Nonproprietary

Mechanistic Source Term

Dr. David E. Leaver

October 3, 2012

NuScale Power™

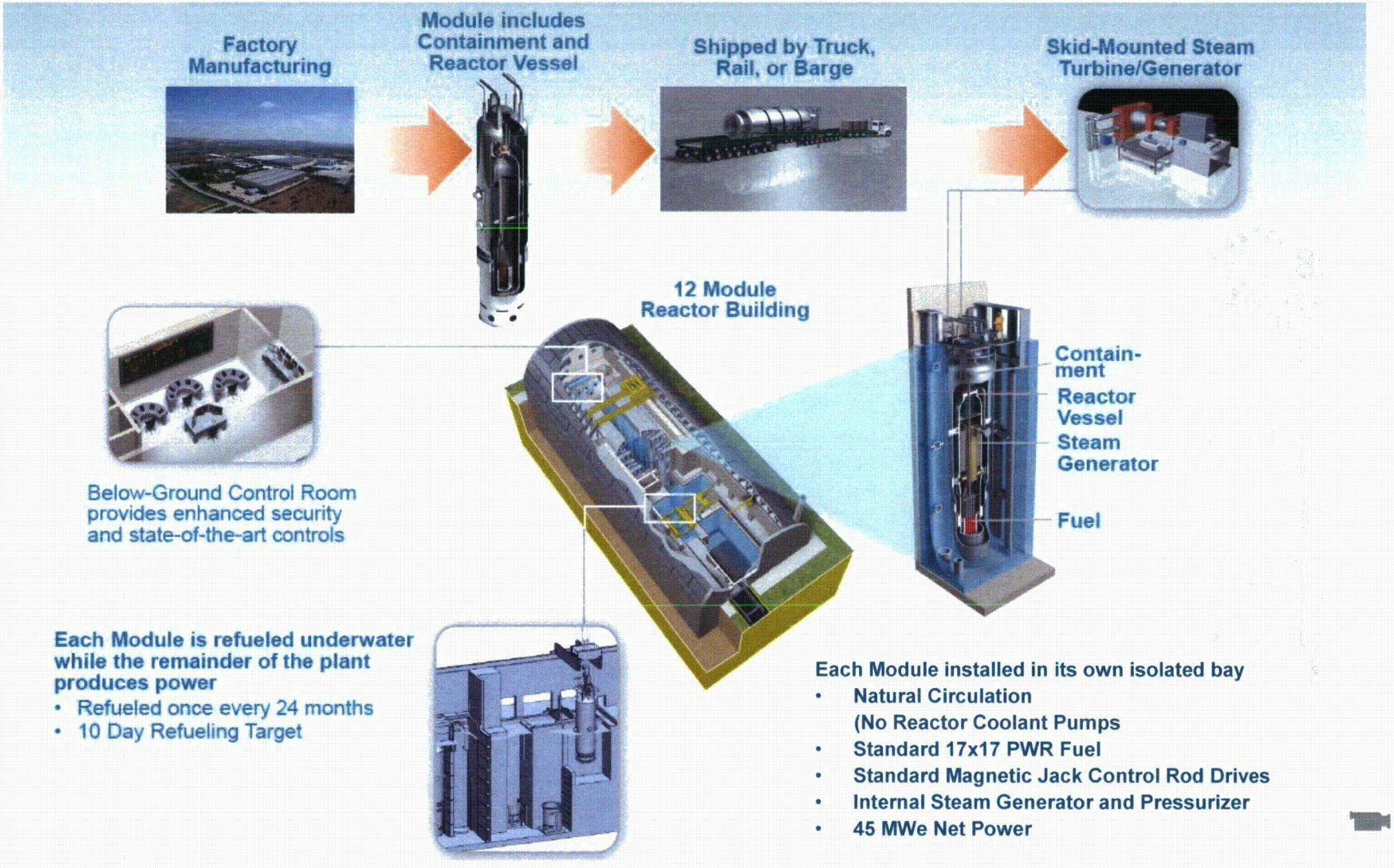
Agenda

- Purpose
- Background of NuScale design
- NuScale mechanistic source term (MST) methodology for DCD
- NuScale scoping dose results
- Future MST pre-application engagement

Purpose

- Communicate NuScale pre-application objectives
  - agreement on the approach to MST for evaluation of DBA
  - recognize differences in the NuScale design and the impact on MST
- Discuss NuScale analysis methods and tools
- Present NuScale design-specific scoping Chapter 15 dose results
- Agreement on future NuScale MST pre-application engagement

Plant Overview



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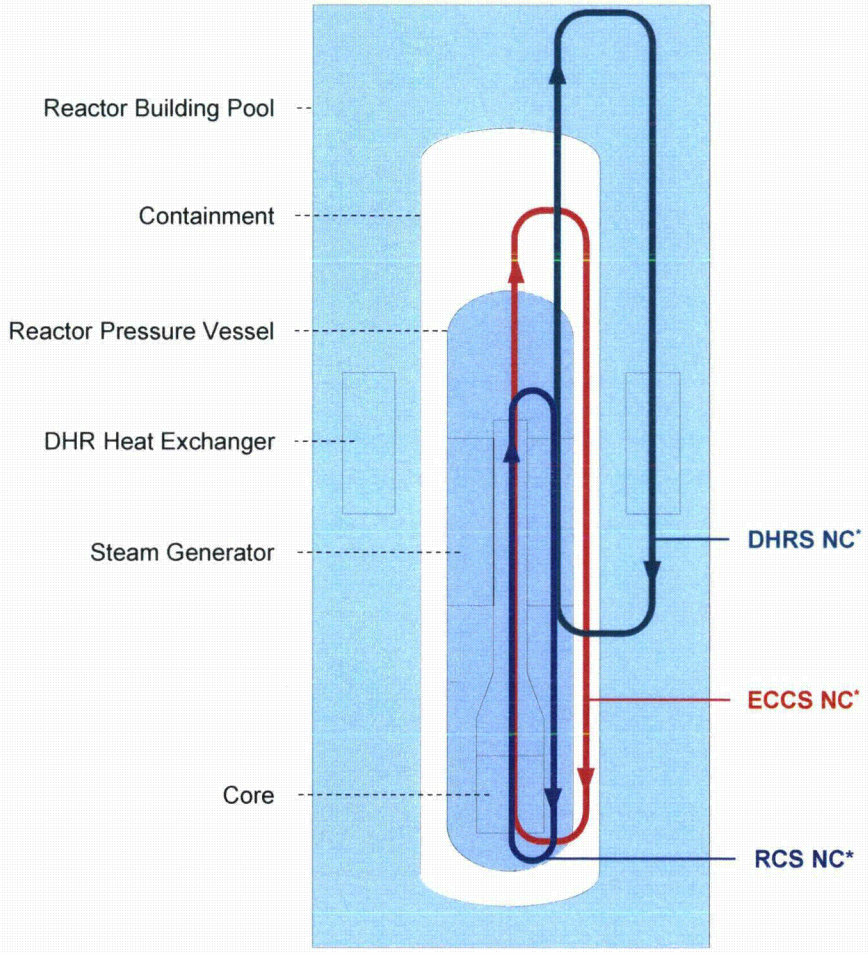
Plant Overview – Natural Circulation



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- Natural circulation in the emergency core cooling system (ECCS)

