NuScale Technology Overview

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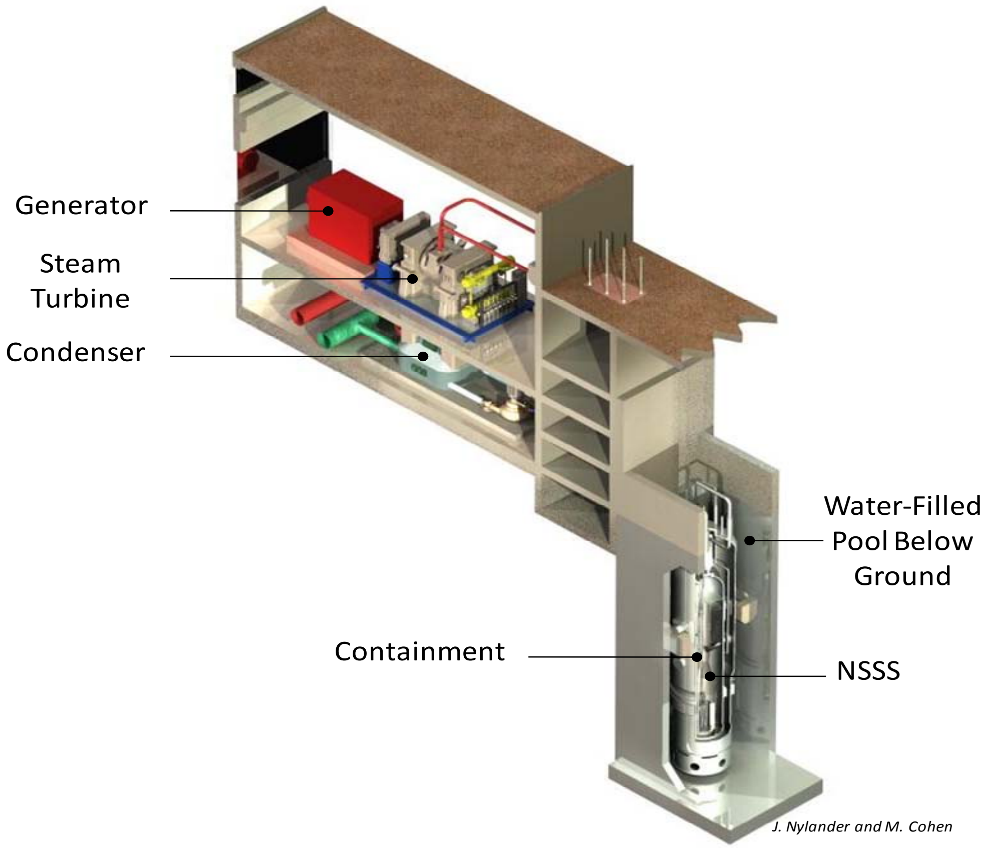
NuScale Technology

A Scalable Approach to Energy



- Each module has a dedicated Steam-Turbine Generator
- Complete facilities have the capability of variable power output
  - Energy Supply Tailoring
  - Initial Investment Reduction
  - Total Capacity of 12 Reactor Modules
- Modules are designed for independent safety

