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Infrastructure Development Working Group Workshop on New Challenges Facing Nuclear Regulators:

Design Certification of the NuScale Small Modular Reactor

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May 28-29, 2018

Objectives

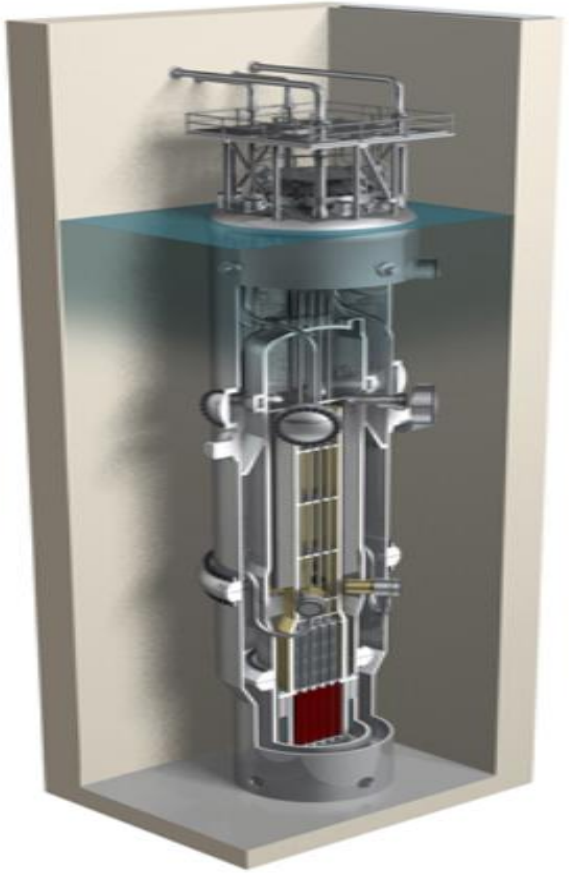
- Small Modular Reactor (SMR) Applications
- NuScale Design Certification (DC) Review
- Licensing Challenges for SMRs
- Significantly Challenging Technical Issues for the NuScale DC Review

SMR Application Reviews

- Active SMR Applications Under Review:
  - TVA Clinch River Early Site Permit
    - *Application docketed in January 2017*
  - NuScale Design Certification
    - *Application docketed in March 2017*
    - *Issued final DSRS for NuScale in August 2016*
- Potential NuScale COL Applicants:
  - TVA (Clinch River Site)
  - Utah Associated Municipal Power Systems (UAMPS)
- As with large light water reactors (LLWRs), addressing key SMR issues early is vital in supporting docketing decisions and establishing review schedules. Examples include emergency preparedness and security requirements, no Class 1E power, control staffing, etc.

NuScale Review (1/3)

- Application submitted in January 2017
- Completed NuScale acceptance review in March 2017
- Milestone schedule for DC application issued in May 2017
- Employing lessons-learned during the review