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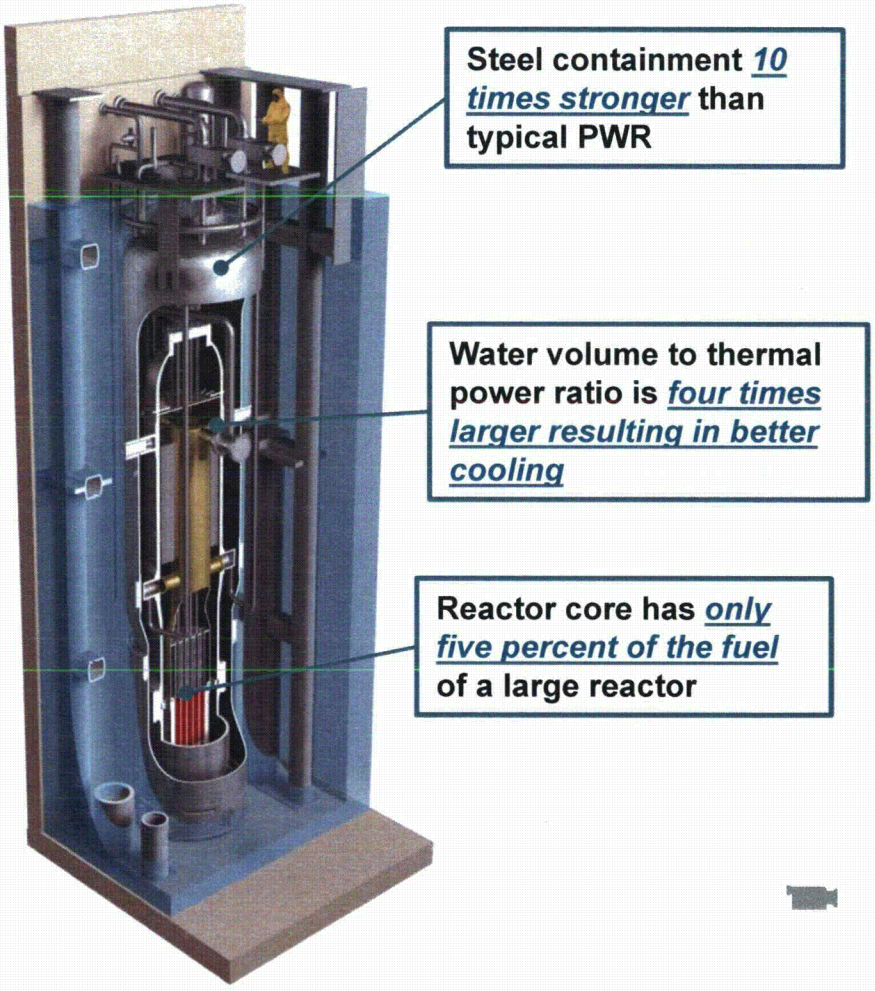
45 MWe Reactor Module



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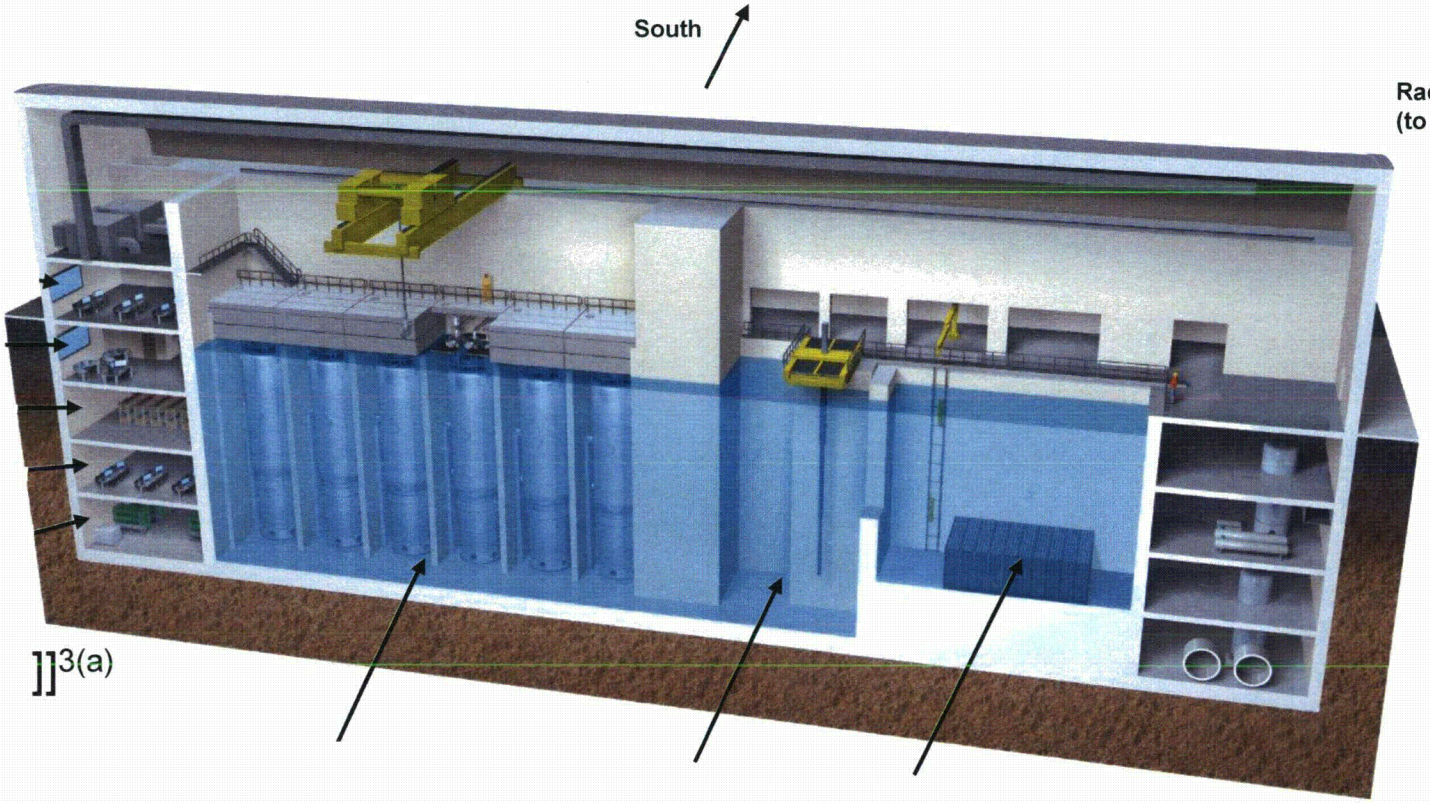
Reactor Building Cutaway View



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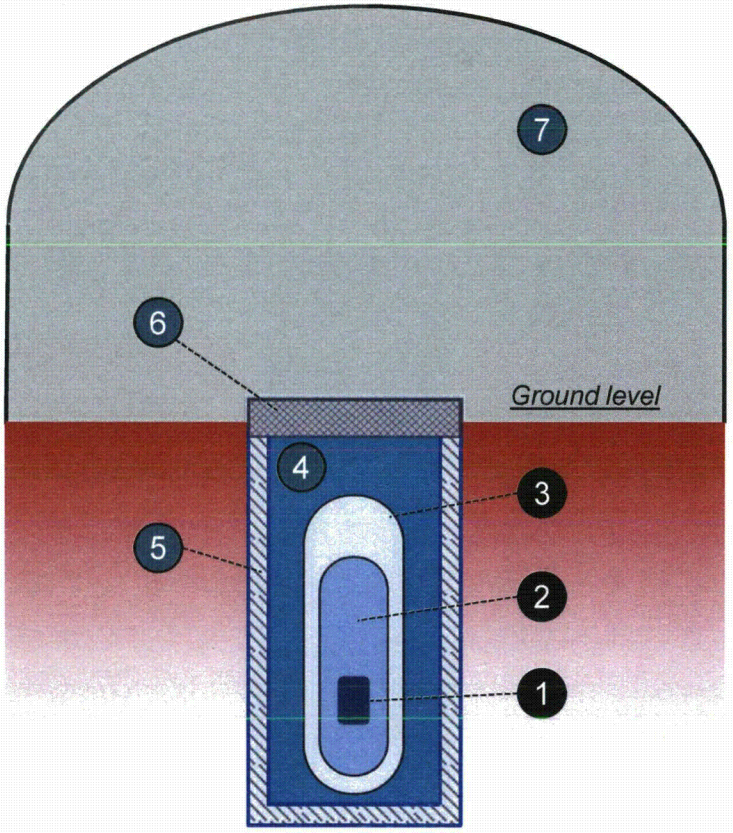
Barriers between Fuel and Environment