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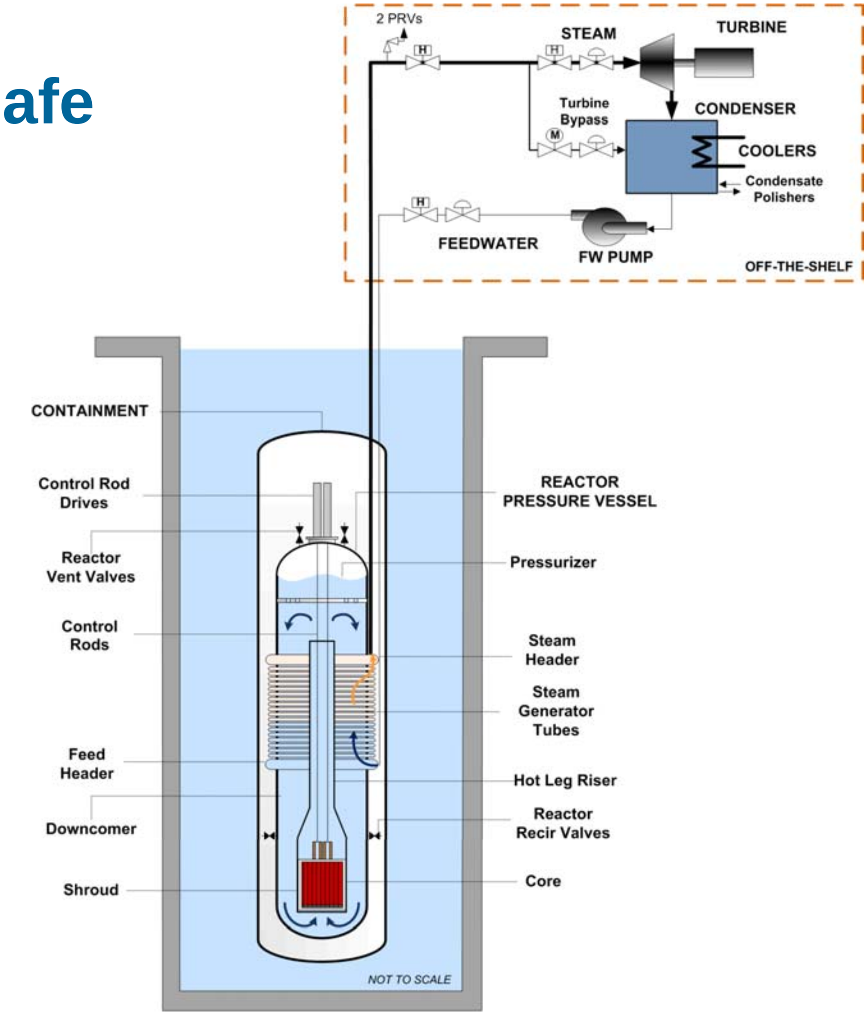
Prefabricated, Simple, and Safe

- Construction Simplicity
  - Major components prefabricated and shipped by rail, truck or barge
- Natural Circulation Cooling:
  - Inherently safe – Eliminates major accident scenarios
  - Improves economics – Eliminates pumps, pipes, valves
  - Simplifies and enhances safety case
- Proven Technology
  - CRDM and fuel rely on existing technology; no pump issues
- Below Ground
  - Enhances security and safety



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Nuclear Steam Supply System & Containment

- Integral Reactor System
  - Reactor Core
  - Helical Steam Generator
  - Pressurizer
- Small, High-Strength Containment
  - Replaceable Units
  - Ease of Inspection and Service
- Large Natural Heat Sink
  - Safety System Development

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Core & Fuel

- Approximately Half-Height
- 17x17 Lattice
- UO2 fuel pellets
- Clad Material – Zirc-4 or Advanced Clad
- Negative Reactivity Coefficients
- 24 Month Cycle Length at 95% capacity factor
- U235 Enrichment < 4.95 %
- Design Goals
  - Lower Power Density (45-65 kW/L)
  - Minimize Power Peaking
  - Maximum Node Relative Power Factor ≤ 2.0
  - Assembly Average Radial Peaking Factor ≤ 1.3

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Helical Coil Steam Generator

- Design
  - Compact
  - Superheated steam outlet conditions
  - Replaceable
  - Tube lengths and materials Inconel 690 are commercially available
- Benchmarks
  - Best Estimate tools
  - Full scale data from Ansaldo
  - OSU Integral System and separate effects tests
- Tube Inspection System

Extensive test experience on 25 MWt helical coil steam generator validating and informing NuScale design

