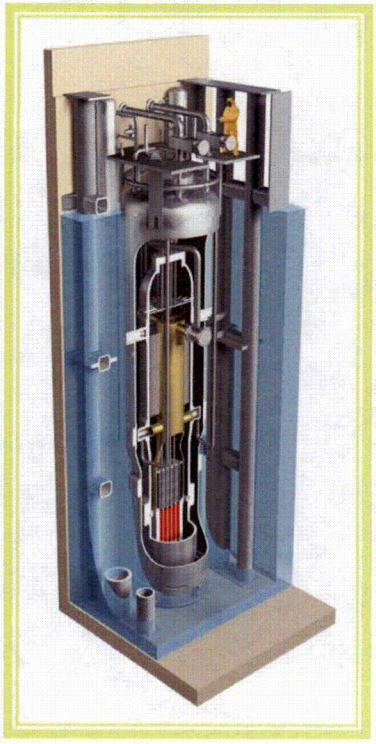
Enclosure 1:

Enclosure 1: "Safety Classification of NuScale Electrical Systems", PM-0615-15469-NP, Revision 0, nonproprietary version

NuScale Power, LLC
1100 NE Circle Blvd., Suite 200 Corvallis, Oregon 97330 Office 541.360-0500 Fax 541.207.3928
www.nuscalepower.com

Safety Classification of NuScale Electrical Systems



Matt Featherston
Nuclear Licensing Engineer

Meghan McCloskey
Safety Analysis Engineer

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Overview

- Purpose
  - discuss NRC questions about Class 1E power by describing how the NuScale plant safety is ensured and how regulations are met without having a Class 1E electrical power system
- Outcome
  - NRC understanding of the NuScale approach and basis for no Class 1E electrical power
- Process
  - prior preapplication meetings on Chapter 8—electrical power in March 2014, November 2014
  - Class 1E power questions identified by NRC staff in spring 2015
  - presentation today
    - classification of NuScale electrical systems
    - plant safety system response to loss of power
    - Chapter 15 design-basis safety analysis and regulatory implications
  - future actions
    - submittal of topical report on electrical system safety classification and GDC applicability
    - submittal of safety analysis methodology topical reports
    - preapplication engagement as needed regarding AOO acceptance criteria
    - determine with NRC if exemption to 10 CFR 50.34(f)(2)(xx), 10 CFR 50.34(f)(2)(xiii) is needed

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NRC Questions on Class 1E Power

1. What are NuScale's plans for addressing licensing requirements, and regulations for safety systems that require Class 1E power?
2. Describe how systems which require Class 1E AC/DC electrical power by regulations are classified and how NuScale intends to demonstrate compliance with requirements.
3. 10 CFR 50.55a(h)(3) requires compliance with IEEE Std. 603-1991. Clause 8.1, "Electric Power Sources," requires those portions of the Class 1E power system that are required to provide power to the many facets of the safety system are governed by the criteria of this document and are a portion of the safety systems.
4. 10 CFR 50.34(f)(2)(xx) requires power supplies for pressurizer relief valves, block valves, and level indicators such that: (A) level indicators are powered from vital (i.e., Class 1E) buses; (B) motive and control power connections to the emergency power sources are through devices qualified in accordance with requirements applicable to systems important to safety; and (C) electric power is provided from emergency power sources. "Emergency power sources" is somewhat ambiguous in the regulation, and NuScale may say that it can be important to safety, but nonsafety-related. However, vital power is typically identified as Class 1E power.
5. How is the NuScale plant monitored/managed in the control room without electrical power? Discuss availability of displays, instrumentation, and habitability in the control room.
6. Is NuScale's electrical design completely Class-1E-free, or is it 'partially' Class-1E-free? Are there any systems that are supplied by a Class 1E electrical system?
7. Regarding the topical report on Class 1E power, what does the topical report intend to demonstrate and what type of approval is sought from the staff?
8. How do various safety systems function without Class 1E AC/DC power?
9. How are design-basis accidents and beyond-design-basis accidents managed without Class 1E power?
10. What is the status of DCD Chapter 15 and what information will be included in Chapter 15?

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Classification of NuScale Electrical Systems

Matt Featherston

Nuclear Licensing Engineer

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NRC Questions on Class 1E Power

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2. Describe how systems which require Class 1E AC/DC electrical power by regulations are classified and how NuScale intends to demonstrate compliance with requirements?
3. 10 CFR 50.55a(h)(3) requires compliance with IEEE Std. 603-1991. Clause 8.1, "Electric Power Sources," requires those portions of the Class 1E power system that are required to provide the power to the many facets of the safety system are governed by the criteria of this document and are a portion of the safety systems.
4. 10 CFR 50.34(f)(2)(xx) requires power supplies for pressurizer relief valves, block valves, and level indicators such that: (A) level indicators are powered from vital (i.e., Class 1E) buses; (B) motive and control power connections to the emergency power sources are through devices qualified in accordance with requirements applicable to systems important to safety; and (C) electric power is provided from emergency power sources. "Emergency power sources" is somewhat ambiguous in the regulation, and NuScale may say that it can be important to safety, but nonsafety-related. However, vital power is typically identified as Class 1E power.
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Definitions

Term	Definition
AOO	anticipated operational occurrence
BDB	beyond-design-basis
BPS	backup power system
CRH	control room habitability
ECC	emergency core cooling
ESFAS	engineered safety features actuation system
FWIV	feedwater isolation valve
GDC	general design criterion
I&C	instrumentation and controls
LOOP	loss of off-site power
MCC	motor control center
MCHFR	minimum critical heat flux ratio
MCR	main control room
MPS	module protection system
MSIV	main steam isolation valve