Conventional Designs

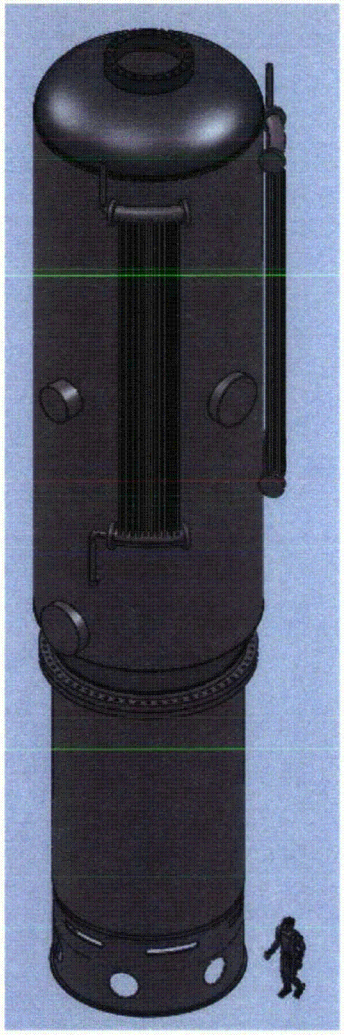
1. Fuel pellet and cladding
2. Reactor vessel
3. Containment

Additional Features in NuScale Design

4. Water in reactor pool (10 million gallons)
5. Stainless steel lined concrete reactor pool
6. Biological shield covers each reactor
7. Reactor building (Seismic Category I)



Passive Decay Heat Removal System



- Main steam and main feedwater isolated
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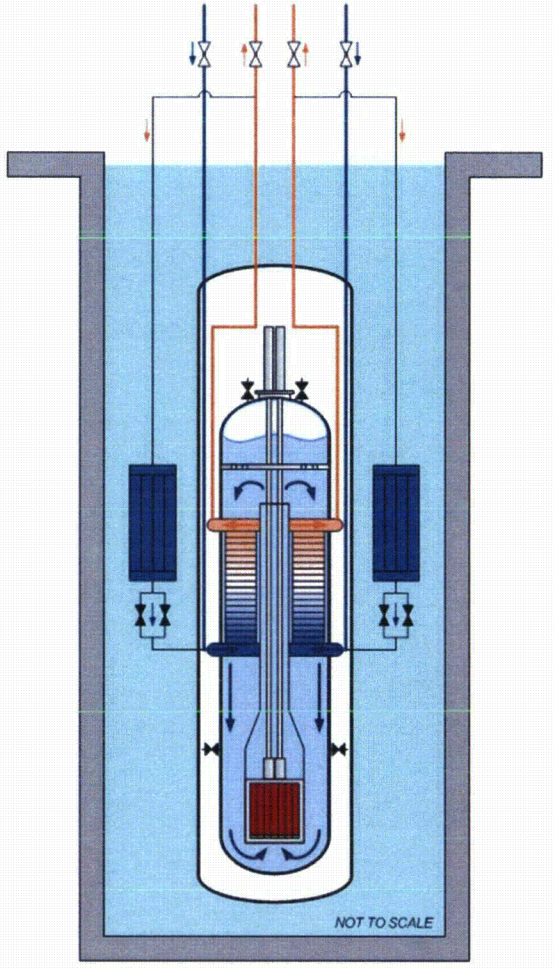

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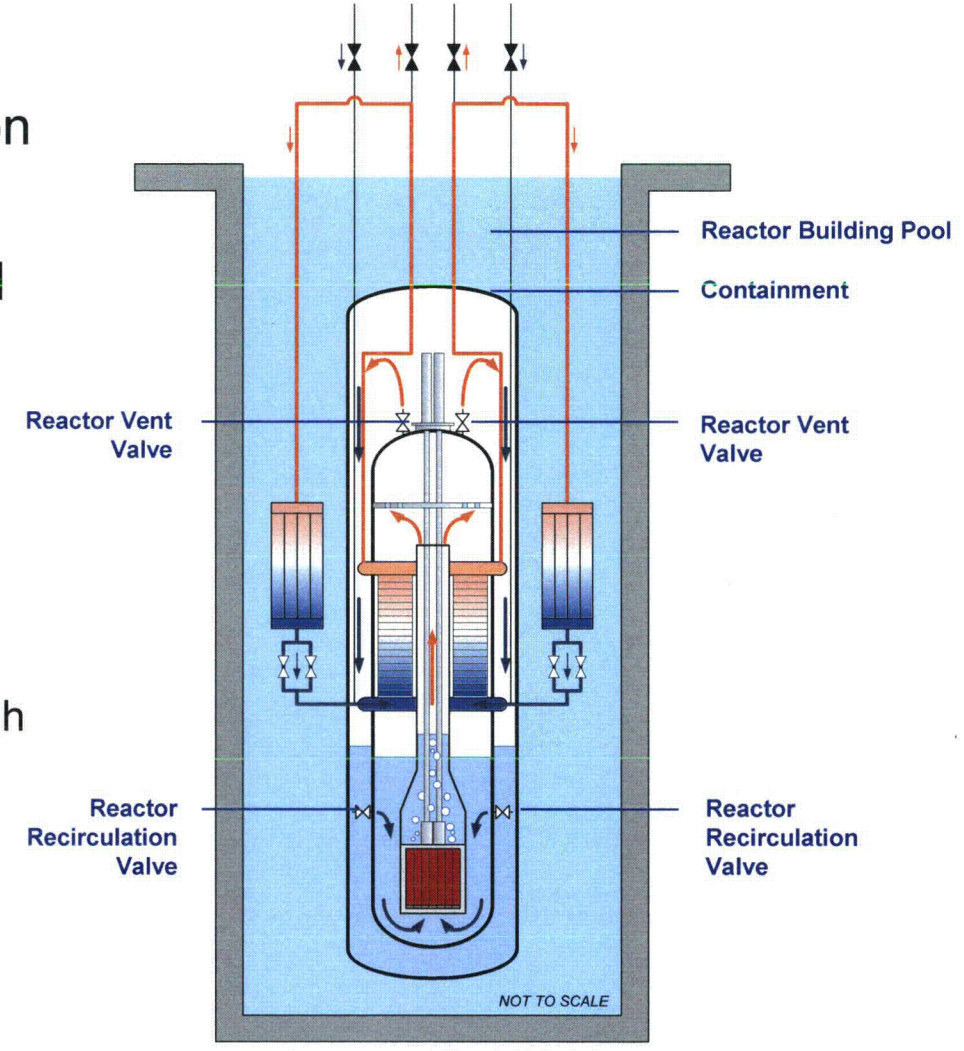
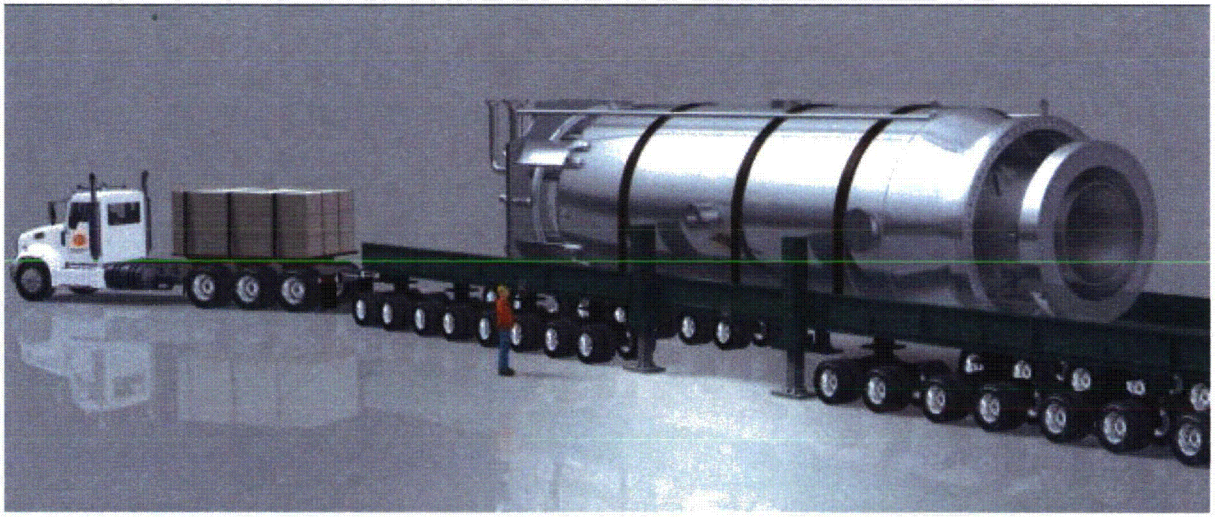
ECCS/Containment Heat Removal