AnsaldoEnergia
Una Società Finmeccanica

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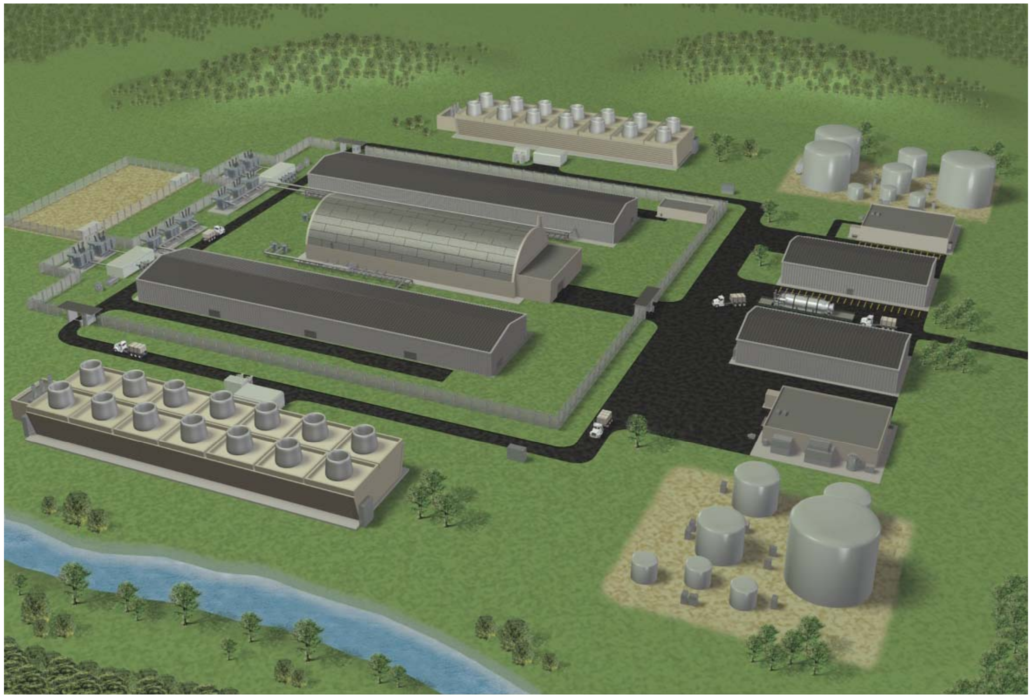
NuScale 12-Module Plant



- 540 MWe nominal power output
- Modernized Emergency Planning and Security Features
- Deigned to withstand aircraft impact
- Seismically robust
- In-line refueling reduces operating costs
- “Plug & Play” modular equipment and components
- Digital I&C

NuScale Power

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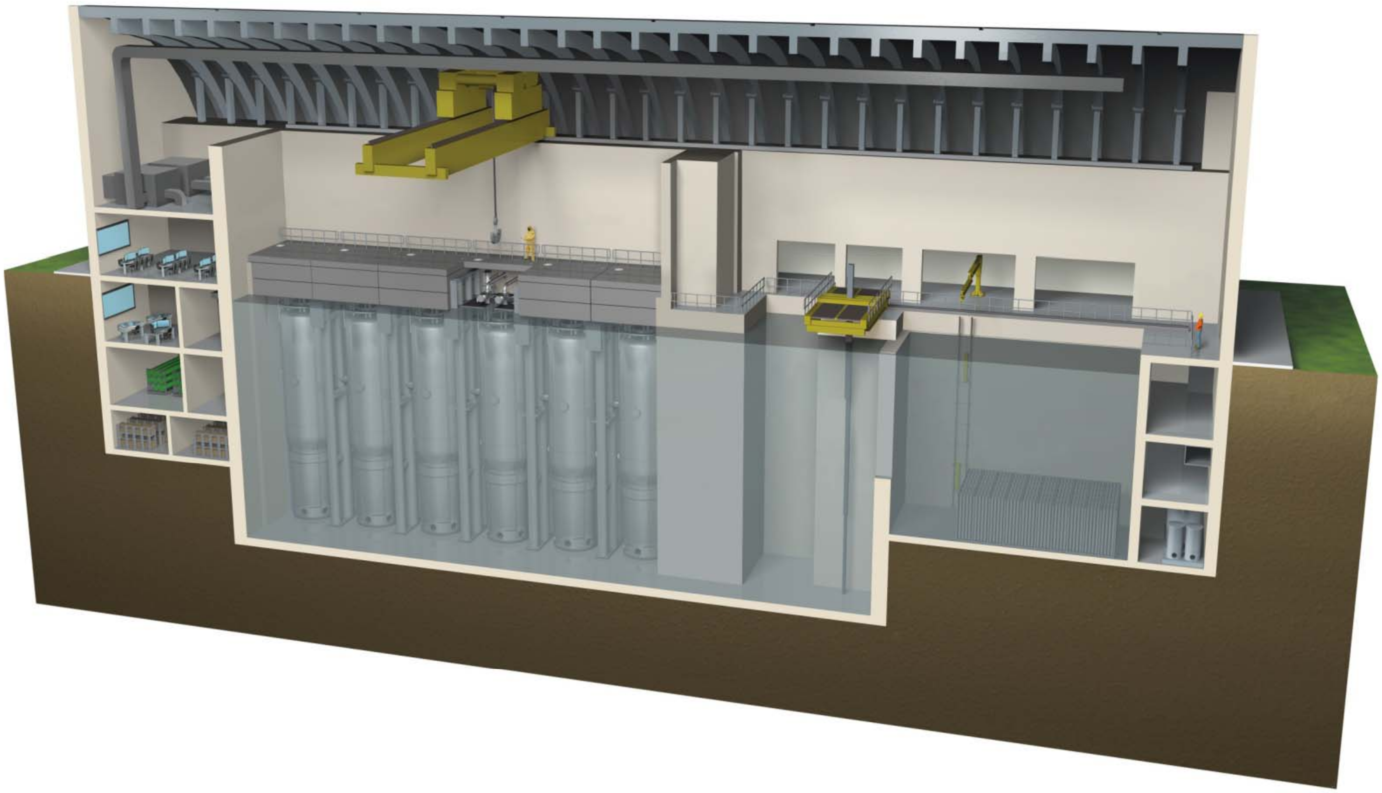
Cross-sectional view of 6 modules



