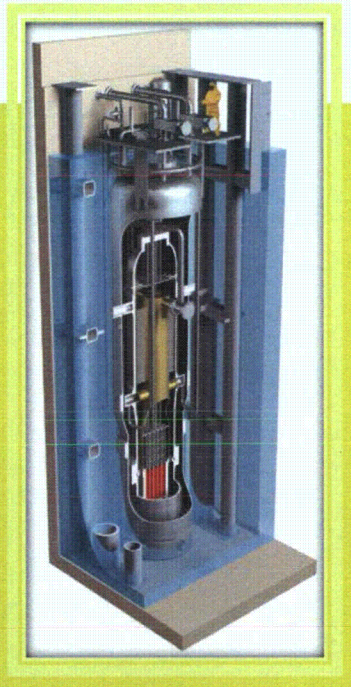
Design-Basis Event Classification



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NuScale Nonproprietary

NuScale Power™

Agenda

- Purpose
- Plant overview
- Scope
- Event selection methodology
- Codes and methods
- Event selection results
- Example event review
- DSRS implications
- Results achieved and next steps

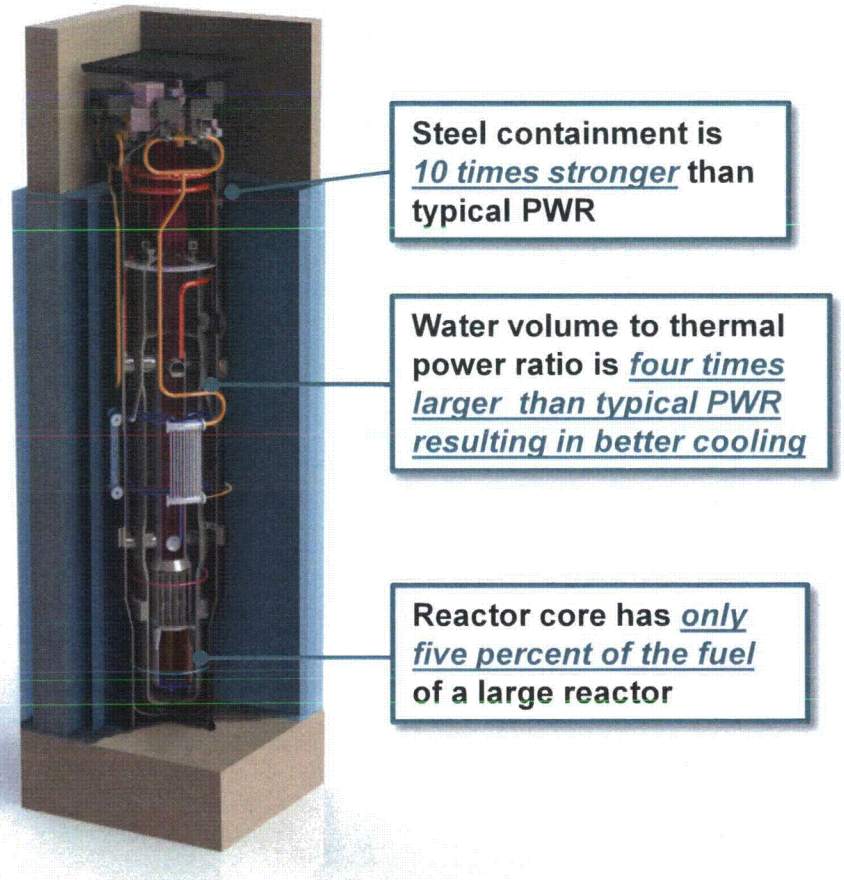
Purpose

- Describe NuScale event classification methodology and preliminary event classification results for design-basis events
  - Classification of Transients and Accidents for the NuScale Power Small Modular Reactor white paper, NP-WP-0613-3803-P, ADAMS Accession No. ML13255A481
- Establish basis for shared understanding of expected plant response
- Provide an overview of safety analysis codes and methods
- Provide examples of preliminary design-basis analyses
- Provide input to Chapter 15 design-specific review standard (DSRS) development

Reactor Module Overview

All safety equipment needed to protect the core is shown on 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
- Simple and small
  - reactor core is 1/20th the size of large reactor cores
  - integrated reactor design, no large-break loss-of-coolant accidents
- Defense-in-depth
  - multiple additional barriers to protect against the release of radiation to the environment



160 MWt Reactor Module

Reactor Safety Design Principles

- Utilize decades of proven pressurized-water reactor (PWR) technology and operating data
- Inherent safety through simple, passive design
- Comply with NRC General Design Criteria
- Enhance resistance to natural phenomena
- Eliminate reliance on electrical power for safety
- Comprehensive requirements management program
- Robust safety culture