- Reactor vent valves opened on safety signal
- When containment liquid level is high enough, reactor recirculation valves open.
- Decay heat removed:
  - condensing steam on inside surface of containment vessel
  - convection and conduction through liquid and both vessel walls



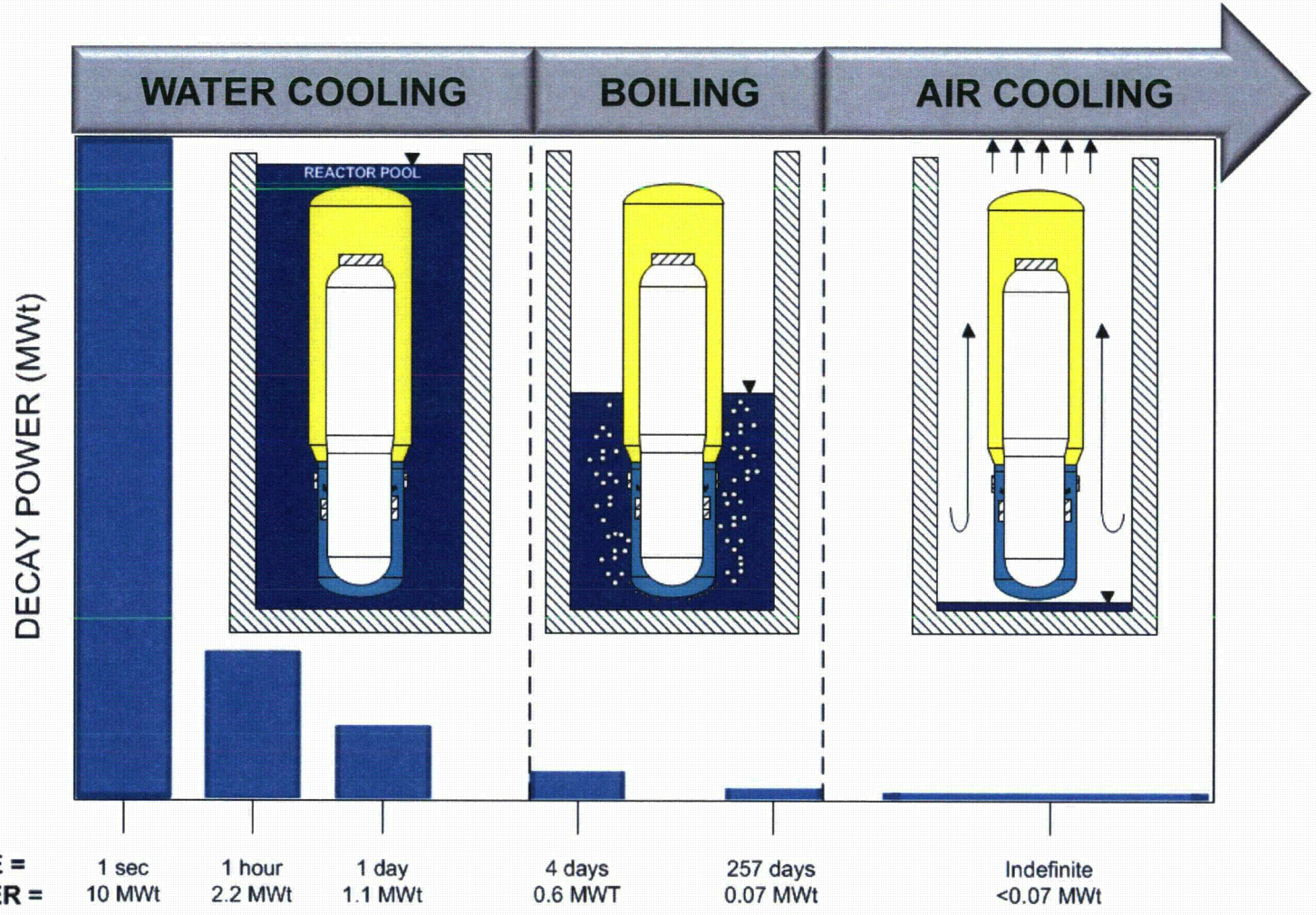
Ship by Truck, Rail, or Barge

- Integrated reactor module
- Factory manufactured
- Transportable by truck, rail, or barge
- 15 meters x 4.5 meters
  - 400 tons



Stable Long-Term Cooling without Pumps or Power

Containment and fuel cooled indefinitely for all 12 modules without pumps or power



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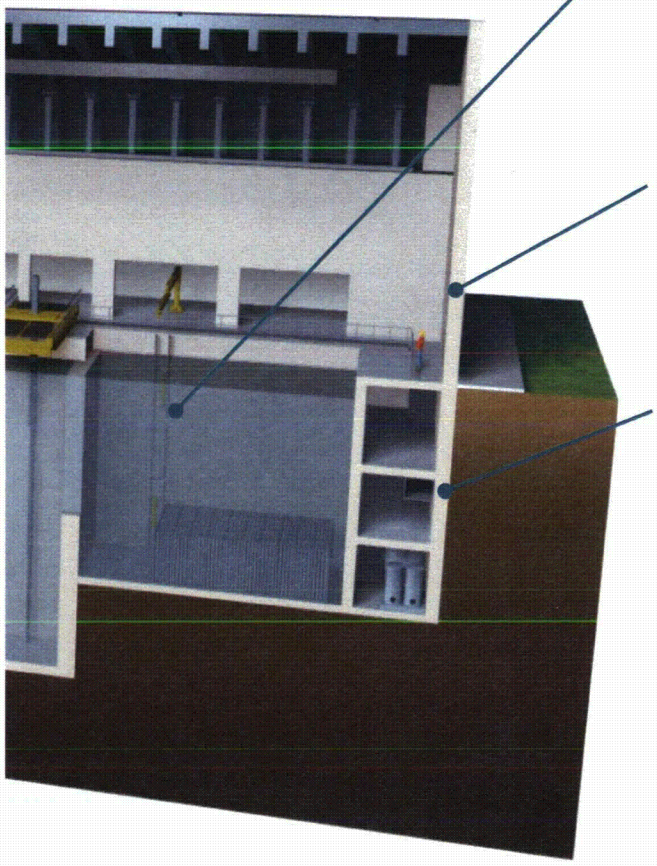
Spent Fuel Pool Safety



Increased Cooling Capacity

- ***More water volume for cooling per fuel assembly*** than current designs
- Redundant, cross-connected reactor and refueling pool heat exchangers provide full back-up cooling to spent fuel pool.

External Coolant Supply Connections

- Auxiliary ***external water supply connections are easily accessible*** to plant personnel and away from potential high radiation zones (current problem in Japan).

Below Ground, Robust Deep-Earth Structure

- Below ground spent fuel pool is housed in a ***seismically robust reactor building.***
- Stainless steel refueling ***pool liners are independent from concrete structure to retain integrity .***
- Pool wall located underground is ***shielded from tsunami wave impact and damage.***
- ***Construction of structure below ground in engineered soil limits the potential for any leakage.***

Purpose and Desired Outcomes

Design basis accidents for which consequences are to be calculated in DCD (red shaded row shows LOCA accident, which is being addressed today)

SRP Section	Accident	SMR Basis and Notes
15.0.1	LOCA	No large LOCA, but small LOCA may be important
15.1.5	Main steam line system pipe breaks (MSLB)	All designs have main steam systems, main steam isolation valves, and a secondary side coolant activity
15.3.3 and 15.3.4	RCP rotor seizure or shaft break	Applicable to designs that use reactor coolant pumps
15.4.8	Rod ejection	Applicable to designs with control rod drives that are external to the reactor pressure vessel
15.6.2	Small primary coolant line break outside containment	All designs have small pipe lines that penetrate both the primary coolant system and containment
15.6.3	Steam generator tube failure (SGTF)	All designs have steam generators with tubes and an assumed primary coolant activity
15.7.4	Fuel handling accident (FHA)	All designs handle spent fuel under water in a pool
15.7.5	Spent fuel cask drop	Applicable to designs that will transport spent fuel from the spent fuel pool