Term	Definition
NMS	neutron monitoring system
PORV	power-operated relief valve
PAM	postaccident monitoring
PPS	plant protection system
QA	quality assurance
RBV	reactor building ventilation
RCPB	reactor coolant pressure boundary
RSS	remote shutdown station
RTNSS	regulatory treatment of nonsafety systems
RTS	reactor trip system
RXB	reactor building
SDI	safety display and indication
SSC	structure, system, and component
VAC	volts, (alternating current) AC
Vlv	valve

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Highly Reliable Electrical System Design

- NuScale highly reliable DC power system (EDSS)

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Highly Reliable Electrical System Design

- NuScale highly reliable DC power system (EDSS)

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Highly Reliable Electrical System Design

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Highly Reliable Electrical System Design

- NuScale highly reliable DC power system

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RXB Layout

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Background—Definition of Class 1E

*Class 1E: The safety classification of the electric equipment and systems that are essential to emergency reactor shutdown, containment isolation, reactor core cooling, and containment and reactor heat removal, or that are otherwise essential in preventing significant release of radioactive material to the environment.**

**Class 1E is a functional term. Equipment and systems are to be classified Class 1E only if they fulfill the functions listed in the definition. Identification of systems or equipment as Class 1E based on anything other than their function is an improper use of the term and should be avoided.*

--IEEE Std. 603-1991, as specified in 10 CFR 50.55a

--IEEE Std. 308-2001, as endorsed by RG 1.32, Rev. 3

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Background—Basis for Class 1E Design

*Safety function: One of the processes or conditions (e.g., emergency negative reactivity insertion, postaccident heat removal, emergency core cooling, postaccident radioactivity removal, containment isolation) essential to maintain plant parameters within acceptable limits established for a design-basis event.**

**A safety function is achieved by the completion of all required protective actions by the reactor trip system and the engineered safety features, or both, concurrent with the completion of all required protective actions by the auxiliary supporting features.*

--IEEE Std. 603-1991, as specified in 10 CFR 50.55a

--IEEE Std. 308-2001, as endorsed by RG 1.32, Rev. 3

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Background—Basis for Class 1E Design

- For a typical reactor design, electrical power is an auxiliary supporting feature (i.e., provides services that are required for safety systems to accomplish their safety functions)

In the NuScale plant design, neither AC nor DC electrical power, is relied upon for safety systems to accomplish safety functions in response to a design-basis event.

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Background—Basis for Class 1E Design

- Principal design criteria—IEEE 308-2001, Section 4.1

  The Class 1E power systems shall be designed to ensure that no design-basis event causes

  – a loss of electric power to a number of engineered safety features, surveillance devices, or protection system devices so that a required safety function cannot be performed

In the NuScale plant design, a design-basis event with a loss of all (i.e., both AC and DC) electrical power has no adverse effect on performance of safety functions.

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Background—Basis for Class 1E Design

- Principal design criteria—IEEE 308-2001, Section 4.1

  The Class 1E power systems shall be designed to ensure that no design-basis event causes

  – a loss of electric power to equipment that could result in a reactor transient capable of causing significant damage to the fuel cladding or to the reactor coolant pressure boundary (RCPB)

In the NuScale plant design, a design-basis event with a loss of all (i.e., both AC and DC) electrical power does not result in a transient capable of damage to the fuel cladding or RCPB.

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Safety Classification Assessment

- Assessment of functions for which Class 1E power is typically provided, to determine appropriate electrical system safety classification
  - power module (reactor) safety functions (i.e., safe shutdown, core cooling, containment isolation and integrity, RCPB integrity)
  - spent fuel assembly and refueling fuel assembly cooling
  - control room habitability
  - cooling for building areas containing safety-related equipment
  - emergency lighting
  - postaccident monitoring

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Safety Classification Assessment

- Power module safety functions
  - electrical power is not required in response to design-basis events to actuate or maintain safety functions
    - safe shutdown
      - » reactor trip on loss of electrical power

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Safety Classification Assessment

- Power module safety functions
  - electrical power is not required in response to design-basis events to actuate or maintain safety functions
    - core cooling
      - » power modules partially immersed in the ultimate heat sink (UHS), supporting safety-related core cooling via natural circulation and passive heat transfer to UHS

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    - containment isolation and integrity

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Safety Classification Assessment

- Power module safety functions
  - electrical power is not required in response to design-basis events to actuate or maintain safety functions
    - RCPB integrity
      - » module protection system (reactor trip and ESFAS)
      - » design of pressure-retaining components per 10 CFR 50.55a (ASME Code Section III) and GDC 14, GDC 15, GDC 30, and GDC 31
      - » overpressure protection per ASME Code Section III

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Safety Classification Assessment

- Assessment of functions for which Class 1E power is typically provided to determine electrical system safety classification
  - power module (reactor) safety functions (i.e., safe shutdown, core cooling, containment integrity, RCPB integrity)—per IEEE 603 and IEEE 308 definition, Class 1E power not warranted
  - spent fuel assembly and refueling fuel assembly cooling
  - control room habitability
  - cooling for building areas containing safety-related equipment
  - emergency lighting
  - postaccident monitoring

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Safety Classification Assessment

- Spent fuel assembly and refueling fuel assembly cooling
  - in addition to its core decay and CNV heat sink function, the UHS also is the heat sink for decay heat generated by spent fuel assemblies and fuel assemblies associated with a power module in the process of refueling (i.e., refueling fuel assemblies)
  - active UHS cooling and makeup systems maintain UHS water level, temperature, and quality/cleanliness when AC electrical power is available
    - these systems and their electrical power supplies are not safety-related
    - large UHS water volume is the safety-related water source relied upon to provide the cooling and shielding of spent fuel and refueling fuel assemblies per GDC 61

