Design Overview

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NuScale Power™

Outline

- Technology and Safety Overview
- Applicability of Near-Term Task Force Fukushima recommendations

Description of NuScale Module

NSSS is Factory Built

- *Entire NSSS prefabricated and shipped by rail, truck or barge*

Natural Circulation Cooling

- *Inherently safe – Eliminates major accident scenarios*
- *Improves economics - Eliminates pumps, pipes, valves*

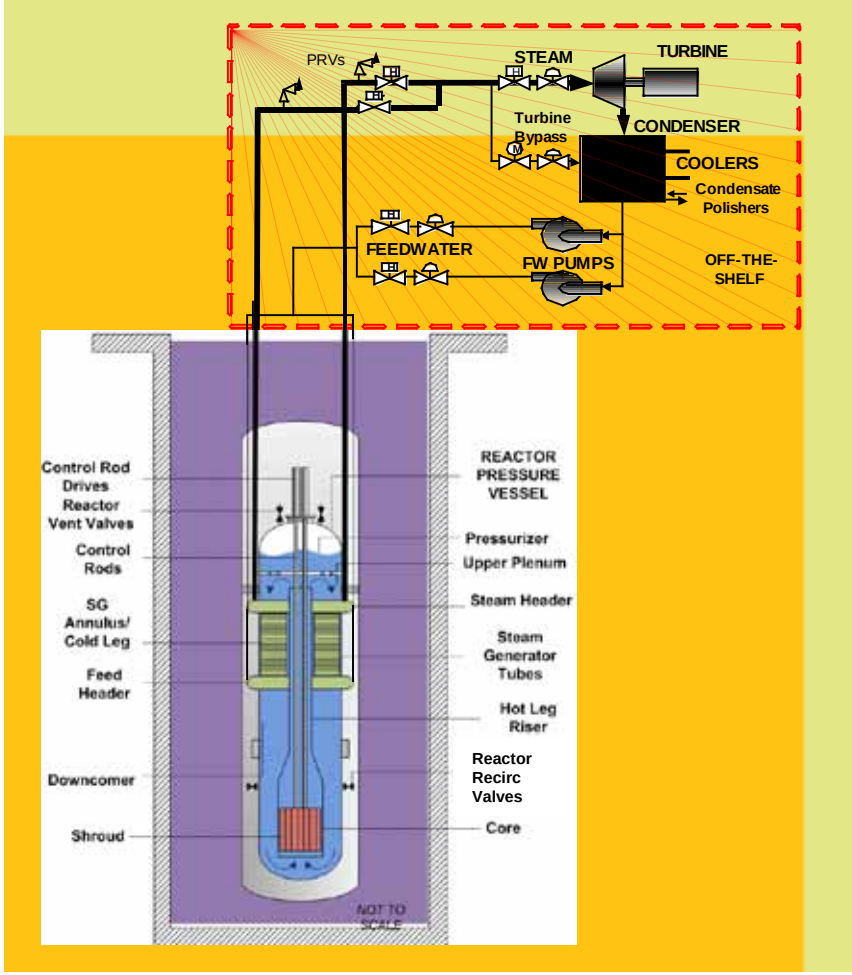
Large natural heat sink

- *Simplifies and enhances safety case*

Proven Technology

Below Ground

- *Enhances security and safety*

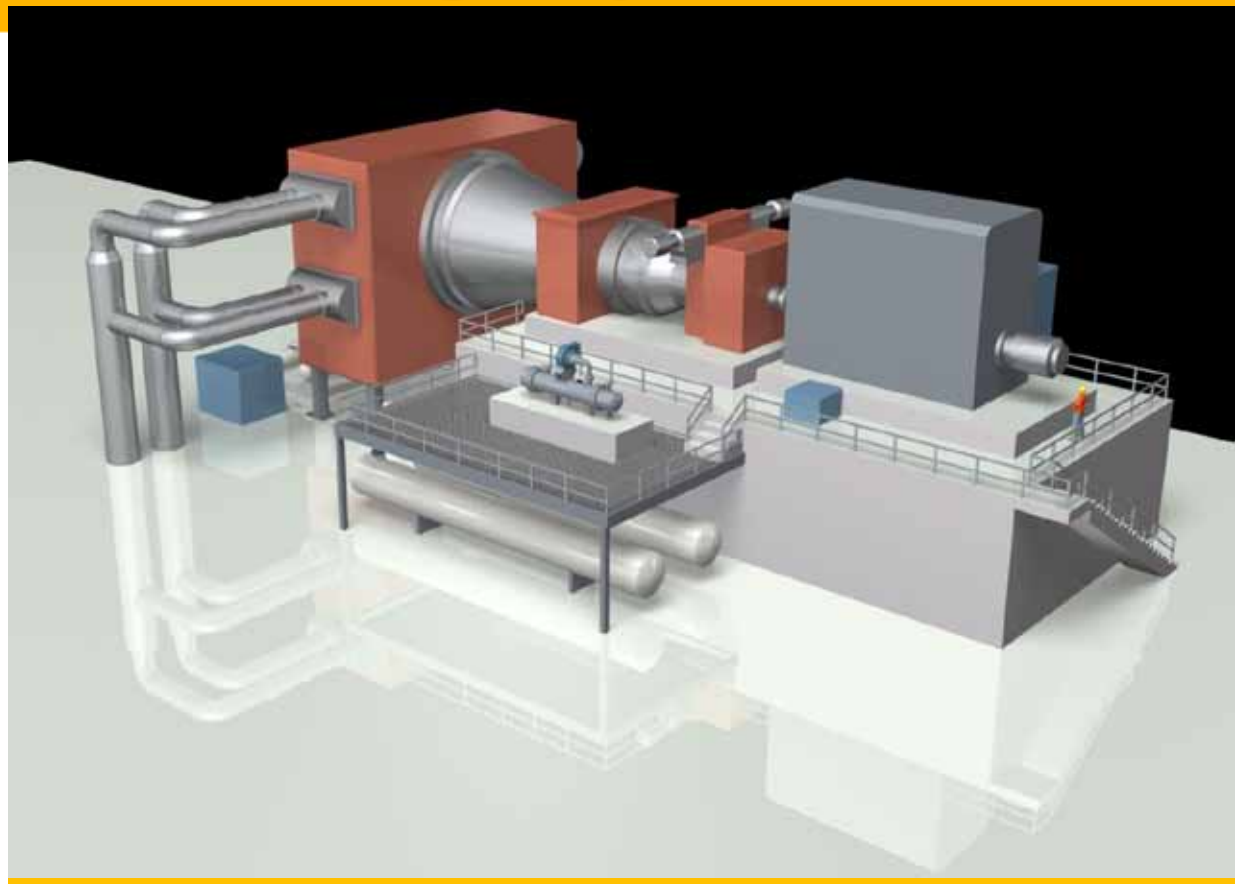


NuScale Technology

NSSS and Containment

Turbine Building Layout

- Skid mounted
- Easy to transport
- Controlled fabrication
- Fast onsite installation
- Off-the-shelf models currently available
- Direct coupling to steam turbine, allowing a much safer water- or air-cooled design