Simplified Design

- Integrated reactor, steam generator, and pressurizer reduces primary system piping (e.g., no hot or cold legs)
  - eliminates large-break loss-of-coolant accident (LBLOCA)
  - eliminates reactor coolant pump failure events
- Indefinite cooling for all conditions and events without the need for additional makeup water
  - low core power and large volume of available water
  - no need for AC or DC power for safe configuration
  - direct access to ultimate heat sink/reactor pool
- Simple and robust emergency core cooling system
  - water from primary system is captured in containment and returned to core using only four valves during LOCAs

NuScale Safety Systems

Systems and components needed to protect fission product barriers

- NuScale systems
  - reactor coolant pressure boundary
  - containment vessel
  - decay heat removal system
  - emergency core cooling system
  - control rod drive system
  - containment isolation system
  - ultimate heat sink
- Additional typical PWR systems
  - active residual heat removal system
  - active safety injection system
  - active 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

Plant and System Safety Functions

- Four dedicated safety systems (reactor protection system [RPS], decay heat removal system [DHRS], control room habitability system [CRHS], and ECCS) required to keep plant safe during normal operation and off-normal conditions

Safety Function	Safety-Related Actuated Component(s)
Initiate reactor trip	{{
Initiate decay heat removal	
Initiate emergency core cooling	
Initiate containment isolation	
Initiate reactor coolant system makeup flow isolation	
Initiate reactor coolant system letdown flow isolation	
Initiate main steam isolation	
Initiate feedwater isolation	
Initiate cold overpressurization protection	
Initiate hot overpressurization protection	
Initiate control room isolation	}}3(a)-(c)

Event Classification Scope

- Scope

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  - considers thermal-hydraulic, neutronic and radiological response of the plant
  - event class-specific acceptance criteria

- Not included

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  - severe accidents

Classification Method

- Event classification based on

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  - probability of occurrence
  - radiological consequence criteria

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Classification Method

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Event Classification Screening Criteria

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Event Classification Results

Events by type

1. Increase in heat removal by the secondary system
2. Decrease in heat removal by the secondary system
3. Decrease in reactor coolant system (RCS) flow rate
4. Reactivity and power distribution anomaly
5. Increase in reactor coolant inventory
6. Decrease in reactor coolant system inventory
7. Failure in the gas or liquid waste management system
8. Liquid-containing tank failures
9. Fuel handling accidents
10. Spent fuel cask drop accidents
11. Anticipated transient without scram (ATWS) initiated by the previously classified AOOs
12. Reactor stability
13. AOO with reactor scram on backup signal
14. Containment pressurization and heat up for design-basis events (DBEs)
15. Station blackout

Event Classification Results

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Event Classification Results

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Event Classification Results

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Event Classification Results

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Acceptance Criteria

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Acceptance Criteria

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Acceptance Criteria

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Preliminary Limiting Events

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Preliminary Limiting Events

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Codes and Methods

- NuScale Codes and Methods Framework Description Report, NP-TR-0812-1682-P, ADAMS Accession No. ML13018A154
  - submitted to the NRC January 2013

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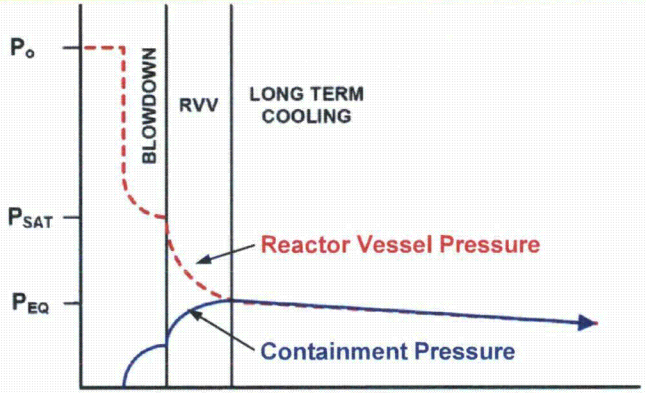
- Appendix K method for LOCA
- RELAP5 full-plant model sent to NRC September 2013

Inadvertent ECCS Actuation



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Inadvertent ECCS Actuation

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Inadvertent ECCS Actuation

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Inadvertent ECCS Actuation

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Inadvertent ECCS Actuation

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Main Steam Line Break

- Radiological consequences of a MSLB

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Main Steam Line Break

- Radiological consequences of a MSLB

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Main Steam Line Break

- Radiological consequences of a MSLB

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Preliminary (Rev A) Safety

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Event Categorization Summary

- NuScale plant response requires only four dedicated safety systems to mitigate transients and accidents events (ECCS, DHRS, CRHS, RPS)

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- Future meeting to present additional events

Implications for DSRS

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Implications for DSRS

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Implications for DSRS

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Implications for DSRS

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Implications for DSRS

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Implications for DSRS

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Implications for DSRS

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Results Achieved and Path Forward

- NuScale provided information to show plant response to transients requires only four dedicated safety systems
  - ECCS
  - DHRS
  - CRHS
  - RPS

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- Provided information relating to initial event classification effort
  - classification methodology
  - NuScale DSRS insights
- Plan for future interactions

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