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Safety Classification Assessment

- Spent fuel assembly and refueling fuel assembly cooling
  - a significant UHS water level reduction would involve the extended unavailability of UHS cooling and makeup systems

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  - large UHS water volume provides sufficient time for actions to restore UHS cooling/makeup using defense-in-depth provisions
    - restore permanently installed AC power source(s)
    - connect portable AC generator(s)
    - Seismic Category I pool water makeup connection and associated piping provides for makeup water via tanker truck
    - connection capability to the fire protection system

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Safety Classification Assessment

- Spent fuel assembly and refueling fuel assembly cooling

Electrical power is not relied upon, during and following, a design-basis event to provide adequate cooling and radiological shielding of the:

- spent fuel assemblies in the spent fuel pool
- fuel assemblies associated with a power module in the process of refueling

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Safety Classification Assessment

- Assessment of functions for which Class 1E power is typically provided to determine electrical system safety classification
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  - spent fuel assembly and refueling fuel assembly cooling—per IEEE 603 and IEEE 308 definition, Class 1E power not warranted
  - control room habitability
  - cooling for building areas containing safety-related equipment
  - emergency lighting
  - postaccident monitoring

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Safety Classification Assessment

- Control room habitability system
  - isolation dampers shut upon loss of power
  - minimum 72-hour passive capability via compressed air
  - neither relies on nor uses forced air emergency filtration (that would require electrical power) to protect operators during accident conditions

In the NuScale plant design, electrical power is not relied upon to actuate or maintain CRH functions.

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Safety Classification Assessment

- Assessment of functions for which Class 1E power is typically provided, to determine electrical system safety classification
  - power module (reactor) safety functions (i.e., safe shutdown, core cooling, containment integrity, RCPB integrity)—per IEEE 603 and IEEE 308 definition, Class 1E power not warranted
  - spent fuel assembly and refueling fuel assembly cooling—per IEEE 603 and IEEE 308 definition, Class 1E power not warranted
  - control room habitability—per IEEE 603 and IEEE 308 definition, Class 1E power not warranted
  - cooling for building areas containing safety-related equipment
  - emergency lighting
  - postaccident monitoring

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Safety Classification Assessment

- Cooling for building areas containing safety-related equipment
  - minimal safety-related equipment required after safety function actuation
  - passive cooling is provided in building areas (e.g., control room, module protection system [MPS] room, etc.) with equipment used during station blackout conditions

In the NuScale plant design, electrical power is not relied upon to maintain cooling to areas containing safety-related equipment.

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Safety Classification Assessment

- Assessment of functions for which Class 1E power is typically provided to determine electrical system safety classification
  - power module (reactor) safety functions (i.e., safe shutdown, core cooling, containment integrity, RCPB integrity)—per IEEE 603 and IEEE 308 definition, Class 1E power not warranted
  - spent fuel assembly and refueling fuel assembly cooling—per IEEE 603 and IEEE 308 definition, Class 1E power not warranted
  - control room habitability—per IEEE 603 and IEEE 308 definition, Class 1E power not warranted
  - cooling for building areas containing safety-related equipment—per IEEE 603 and IEEE 308 definition, Class 1E power not warranted
  - emergency lighting
  - postaccident monitoring

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Safety Classification Assessment

- Emergency lighting
  - no explicit requirement or guidance that specifies that emergency lighting be provided with Class 1E power
    - SRP Section 9.5.3
    - NUREG-0700
    - RG 1.189
  - guidance is intended to verify that adequate emergency lighting is provided in all areas (and the access routes to and from these areas) required for
    - implementing and maintaining safe shutdown during all plant conditions (including fire, transient, and accident conditions)
    - firefighting

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Safety Classification Assessment

- Emergency lighting
  - typical reactor plant design
    - emergency lighting fixtures, controllers, dimmers, and associated cables used are non-Class 1E—consistent with IEEE 308 definition
    - emergency lighting (or portions thereof) provided by Class 1E electrical system
    - isolation devices separate lighting circuits and the Class 1E electrical system, consistent with RG 1.75
  - typical design
    - reflects the need at typical reactors for operator actions following design-basis events to achieve and maintain safe shutdown conditions
    - does not contemplate design where Class 1E power is not required for safety functions

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Safety Classification Assessment

- Emergency lighting
  - in the NuScale design
    - a loss of all electrical power results in actuation of power module safety functions
    - once actuated, there are no credible failures that could prevent continued operation of passive safety systems
    - operator actions not relied upon following design-basis events to achieve and maintain safe shutdown conditions

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Safety Classification Assessment

- Emergency lighting
  - in the NuScale design, emergency lighting does not warrant Class 1E power per the IEEE Std. 603 and IEEE Std. 308 definition (i.e., it is not essential) to:
    - emergency reactor shutdown, containment isolation, reactor core cooling, and containment and RCPB integrity
    - preventing significant release of radioactive material to the environment
  - notwithstanding this conclusion, reliability and defense-in-depth features ensure successful performance of the emergency lighting function

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Safety Classification Assessment

- Emergency lighting
  - reliability and defense-in-depth
    - Design, surveillance, and testing fully consistent with SRP 9.5.3, NUREG-0700, and Regulatory Guide 1.189, including but not limited to:
      - » fixed, self-contained lighting consisting of fluorescent or sealed-beam units with individual 8-hour minimum battery power supplies

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      - » lighting units and their batteries periodically inspected and tested to ensure reliability and functionality
      - » suitable sealed-beam battery-powered portable hand lights provided for emergency use

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Safety Classification Assessment

