NuScale Power
Small Modular Reactor

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Acknowledgement and Disclaimer

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Presentation Overview

- Design overview
  - “What if” questions
  - NuScale passive safety concept
- EQ challenges
  - Magnitude of environmental conditions
  - FOAK challenges from an EQ perspective
- EQ opportunities
  - existing fleet
  - early input into the design

NuScale History

- NuScale first of current U.S. SMRs to begin design of commercial NPP
- NuScale technology in development and design since 2000 (DOE) MASLWR program, lessons from AP1000 ¼-scale testing
- Electrically-heated 1/3-scale integral test facility first operational in 2003
- Began NRC design certification (DC) pre-application project in April 2008
- Fluor became lead investor October 2011
- ~380 FTEs currently on project, ~$230MM spent project life-to-date
- Twelve-reactor simulated control room operational in May 2012 for human factors engineering development
- DOE announces FOA win in 2013

NuScale engineering offices Corvallis

One-third scale test facility

NuScale control room simulator

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Design Overview

- What if
  - no pumps were required to circulate water through the core?
  - no pumps were required for the decay heat removal function?
  - no pumps were required for the ECCS function?
  - no pumps were required to “connect” to the ultimate heat sink?
  - DBEs did not require make-up to the RCS?
  - DBEs did not require operator action?
  - DBEs did not require AC or DC power?

NuScale Power System

- NuScale passive concept
  - C:\Users\though\Videos\NuScale NSSS Operation and BOP Operation.mp4
- NuScale passive safety
  - reactor trip
  - decay heat removal (DHR)
  - emergency core-cooling system (ECCS)
  - containment isolation
  - all completely passive with
    - no additional water
    - no operator action
    - no AC or DC power

Simplicity Enhances Safety

All safety equipment needed to protect the core is shown in this picture

- Natural convection for cooling
  - passively safe, driven by gravity, natural circulation of water over the fuel
  - no pumps, no need for emergency generators
- Seismically robust system
  - submerged in a below-ground pool of water in an earthquake-resistant building
  - reactor pool attenuates ground motion and dissipates energy
- Simple and small
  - reactor core is 1/20th the size of large reactor cores
  - integrated reactor design, no large-break loss-of-coolant accidents

Steel containment is *10 times stronger* than typical PWR

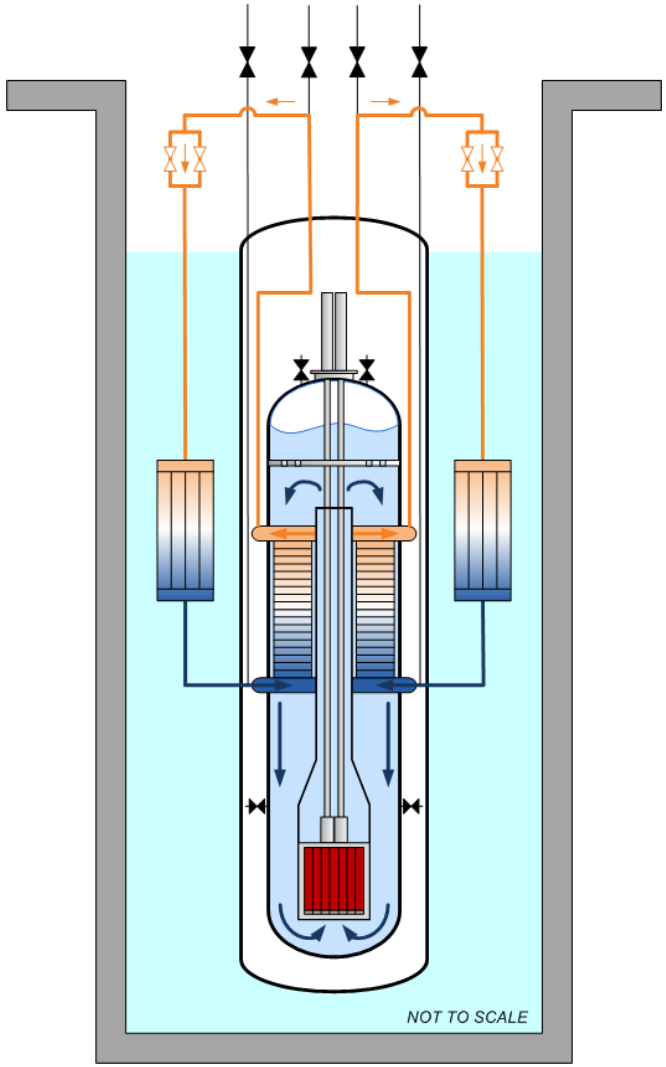
Water volume to thermal power ratio is *four times larger* than typical PWR