NuScale MST DCD Methodology

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Flow Chart of MST Development for DCD

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NuScale MST DCD Methodology

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NuScale MST DCD Methodology

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CVCS LOCA Inside Containment

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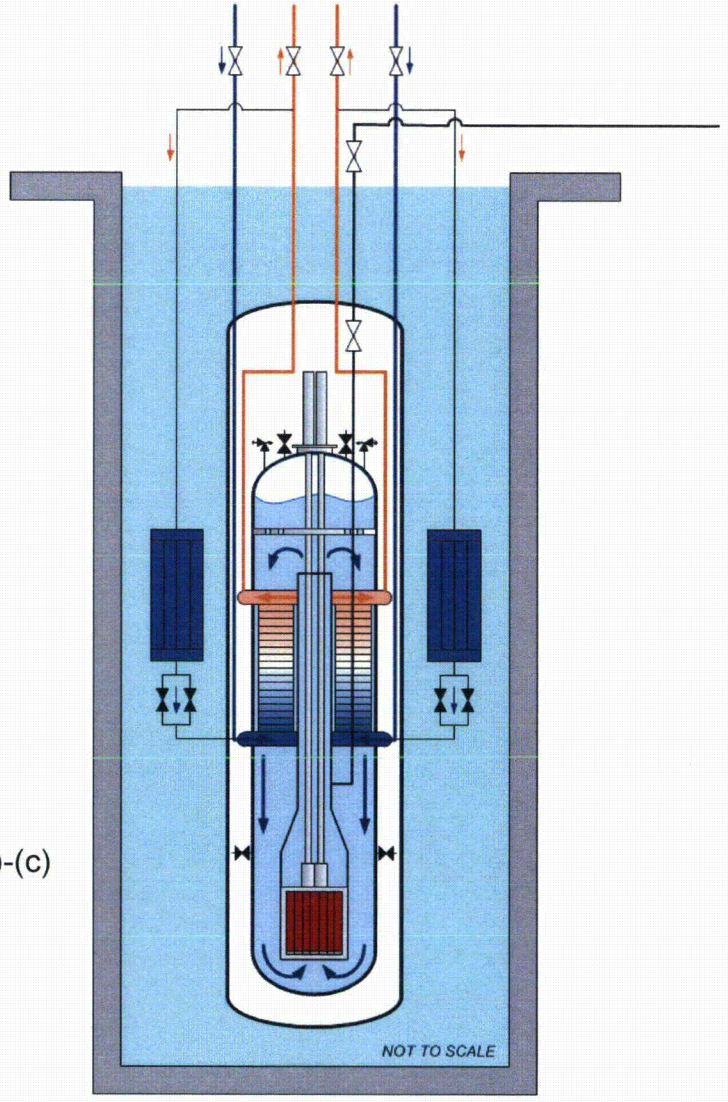

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NuScale MST DCD Methodology

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NuScale MST DCD Methodology

Example for low burnup, LEU early in-vessel release fractions*

Plant	Case	Noble Gases	Halogens	Alkali Metals	Te Group	Ba/Sr Group
Sequoyah	4A	8.9965E-1	8.8787E-2	6.8651E-2	7.4077E-2	1.677E-3
	4B	6.8859E-1	1.6660E-1	1.6848E-1	1.7821E-1	2.9957E-3
	4C	5.8950E-1	1.5635E-1	1.6140E-1	1.5146E-1	3.5057E-3
	4D	7.9759E-1	1.3809E-1	8.6136E-2	9.5699E-2	1.1094E-3
	4E	7.5621E-1	1.7540E-1	9.9710E-2	1.0095E-1	1.3011E-3
	4F	9.4152E-1	6.4745E-1	6.7333E-1	6.7622E-1	5.0103E-3
	4G	8.0231E-1	1.7610E-1	1.1269E-1	1.2463E-1	1.2680E-3
Surry	1A	9.5091E-1	5.2944E-1	2.2071E-1	2.8872E-1	5.9523E-3
	1B	8.3540E-1	3.9021E-1	3.4885E-1	3.7563E-1	5.9087E-3
	1C	9.3994E-1	8.1663E-1	5.9862E-1	7.9121E-1	9.7568E-3
	1D	9.3938E-1	6.9225E-1	5.7164E-1	6.9093E-1	4.2902E-3
	1F	8.7420E-1	3.9375E-1	3.5144E-1	3.8276E-1	5.2463E-3

**Taken from Table 21 of Sandia Report SAND2008-6664, April 2010 on high burnup/mixed oxide source term update*

NuScale MST DCD Methodology

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NuScale MST DCD Methodology

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- Offsite X/Q values same as other advanced plant DCDs (i.e., 80 – 85 percentile site meteorology from ALWR URD)
- Determine NuScale-specific CR X/Q (ARCON96) and control room habitability system parameters
- Determine curie release versus time from containment based on design basis containment leak rate and in-containment transport results
- Calculate doses and compare against CFR TEDE limits:
  - limiting two-hour EAB dose (25 rem)
  - 30-day LPZ dose (25 rem)
  - 30-day control room dose (5 rem)

NuScale Scoping Dose Assessment

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NuScale Scoping Dose Assessment

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Flow Chart of MST Development

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NuScale Scoping Dose Assessment

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NuScale Scoping Dose Assessment

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Future MST Pre-Application Activities and Engagement

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Preliminary Set of NuScale MST DSRS Items

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Nonproprietary

Nuclear Module and Fuel Handling

Maurice LaFountain,
Project Manager, Primary Systems

October 4, 2012

NuScale Power™

Agenda

- Purpose
- Background
- Plant overview
- Regulations and related guidance
- Nuclear module and fuel handling
- Feedback and next steps

Purpose

- Familiarize the U.S. Nuclear Regulatory Commission (NRC) with NuScale nuclear handling
- Obtain agreement on requirements and guidance applicability
- Discuss Design-Specific Review Standard cooperation with the NRC staff

Background

- April 2009 meeting with the NRC to discuss refueling operations
- October 2011 meeting with the NRC to discuss NuScale design and applicability of requirements and guidance

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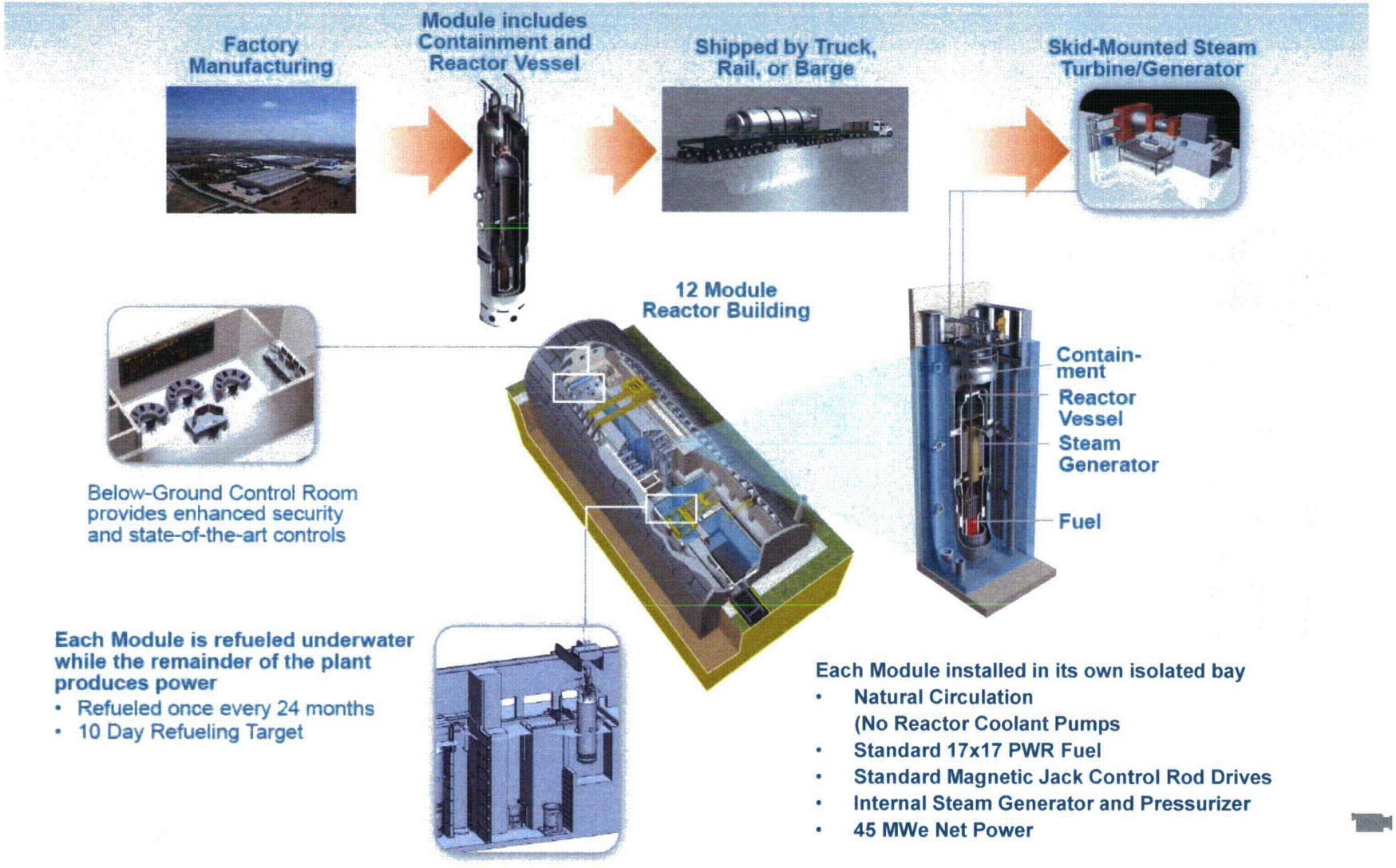