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  - cooling for building areas containing safety-related equipment—per IEEE 603 and IEEE 308 definition, Class 1E power not warranted
  - emergency lighting—per IEEE 603 and IEEE 308 definition, Class 1E power not warranted
  - postaccident monitoring

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Safety Classification Assessment

- Postaccident monitoring
  - current guidance contained in SRP Section 7.5 and RG 1.97, Rev. 4, with clarification in BTP 7-10
  - RG 1.97, Rev. 4, endorses with clarifications the guidance of IEEE 497-2002
  - IEEE 603-1991, specifies that

    "...display instrumentation provided for manually controlled actions for which no automatic control is provided and that are required for the safety systems to accomplish their safety functions shall be part of the safety systems and shall meet the requirements of IEEE Std 497..." --Paragraph 5.8.1

    "The electrical portion of the safety systems, that perform safety functions, is classified as Class 1E." --Section 2

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Safety Classification Assessment

- Postaccident monitoring
  - IEEE 497-2002 specifies Class 1E electrical system to supply instrumentation that monitors Types A, B, and C variables
    - developed with consideration for traditional power reactor designs in which postaccident monitoring is essential to ensuring nuclear safety
    - does not contemplate a design wherein

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Safety Classification Assessment

- Postaccident monitoring
  - typical reactor designs rely on active components (e.g., pumps) and on operator actions during and following design-basis events to ensure that safe shutdown conditions are achieved and maintained
    - electrical power is an auxiliary supporting feature as defined in IEEE Std. 603-1991 (i.e., it is required for safety systems to accomplish their safety functions)
      - » failure of the electrical supply to an active ESF component (e.g., ECCS pump) during a design-basis event would require contingency action to ensure adequate core cooling is maintained
      - » MCR safety system display readings would provide operators the indication that such a safety system failure occurred

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Safety Classification Assessment

- Postaccident monitoring
  - for traditional reactors, postaccident monitoring plays a key role in MCR operations to ensure nuclear safety
    - preplanned operator actions related to accident mitigation
    - assessing plant conditions and safety system performance, in order to make decisions related to plant response and any needed operator actions
    - achieving and maintaining safe shutdown following an accident

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Safety Classification Assessment

- Postaccident monitoring
  - much of the monitoring instrumentation for traditional reactors falls within the category of displays for manually controlled actions, which IEEE 603-1991, Para. 5.8.1, specifies "...shall be part of the safety systems and shall meet the requirements of IEEE Std 497...."
  - for display instrumentation used for these operations (i.e., to identify needed operator actions to achieve or maintain safe shutdown conditions), IEEE 603-1991 and IEEE 497-2002 specify a Class 1E electrical power supply

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Safety Classification Assessment

- Postaccident monitoring
  - postaccident monitoring instrumentation does not serve the same role (i.e., to ensure nuclear safety) in NuScale operations as it does at traditional reactors
    - safety systems rely on passive means, such as gravity, natural circulation, condensation and evaporation, and stored energy
    - a design-basis event concurrent with a loss of electrical power (both AC and DC)
      - » would have no adverse effect on safety-related functions
      - » would not result in a transient capable of significant damage to the fuel cladding or RCPB

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Safety Classification Assessment

- Postaccident monitoring

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Safety Classification Assessment

- Postaccident monitoring
  - in the NuScale design, monitoring instrumentation is
    - used by MCR operators to monitor passive system operation based on natural laws of physics

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Safety Classification Assessment

- Postaccident monitoring

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Safety Classification Assessment

- Postaccident monitoring system

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Safety Classification Assessment

- Postaccident monitoring system
  - RG 1.97, Rev. 3, used graded approach to design, qualification, and QA requirements depending on the importance to safety of the measurement of a specific variable
    - Category 1 provides the most stringent requirements and is intended for key variables
      - » full qualification
      - » redundancy and continuous real-time display
      - » power supply meeting RG 1.32 (Class 1E) and including on-site (standby) power
    - Category 2 provides less stringent requirements and generally applies to instrumentation designated for indicating system operating status
      - » provides for qualification but does not (of itself) include seismic qualification, redundancy, or continuous display
      - » requires only a "high-reliability" power source (not necessarily standby power)
    - Category 3 is the least stringent
      - » provides for high-quality, off-the-shelf (commercial-grade) equipment that requires only off-site power

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Safety Classification Assessment

- Postaccident monitoring system

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Safety Classification Assessment

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  - emergency lighting—per IEEE 603 and IEEE 308 definition, Class 1E power not warranted
  - postaccident monitoring—per IEEE 603 and IEEE 308 definition, Class 1E power not warranted

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NRC Questions on Class 1E Power

1. ***What are NuScale's plans for addressing licensing requirements and regulations for safety systems that require Class 1E power?***

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NRC Questions on Class 1E Power

2. Describe how systems which require Class 1E AC/DC electrical power by regulations are classified and how NuScale intends to demonstrate compliance with regulations.

- Consistent with regulations and guidance, NuScale electrical systems' role in achieving/maintaining safety functions does not warrant Class 1E designation
- Consistent with 10 CFR 50.55a(h) and IEEE 603-1991, safety and protection system circuits are classified as Class 1E

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NRC Questions on Class 1E Power

3. 10 CFR 50.55a(h)(3) requires compliance with IEEE Std. 603-1991. Clause 8.1, "Electric Power Sources," requires those portions of the Class 1E power system that are required to provide the power to the many facets of the safety system are governed by the criteria of this document and are a portion of the safety systems

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NRC Questions on Class 1E Power

4. ***10 CFR 50.34(f)(2)(xx) requires power supplies for pressurizer relief valves, block valves, and level indicators such that: (A) level indicators are powered from vital (i.e., Class 1E) buses; (B) motive and control power connections to the emergency power sources are through devices qualified in accordance with requirements applicable to systems important to safety; and (C) electric power is provided from emergency power sources. "Emergency power sources" is somewhat ambiguous in the regulation, and NuScale may say that it can be important to safety, but nonsafety-related. However, vital power is typically identified as Class 1E power.***

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NRC Questions on Class 1E Power

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NRC Questions on Class 1E Power

5. How is the NuScale plant monitored/managed in the control room without electrical power? Discuss availability of displays, instrumentation, and habitability in the control room.