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Basic Plant Parameters

Overall Plant	
• Net Electrical Output	540 MW(e)
• Plant Thermal Efficiency	30%
• Number of Power Generation Units	12
• Nominal Plant Capacity Factor	> 95%
Power Generation Unit	
• Number of Reactors	One
• Net Electrical Output	45 MW(e)
• Steam Generator Number	Two independent tube bundles
• Steam Generator Type	Vertical helical tube
• Steam Cycle	Superheated
• Turbine Throttle Conditions	~3.1 MPa (450 psia)
• Steam Flow	~70 kg/s (154 lbm/s)
• Feedwater Temperature	~150° C (302° F)
Reactor Core	
• Thermal Power Rating	160 MWt
• Operating Pressure	12.76 MPa (1850 psia)
▪ Fuel	UO_2 (< 4.95% enrichment)
▪ Refueling Intervals	24 months

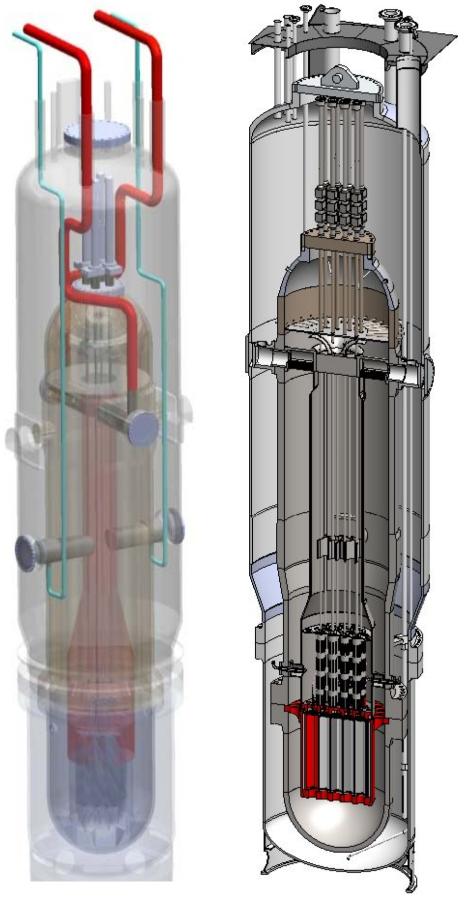
NuScale Power

Engineered Safety Features

ESF	Primary Function(s)
High Pressure Containment Vessel	Prevents release of fission products to environment and provides core decay heat removal.
Decay Heat Removal System (DHRS)	Provides core decay heat removal and emergency feedwater cooling via natural circulation through two independent helical coil steam generator tube bundles.
Containment Heat Removal System (CHRS)	Provides a means to rapidly reduce containment pressure and temperature during any LOCA. Maintains acceptably low pressure and temperature for extended periods of time.
Emergency Core Cooling System (ECCS) • Reactor Vent Valves (RVV) • Reactor Recirculation Valves (RRV) • CHRS	Provides core decay and containment heat removal by steam condensation, natural circulation and sump recirculation. Includes two RVVs on the reactor vessel head to vent steam, two RRVs at the reactor vessel midsection to provide coolant recirculation, and the containment cooling pool to serve as the emergency heat sink.