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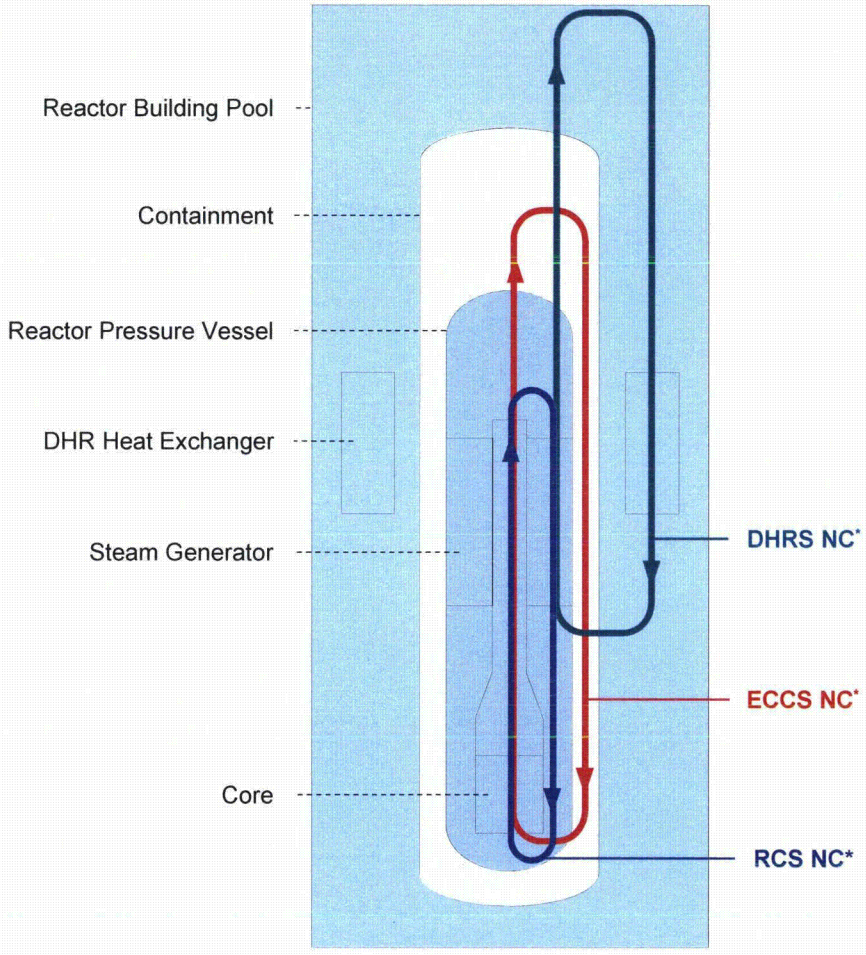

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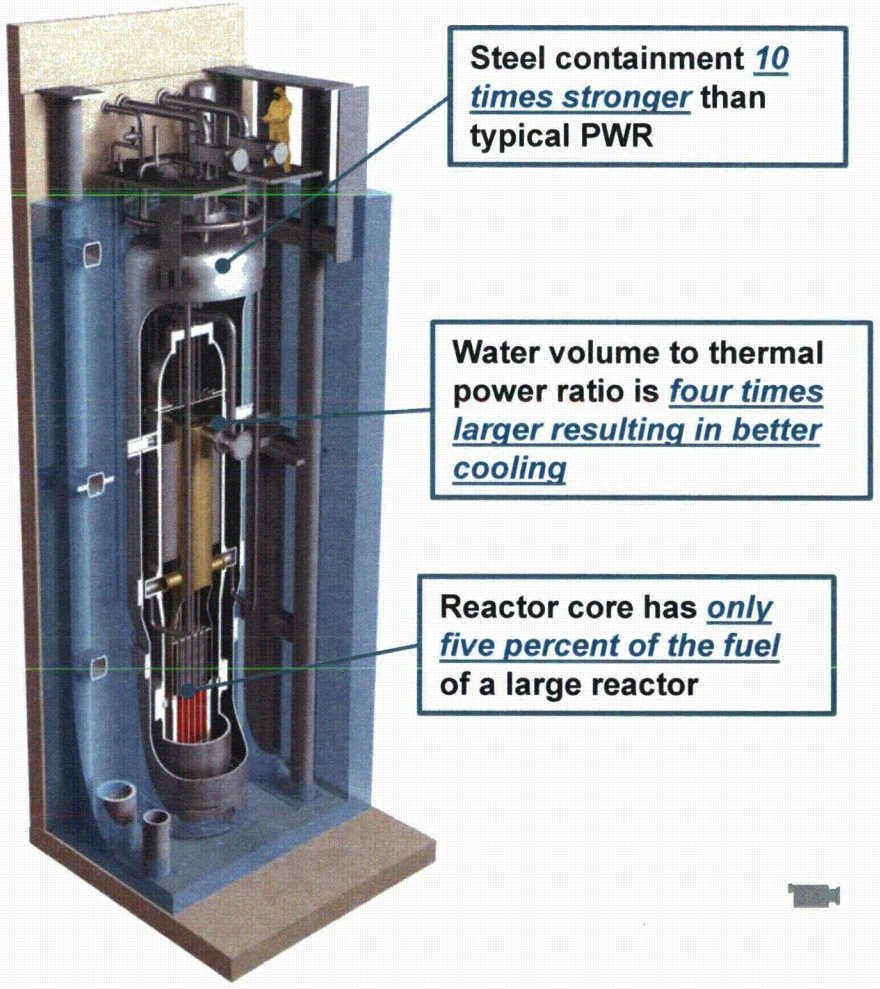