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Power and Data Display Diagram

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NRC Questions on Class 1E Power

6. Is NuScale's electrical design completely Class 1E-free, or is it partially Class 1E-free? Are there any systems supplied by a Class 1E electrical system?

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NRC Questions on Class 1E Power

7. Regarding the topical report on Class 1E power, what does the TR intend to demonstrate and what type of approval is sought from the staff?

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Plant Safety System Response to Loss of Power and DCD Chapter 15 Analysis

Meghan McCloskey

Safety Analysis Engineer

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NRC Questions on Class 1E Power

1. What are NuScale's plans for addressing licensing requirements, and regulations for safety systems that require Class 1E power?
2. Describe how systems which require Class 1E AC/DC electrical power by regulations are classified and how NuScale intends to demonstrate compliance with requirements?
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10. What is the status of DCD Chapter 15 and what information will be included in Chapter 15?

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Safety Functions—Response to Loss of Power

- Key safety functions in NuScale design-basis event thermal-hydraulic response
  - reactor trip
    - reactivity control to shutdown fission chain reaction
  - containment isolation and heat removal
    - provide essentially leak-tight barrier against uncontrolled release of radioactivity to the environment
    - retain sufficient primary system inventory to support heat transfer through ECCS
  - decay heat removal
    - transfer decay heat and other residual heat from reactor vessel to reactor pool portion of ultimate heat sink
    - function accomplished by either
      - » decay heat removal system
      - » emergency core cooling system
- Design philosophy
  - plant safety systems and components 'fail-safe' —use passive forces and go to safe state upon loss of power

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Safety Functions—Response to Loss of Power

- Reactor trip
  - safe state: control rods inserted
  - **on loss of power:** control rods drop
- Containment isolation and heat removal
  - safe state: isolation valves closed to prevent release of radioactivity and retention of RCS inventory
  - **on loss of power:**
    - containment isolation valves fail closed
    - containment heat removal passively achieved by heat transfer through the containment vessel wall to the reactor pool

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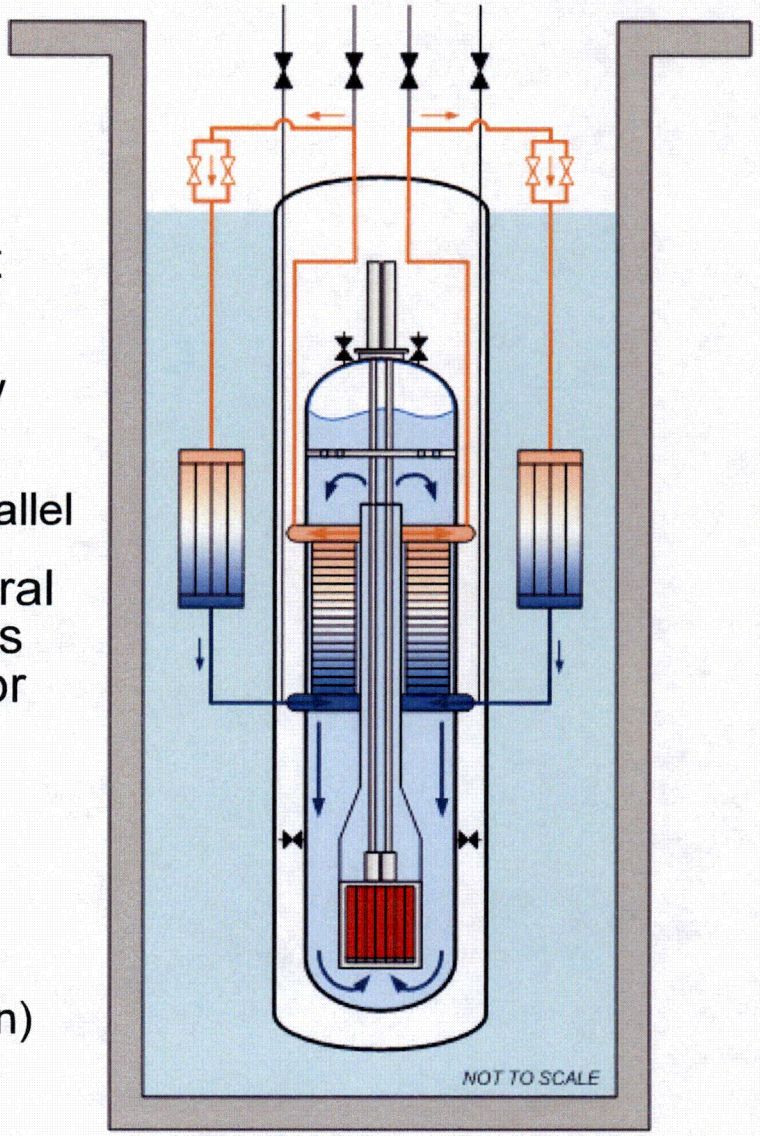
DHRS—Response to Loss of Power