High Pressure Containment – Enhanced Safety

- Pressure Capability – can withstand worst case design basis accident with significant margin
- Insulating Vacuum
  - Significantly reduces convective heat transfer during normal operation
  - No insulation required on reactor vessel.
  - Improves steam condensation rates during a LOCA by eliminating air
  - Prevents combustible mixture in the unlikely event of a severe accident (i.e., little or no oxygen in containment)
  - Eliminates corrosion and humidity problems inside containment



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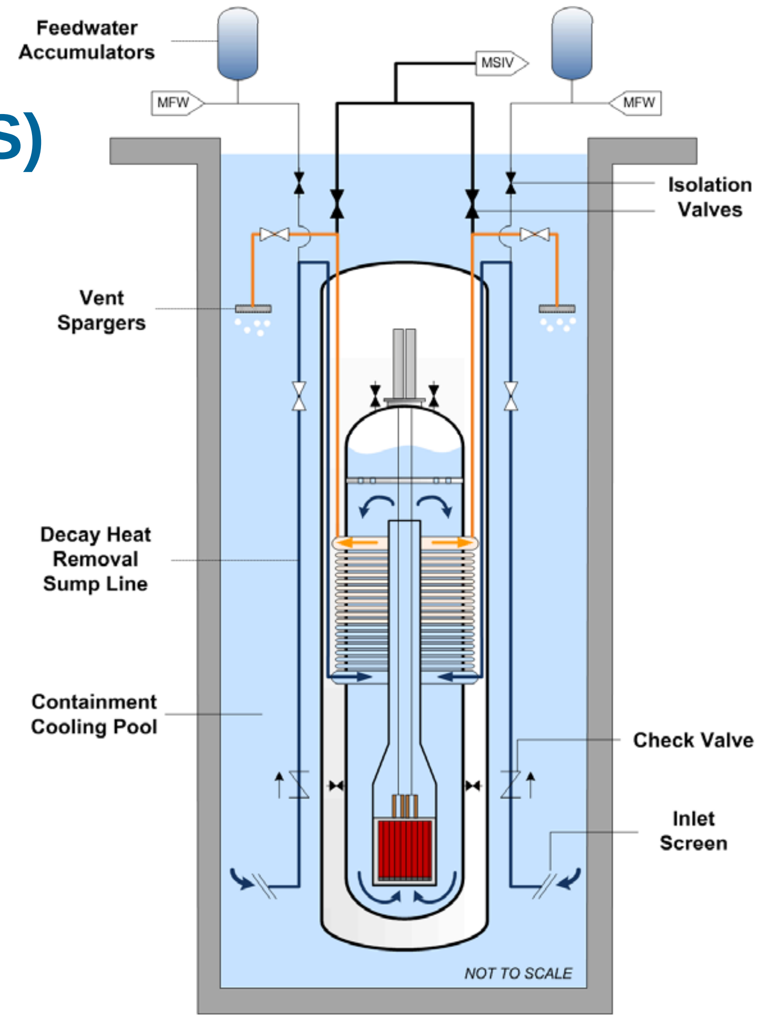
Decay Heat Removal Using Steam Generators (DHRS)

- Two independent trains of emergency feedwater to the steam generator tube bundles
- Water is drawn from the containment cooling pool.
- Steam is vented through spargers and condensed in the pool.
- Feedwater Accumulators provide initial feed flow while DHRS transitions to natural circulation flow.
- Pool provides a 3 day cooling supply for decay heat removal
- *Currently evaluating several design improvements*



