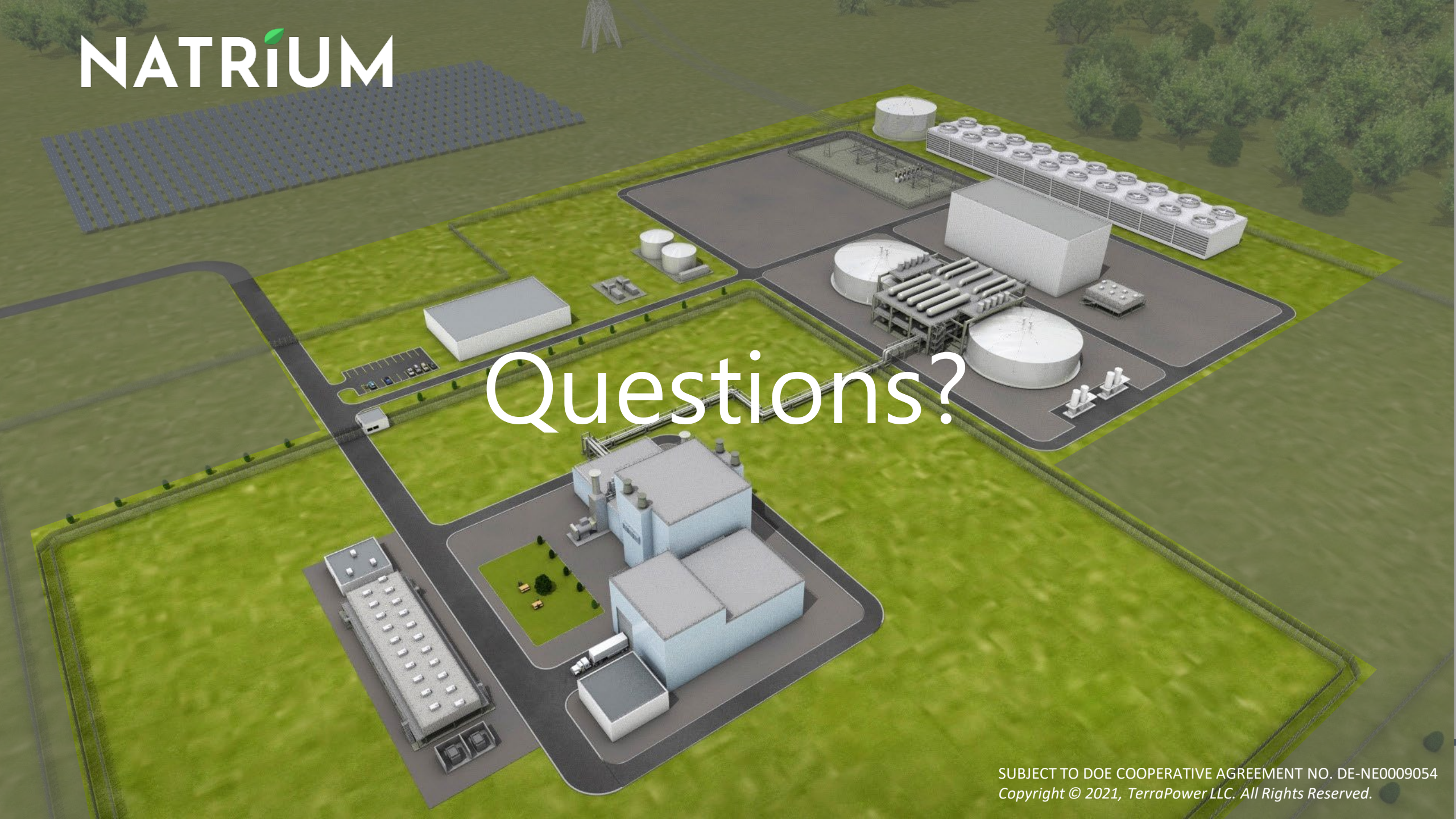

Questions?

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Acronym List

ARCAP – Advanced Reactor Content of Application Project
ARDC – Advanced Reactor Design Criteria
ARDP – Advanced Reactor Demonstration Program
CFR – Code of Federal Regulations
DID – Defense-in-Depth
EBR – Experimental Breeder Reactor
FFTF – Fast Flux Test Facility
GDC – General Design Criteria
LBE – Licensing Basis Event
LMP – Licensing Modernization Project
PDC – Principal Design Criteria
PSAR – Preliminary Safety Analysis Report
RIPB – Risk-Informed, Performance-Based
SFR – Sodium Fast Reactor
SSC – Structures, systems, and components
TICAP – Technology Inclusive Content of Application Project
TREAT – Transient Reactor Test