Decay Heat Removal System

- Safe state: DHRS operating to transfer decay and residual heat to reactor pool
- DHRS is composed of two independent single failure proof trains
  - one of two trains needed to remove decay heat and cool the RCS
  - each train has two actuation valves in parallel
- Decay heat passively removed via natural circulation through the steam generators and DHR heat condensers to the reactor pool
- **On loss of power**
  - reactor trip
  - main steam and main feedwater isolated (fail closed as part of containment isolation)
  - DHR valves fail open



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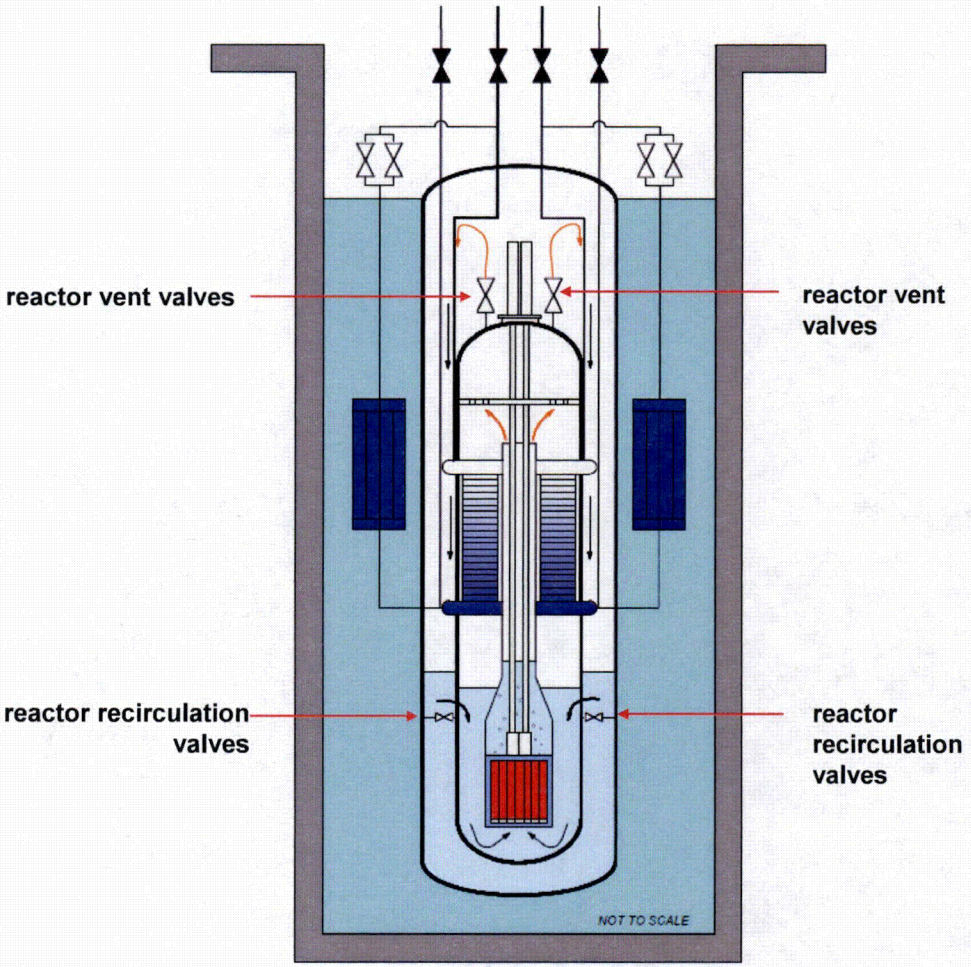
ECCS—Response to Loss of Power

Emergency Core Cooling System

- Safe state: ECCS valves open to provide recirculation flow path to transfer decay and residual heat to reactor pool
- Decay and residual heat removal via natural circulation with ECCS valves open
  - liquid from containment vessel enters RCS through reactor recirculation valves
  - vapor vented from RCS to containment vessel through reactor vent valves
  - steam condenses on inside surface of containment vessel
  - heat transfer through liquid and both vessel walls to the reactor pool



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ECCS—Response to Loss of Power

Emergency Core Cooling System

- ECCS valves open is a safe state

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- **On loss of power:**

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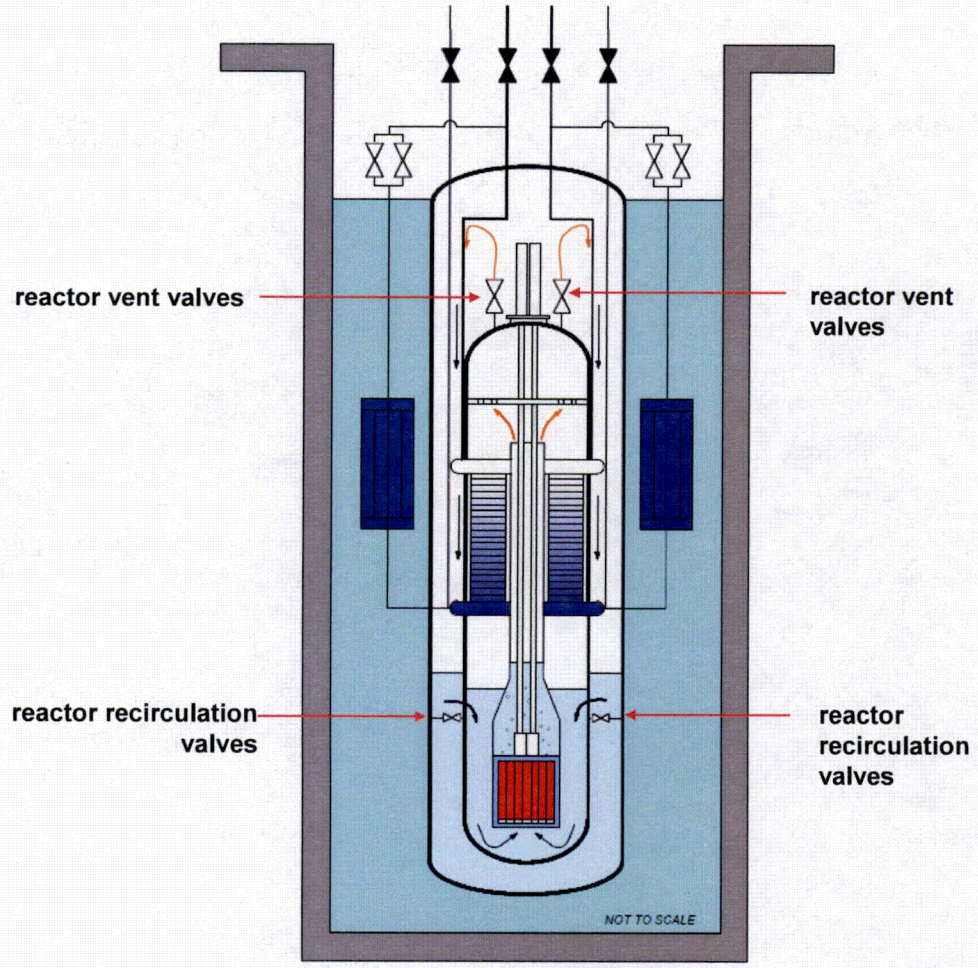