Reactor core has only *five percent of the fuel* of a large reactor

160 MWt NuScale Power Module

Decay Heat Removal

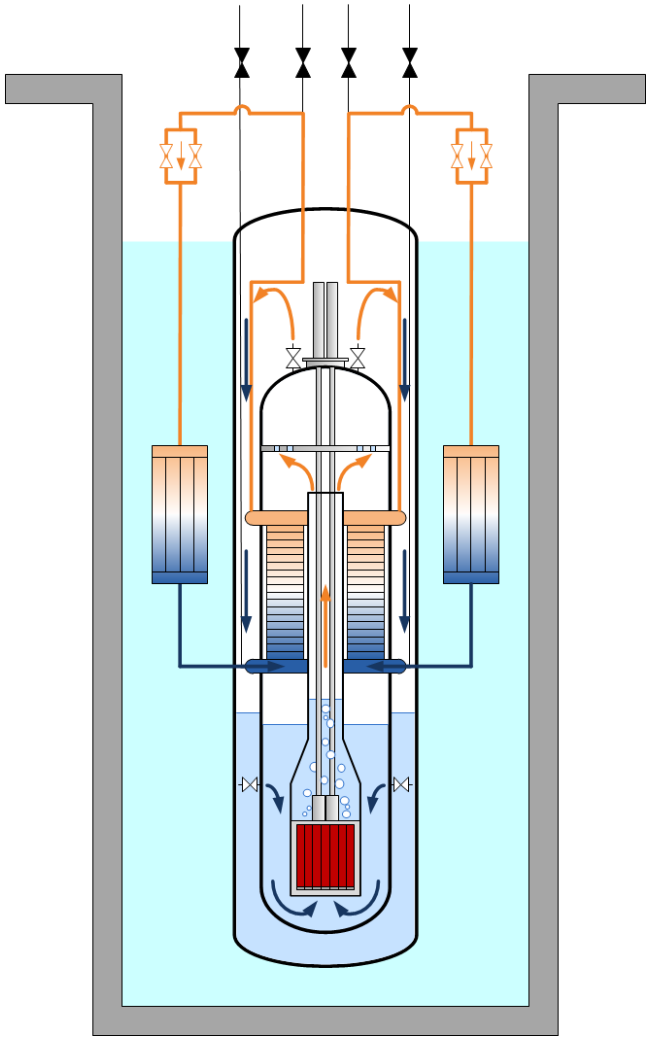
- The DHR system is composed of
  - four DHR actuation valves
  - two DHR heat exchangers
  - main steam and feedwater isolation valves
  - ultimate heat sink (reactor pool)
- Two 100% redundant trains



Emergency Core Cooling

- The ECC system is composed of
  - two reactor vent valves (RVV)
  - two reactor recirculation valves (RRV)
  - containment vessel
  - containment isolation valves
  - ultimate heat sink (reactor pool)

- Only one RVV and one RRV needed



Environmental Qualification Challenges

- The magnitude of the environmental conditions
  - Containment
    - normally kept at a vacuum
    - containment pressure rating exceeds current LOCA chamber capability
    - small containment volume
  - FOAK SSCs
    - NuScale has a comprehensive reactor qualification plan
    - includes about five years of FOAK testing
    - component qualification beyond DCA related testing
    - plan and SSC specific information is proprietary

Environmental Qualification Opportunities

- "*The Best EQ Qualification is No EQ Qualification*" (Ron Wise, circa 19XX)
  - Keep those SSCs out of the harsh environment
- Opportunities that the existing fleet did not have
  - A lot of plants were built or designs complete when TMI happened
  - Minimal number of SSCs that have to actuate
  - Early EQ input into design activities
    - Design meetings, constantly ask and encourage all disciplines to ask
      - » What's the radiation environment
      - » What's the thermal environment
      - » Is there a high-energy line break concern in that area
- Developing the list of electrical and mechanical equipment important to safety

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