Cross-sectional view of NuScale SMR
Photo courtesy of NuScale Power, LLC

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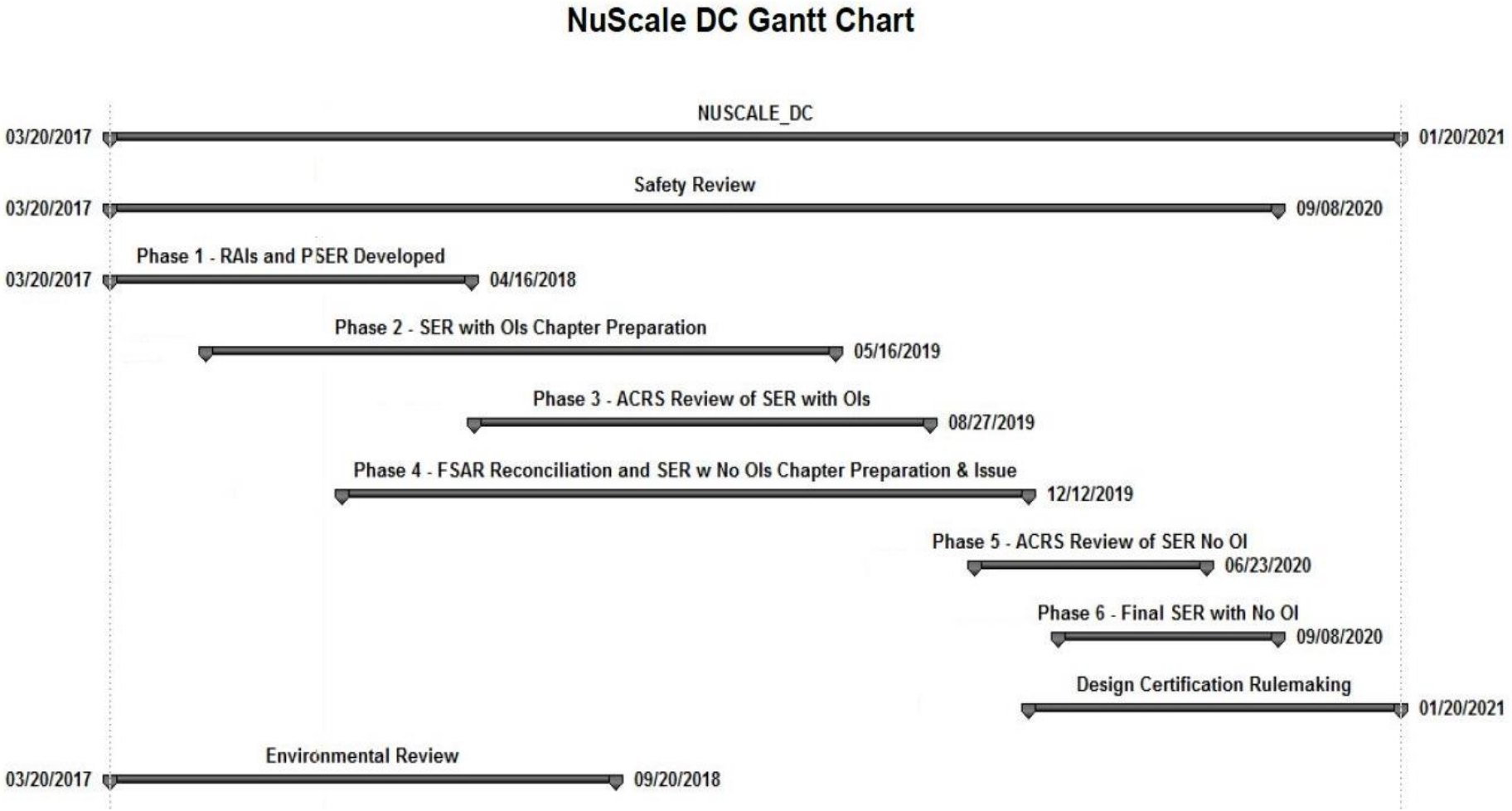
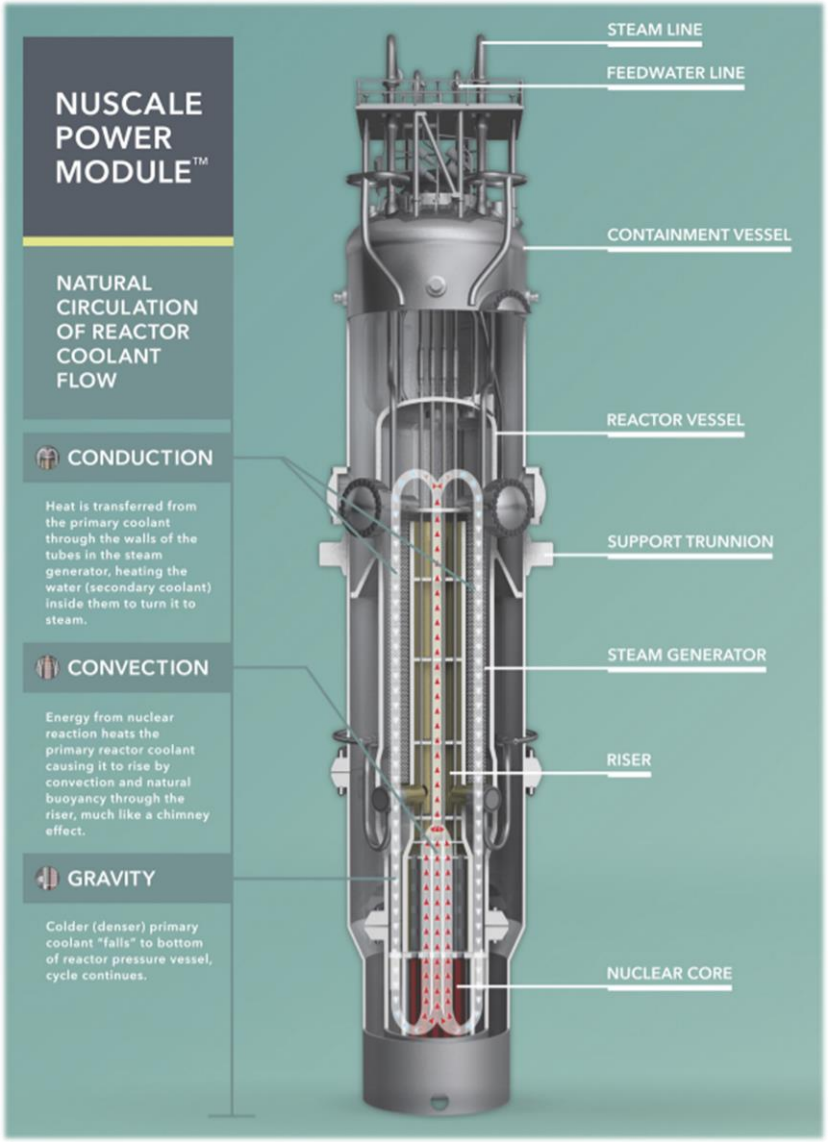
NuScale Review (2/3)