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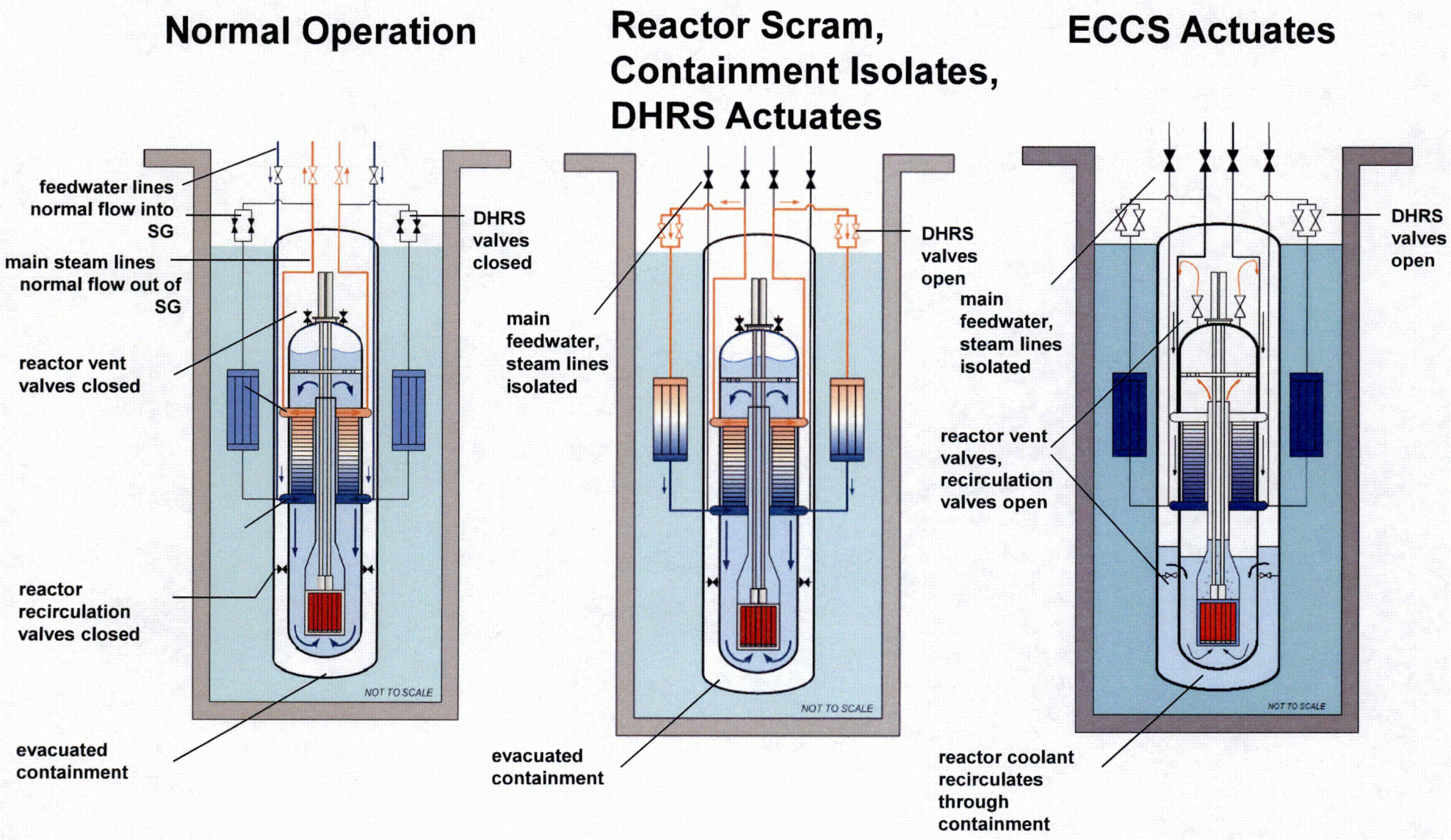
Summary—Response to Loss of Power



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NRC Questions on Class 1E Power

8. *How do various safety systems function without Class 1E AC/DC power?*

- Safety systems fail-safe in response to loss of power
  - control rods insert
  - containment isolation valves close
  - DHRS valves open to establish decay heat removal while ECCS valves are closed

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NRC Questions on Class 1E Power

1. What are NuScale's plans for addressing licensing requirements, and regulations for safety systems that require Class 1E power?
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Design-Basis Event Core Heat Removal

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Transient Progression

- Design-basis event response for single power module
  - example events
    - loss of feedwater
    - inadvertent opening of one RRV
  - consideration of power availability

Case	AC Power	DC Battery Power
1	Available	Available
2	Lost at time of event	Available
3	Lost at time of event	Unavailable

Note: Example calculation results on following slides used preliminary version of NRELAP; NRELAP plant model continues to be updated as detailed design work progresses and safety analysis evaluation models mature.