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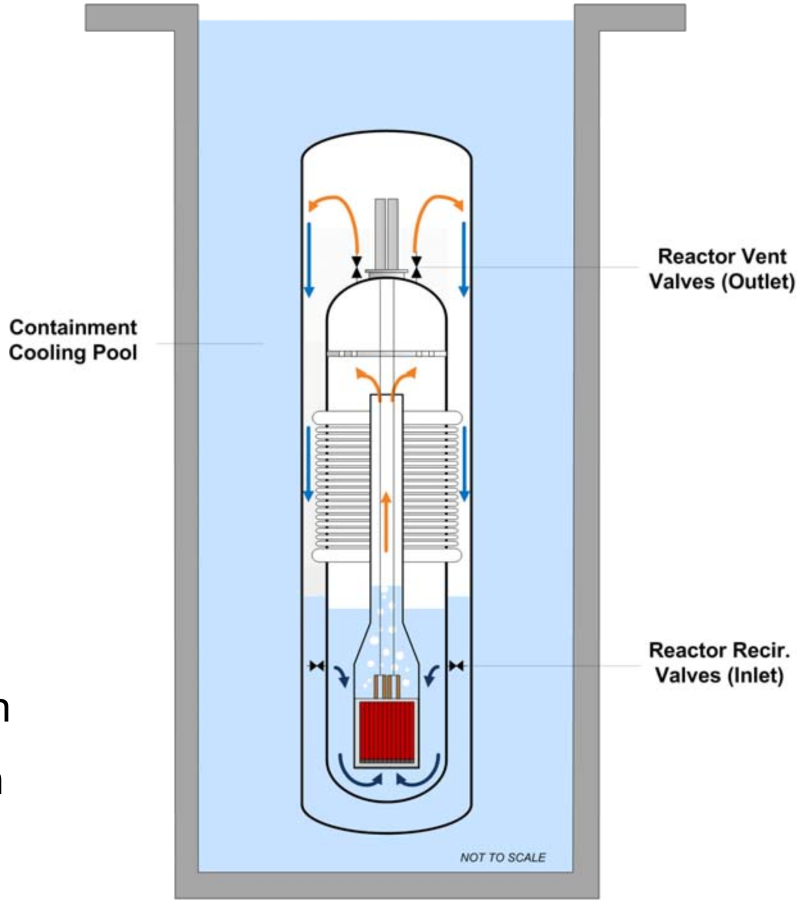
Emergency Core Cooling System (ECCS)

- Provides a means of removing core decay heat and limits containment pressure by:
  - Steam Condensation
  - Convective Heat Transfer
  - Heat Conduction
  - Passive, Buoyancy-Driven Recirculation
- Reactor vessel steam is vented through the RVVs
- Steam condenses on containment inner surface
- Condensate collects in lower containment region
- RRVs open to provide recirculation path through the core



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Safety case validated and design “informed” by PRA and independent PIRT panel reviews

- Level I Probabilistic Risk Assessment (PRA) indicates low overall Core Damage Frequency for Internal Events
- June 2008: Thermal Hydraulic and Neutronics PIRT Panel Review
  - Large-break Loss of Cooling Accident (LOCA) eliminated by design
  - Small Break Design Basis LOCA’s will not uncover the core, thus do not challenge plant safety
- Feb 2009: Severe Accident PIRT Panel Review
  - PRA is overly conservative with regard to events that lead to core damage

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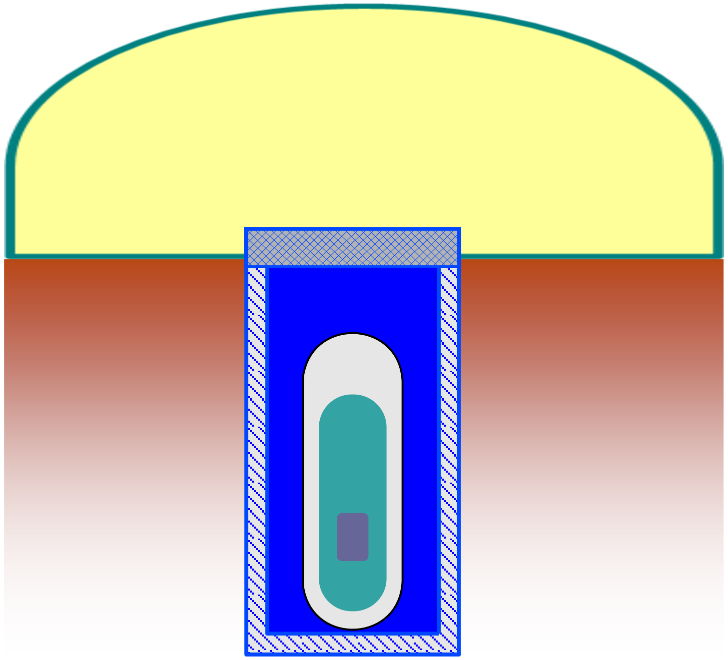
Additional Fission Product Barriers

- Fuel Pellet and Cladding
- Reactor Vessel
- Containment
- Containment Cooling Pool Water
- Containment Pool Structure
- Biological Shield
- Reactor Building



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Defense-in-Depth

Independence, Diversity, Redundancy, Security

- Robust and Passive Core and Containment Cooling Systems
- Natural Circulation Operation and Cooling
- Additional Fission Product Barriers
- Module Independence
- Active Non-Safety Backups for Passive Safety Systems

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