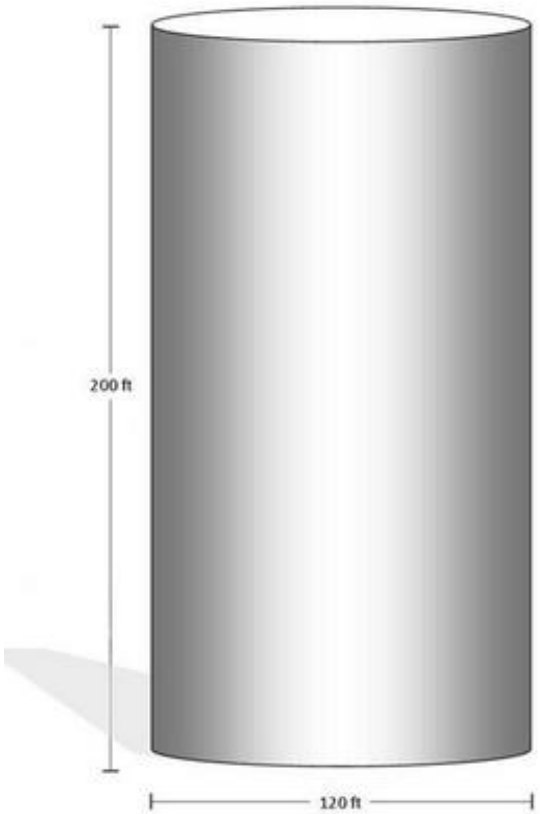
NuScale Review (3/3)

- NuScale quarterly executive meetings
- Approximately 1,200 RAI Questions have been issued to NuScale
- Completed Phase 1 of review in April 2018
- Revised review processes
  - Management oversight of RAIs
  - Enhanced use of audits
  - Enhanced safety-focused review

NuScale Design (1/3)



Comparison size envelope of new nuclear plants currently under construction in the United States



Containment

NuScale's combined containment vessel and reactor system

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NuScale Design (2/3)