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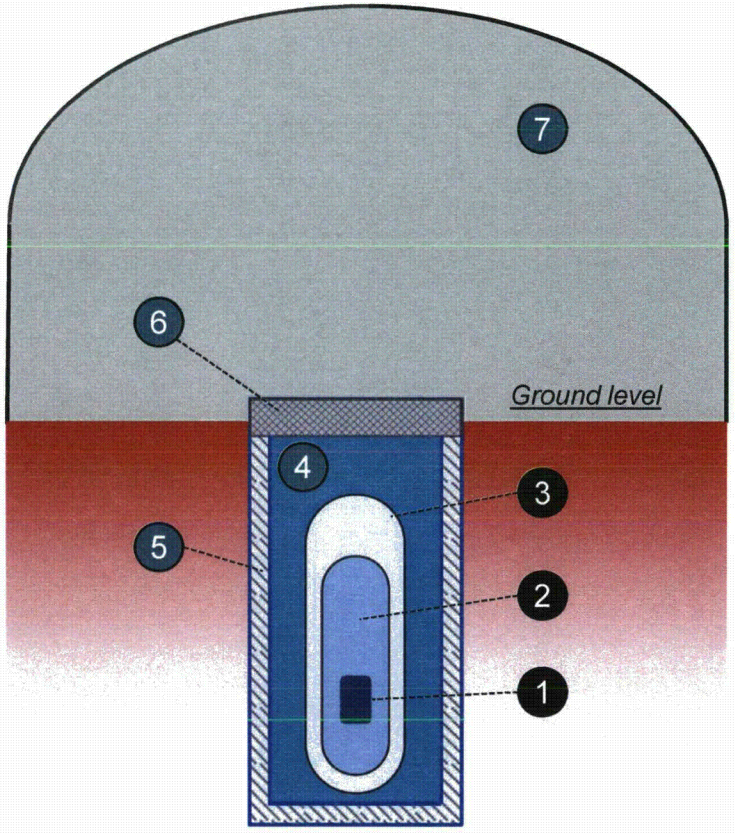

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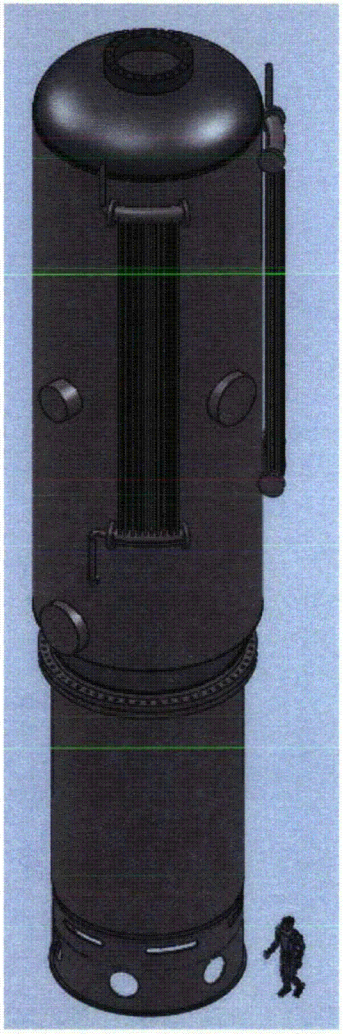

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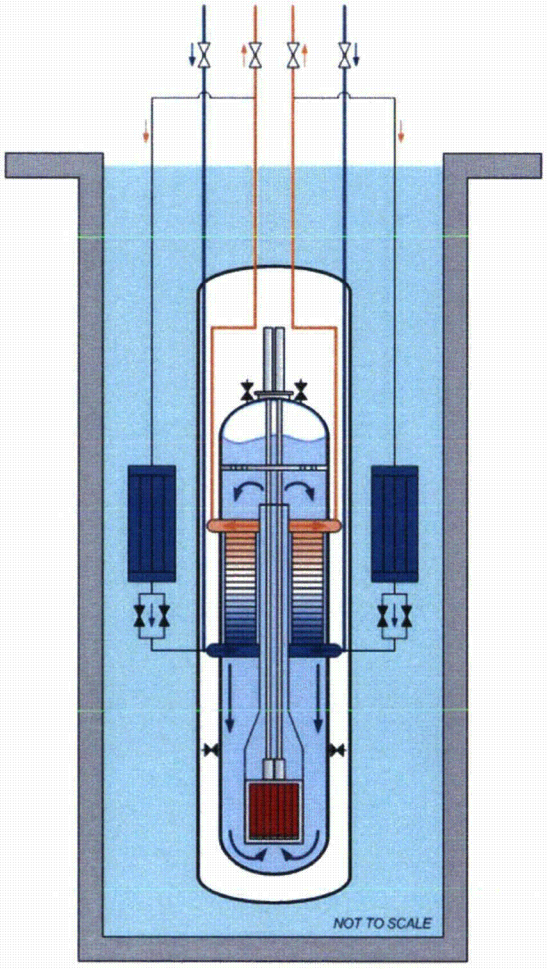

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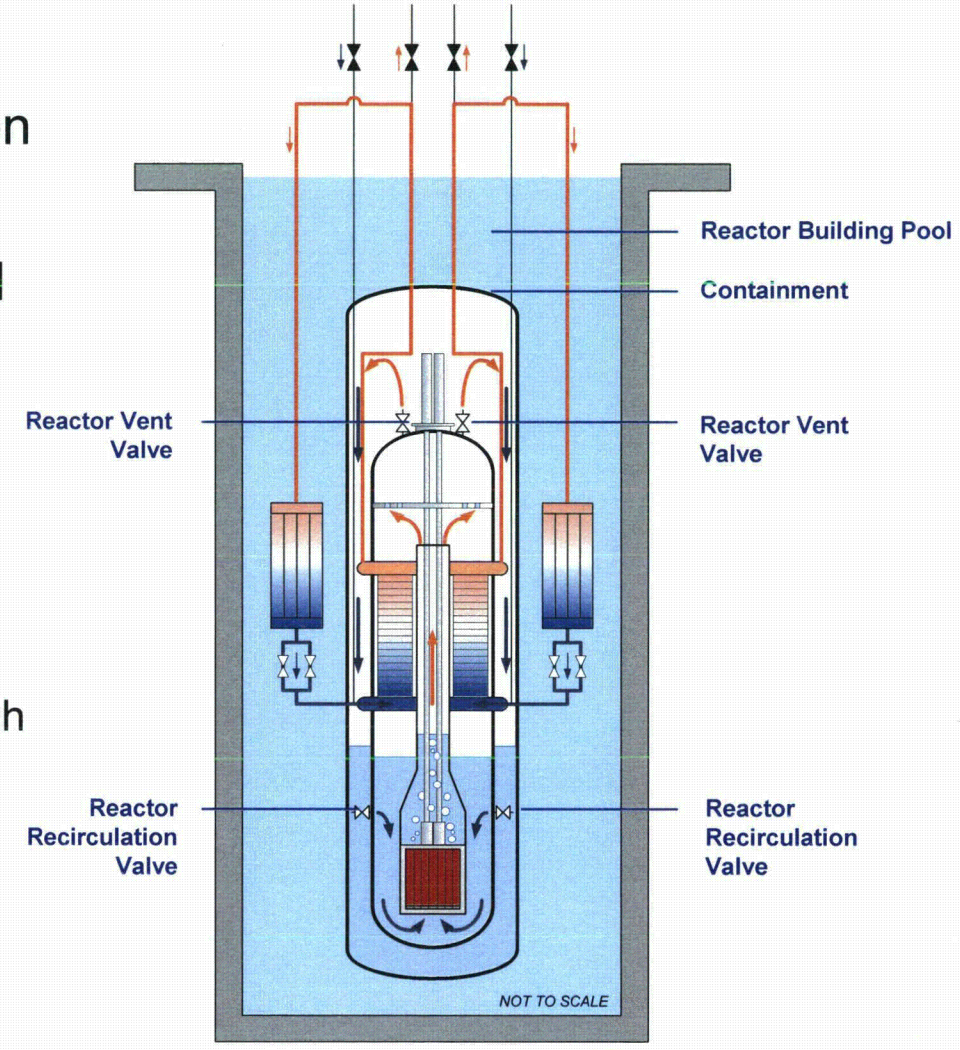