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General Transient Progression

- Example—loss of feedwater

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LOFW—RPV Pressure

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LOFW—SG Pressure

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LOFW—DHRS Flow Rate

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LOFW—Max Cladding Temperature

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LOFW—Containment Pressure

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LOFW—RCS Water Level in Riser

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LOFW—Containment Water Level

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General Transient Progression

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Inadvertent RRV Opening

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Inadvertent RRV Opening

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Beyond-Design-Basis Events

- BDB event analysis for probabilistic risk analysis (PRA) is a best estimate analysis
- PRAs consider both safety-related and nonsafety-related systems which could mitigate an event
  - systems considered include non-1E power supply systems
  - account for availability of electrical power based on reliability of system design

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NRC Questions on Class 1E Power

9. How are design-basis accidents and beyond-design-basis accidents managed without Class 1E power?

- Design-basis events:
  - safety systems fail-safe in response to loss of power
  - decay and residual heat removed via DHRS or ECCS depending on specific event, power availability, and time in the event progression
- Beyond-design-basis accident analyses for PRA account for power availability based on reliability of system design

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NRC Questions on Class 1E Power

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DCD Chapter 15

- DCD Chapter 15 structured following RG 1.206 and design specific review standard
  - incorporate NUREG-0800 as applicable

- Key aspects of Chapter 15 analysis related to non-1E power design
  - consideration of events with AC power unavailable, and treatment of highly reliable DC power in those cases
  - implications of ECCS actuation following an AOO

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Consideration of Power Availability in Ch. 15

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Consideration of Power Availability in Ch. 15

- DCD Chapter 15 design-basis analyses

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  - conservative results will be presented in DCD

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ECCS Actuation Following AOOs

AOO Event Acceptance Criteria—SRP 15.0

Parameter	Acceptance Criteria
Maximum reactor coolant system pressure	≤ 110% of design pressure
Maximum main steam system pressure	≤ 110% of design pressure
Minimum critical heat flux ratio (MCHFR)	≥ 95/95 CHFR limit
Maximum fuel centerline temperature	≤ melting temperature
An AOO should not generate a postulated accident without other faults occurring independently	A postulated accident is not generated by the AOO
An AOO should not result in a consequential loss of function of the RCS barrier	RCS barrier function is not lost
An AOO should not result in a consequential loss of reactor containment barrier	Maximum containment pressure ≤ 90% design pressure

- Acceptance criteria, with respect to the NuScale design, need to be considered
- NuScale will follow up with preapplication engagement as needed

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NRC Questions on Class 1E Power

10. What is the status of DCD Chapter 15 and what information will be included in Chapter 15?

- DCD Chapter 15 structured following RG 1.206, NUREG-0800, NuScale DSRS

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  - NuScale will follow up with preapplication engagement as needed regarding AOO acceptance criteria

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Results Achieved and Path Forward

- Discussed how NuScale plant safety is ensured and regulations are met without having a Class 1E electrical power system
  - why the appropriate classification of NuScale's plant electrical systems is non-Class 1E
  - how regulations are met without having a Class 1E electrical power system
  - description of highly reliable non-1E DC power system
  - ESF response to loss of power
  - examples of how design-basis events are managed without Class 1E power
  - treatment of power availability in DCD Chapter 15 events and regulatory implications of non-Class 1E power
- Path forward
  - submittal of topical report on non-Class 1E power
  - submittal of safety analysis methodology topical reports
  - preapplication engagement as needed regarding AOO acceptance criteria
  - determine with NRC if exemption to 10 CFR 50.34(f)(2)(xx), 10 CFR 50.34(f)(2)(xiii) is needed

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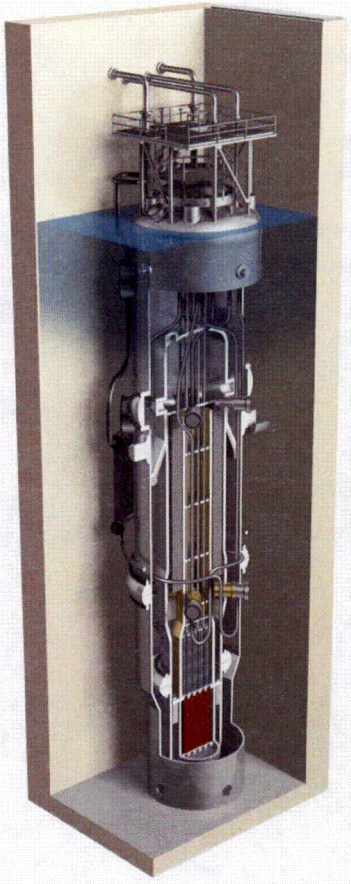
6650 SW Redwood Lane, Suite 210
Portland, OR 97224
503.715.2222

1100 NE Circle Blvd., Suite 200
Corvallis, OR 97330
541.360.0500

11333 Woodglen Ave., Suite 205
Rockville, MD 20852
301.770.0472

6060 Piedmont Row Drive South, Suite 600
Charlotte, NC 28287
704.526.3413

http://www.nuscalepower.com



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