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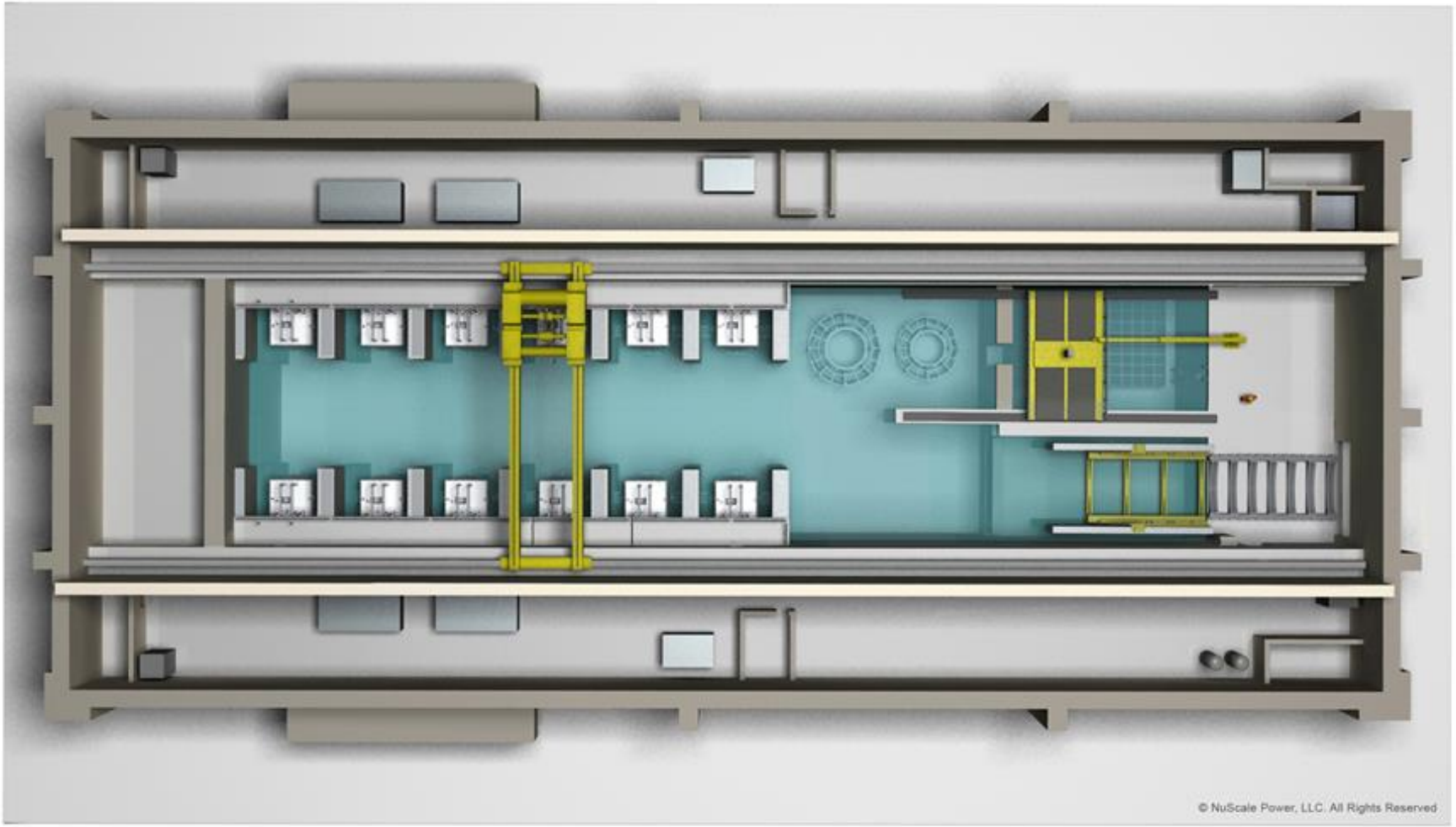
NuScale Design (3/3)



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Licensing Challenges for SMRs

NuScale requested exemptions from the following regulations:

1. 10 CFR 50.46a and 10 CFR 50.34(f)(2)(vi) Reactor Coolant System Venting
2. 10 CFR 50.44 Combustible Gas Control
3. 10 CFR 50.62(c)(1) Reduction of Risk from Anticipated Transients Without Scram
4. 10 CFR 50, Appendix A, Electric Power Systems GDCs
5. 10 CFR 50, Appendix A, GDC 33 Reactor Coolant Makeup
6. 10 CFR 50.54(m), Control Room Staffing
7. 10 CFR 52, App. A, GDC 52 Containment Leakage Rate Testing
8. 10 CFR 50, Appendix A, GDC 40 Testing of Containment Heat Removal System
9. 10 CFR 50, Appendix A, GDC 55, 56, and 57 Containment Isolation
10. 10 CFR 50, Appendix K, Emergency Core Cooling System Evaluation Model
11. 10 CFR 50.34(f)(2)(xx) Power Supplies for Pressurizer Relief Valves, Block Valves, and Level Indicators
12. 10 CFR 50.34(f)(2)(xiii), Pressurizer Heater Power Supplies
13. 10 CFR 50.34(f)(2)(xiv)(E) Containment Evacuation System Isolation
14. 10 CFR 50.46, Fuel Rod Cladding Material
15. 10 CFR 50, Appendix A, Criterion 27, Combined Reactivity Control Systems Capability

Lessons Learned for Future SMR DC Applications

- Lesson 1: Enhanced pre-application interactions and timely readiness reviews are critical. Result: Readiness review guidance was revised; use of "gap letters."

- Lesson 2: Design Specific Review Standards can be difficult to develop when a reactor design is still changing. Results: Potential applicants should discuss with NRC whether a DSRS would be helpful so that a case-specific decision can be made.

Significant Technical Challenges for the NuScale Technical Review

- Integrated Systems Validation testing
- Control room staffing
- No Class 1E electrical power
- Seismic analysis of flange tool
- Comprehensive vibration assessment program
- Pipe break location
- Integrated leak rate testing
- GDC 27 exemption (aka return to power)

Summary

- The NRC is actively reviewing 2 SMR applications – Clinch River ESP and NuScale DC applications
- Licensing challenges exist for SMR applications which require exemptions from the current Part 52 regulations
- The staff identified multiple significantly challenging technical issues related to the NuScale DC – NuScale is working with the NRC to resolve these issues

Questions

Thank You!

For additional information on the NuScale design review please visit us at:
www.nrc.gov/reactors/new-reactors/design-cert/nuscale.html

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Acronyms

10 CFR	Title 10 of the *Code of Federal Regulations*
ACRS	Advisory Committee on Reactor Safeguards
DC	Design Certification
DSRS	Design Specific Review Standard
FSAR	Final Safety Analysis Report
GDC	General Design Criteria
LLWR	Large Light Water Reactor
OI	Open Item
PSER	Preliminary Safety Evaluation Report
RAI	Request for Additional Information
SER	Safety Evaluation Report
SMR	Small Modular Reactor
TVA	Tennessee Valley Authority
UAMPS	Utah Associated Municipal Power Systems

Background Slides

Typical LWR Safety Systems

Systems and components needed to protect the core:

- Reactor pressure vessel
- Containment vessel
- Reactor coolant system
- Decay heat removal system
- Emergency core cooling system
- Reactor protection system
- Containment isolation system
- Ultimate heat sink
- Residual heat removal system
- Safety injection system
- Refueling water storage tank
- Condensate storage tank
- Auxiliary feedwater system
- Emergency service water system
- Hydrogen recombiner or ignition system
- Containment spray system
- Reactor coolant pumps
- Safety related electrical distribution systems
- Alternative off-site power
- Emergency diesel generators
- Safety related 1E battery system
- Anticipated transient without scram (ATWS) system

NuScale Safety Systems

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NuScale Design Simplification

- **New systems**
  - containment evacuation
  - containment flooding and drain
- **Eliminated systems**
  - containment spray
  - containment fan cooler
  - auxiliary feedwater
  - ECCS injection and recirculation
  - steam generator blowdown
  - electrical generator hydrogen supply
  - safety-related electrical systems
- **Eliminated components**
  - reactor coolant pumps
  - ECCS pumps, tanks, and RPV injection lines
  - containment sumps and tanks
  - refueling water storage tank
  - reactor coolant hot leg and cold leg piping
  - pressurizer surge line and relief tank
  - reactor vessel and primary coolant system insulation
  - safety-related emergency diesel generators