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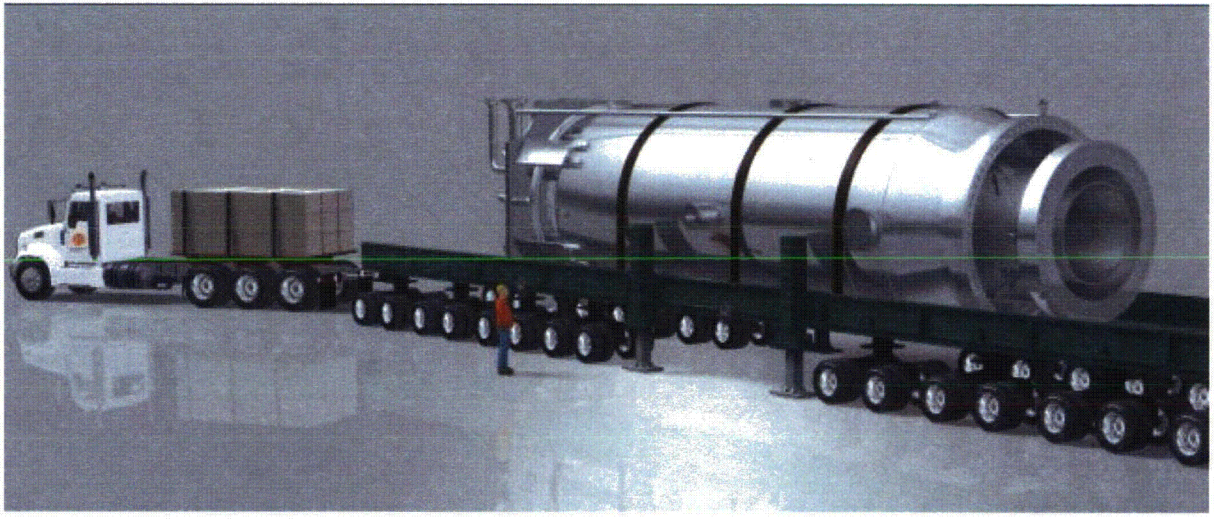

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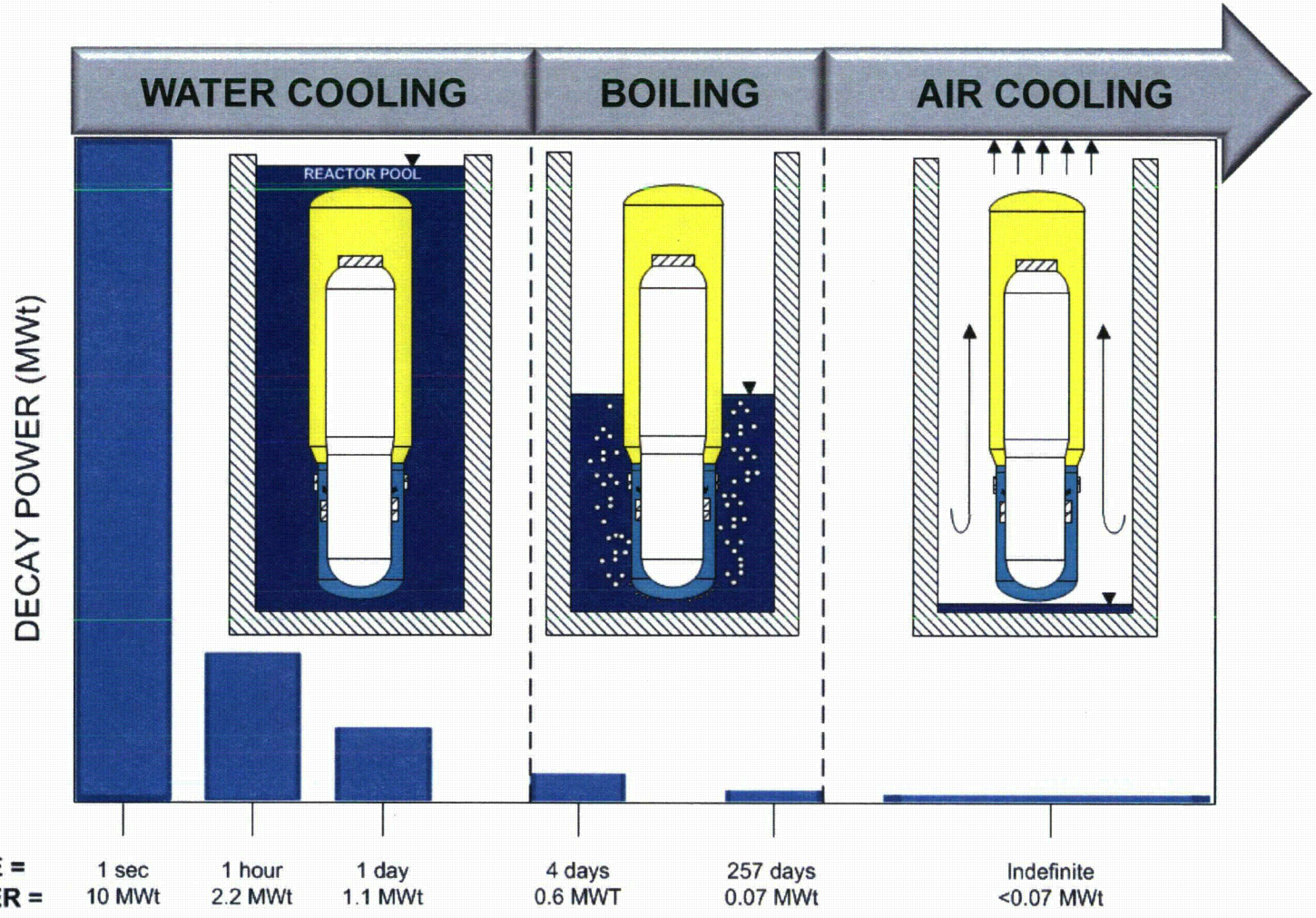

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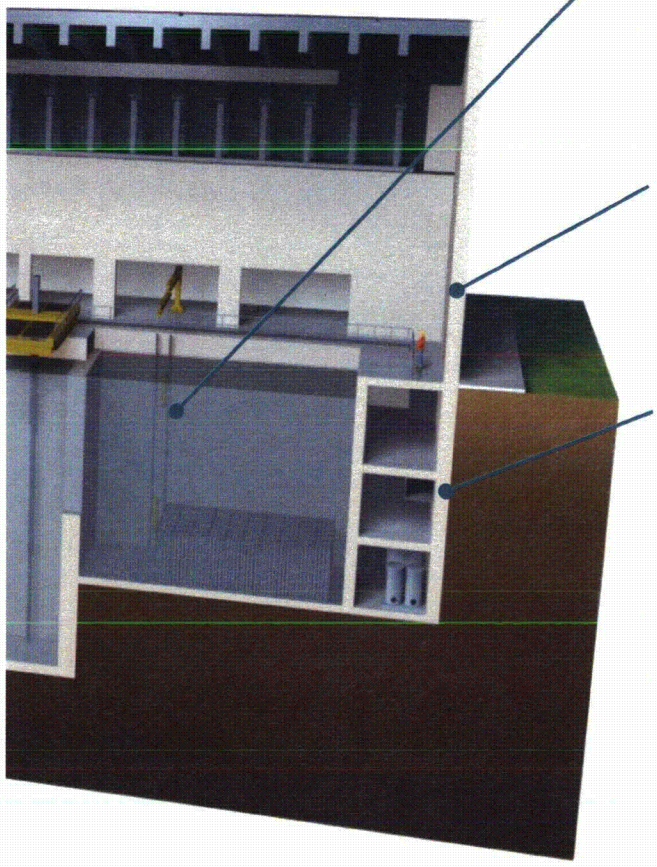
Spent Fuel Pool Safety



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Handling Overview

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Regulations and Guidance

- Regulations
  - 10 CFR Part 50
  - GDC 32, 61, 62, 63
- Regulatory Guides
  - 1.13, 1.26, 1.33
- NUREGs
  - 0612, 0554, 0800 (SRP)
- Codes and standards
  - ASME NQA-1, NOG-1, BTH-1, B30.2
  - ANSI/ANS 57.1
  - ANSI N14.6

Nuclear Module and Fuel Handling

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Receiving New Fuel

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New Fuel Elevator

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Fuel Handling Machine

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Reactor Building Crane

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Module Import Trolley

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NuScale Power™

Lower Reactor Pressure Vessel Loading from Transport

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Module Import

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Upper Reactor Module Import

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Upender and Dry Dock Operation

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Module Upender

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Initial Fueling of Lower Reactor Pressure Vessel

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Module Assembly

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Module Assembly

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Reactor Flange Tool

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Cart Assembly

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Flange Bolting Operation

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Refueling

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Dry Spent Fuel and Cask Handling

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Design Progress Summary

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Feedback and Next Steps

- Regulatory guidance and NuScale compliance
- Standard operations and equipment
- Special requirements
- Design-Specific Review Standard development
- Future interactions