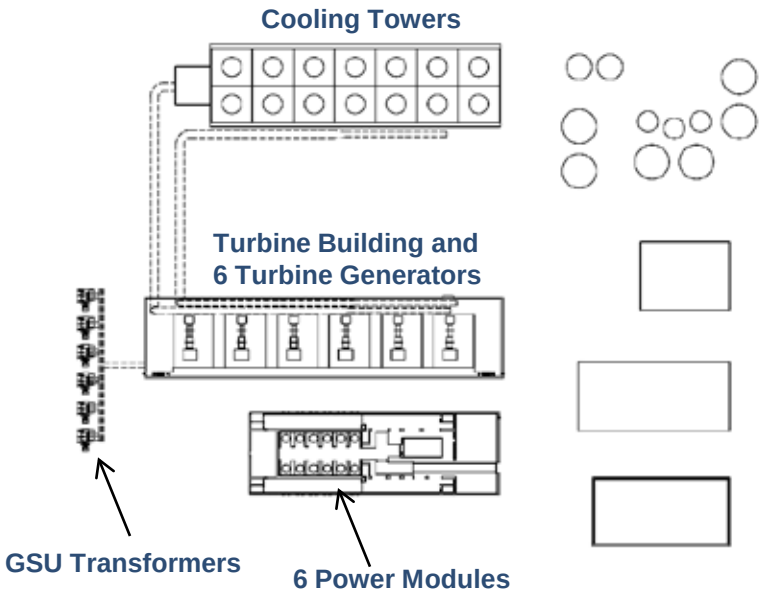


Modularity Permits Scaling to Any Size

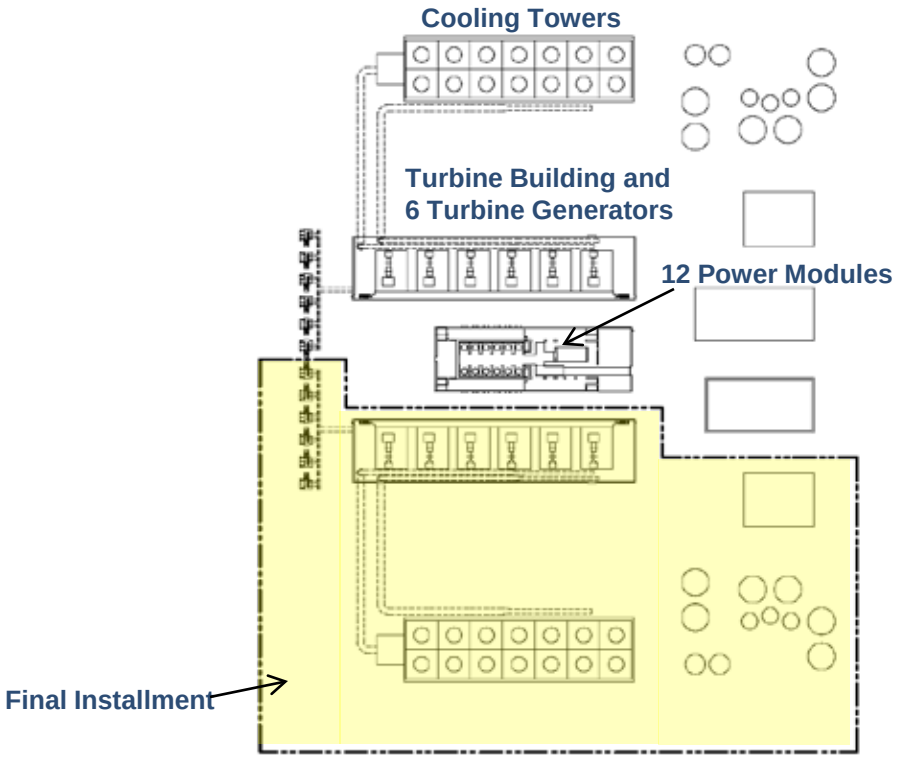
12 modules, 45 MWe each produces 540 MWe

Incremental Build Out Minimizes Risks: Matches Demand to Load Growth

Initial installment (270 MWe)



Final Installment (540 MWe)



NuScale Site Layout

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	> 90%
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	71.3 kg/s (565,723 lb/hr)
· Feedwater Temperature	149 ° C (300 ° F)
Reactor Core	
· Thermal Power Rating	160 MWt
· Operating Pressure	8.72 MPa (1850 psia)
§ Fuel	UO_2 (< 4.95% enrichment)
§ Refueling Intervals	24 months

Passively Safe Reactor Modules

Natural Convection for Cooling

- Inherently safe natural circulation of water over the fuel driven by gravity
- No pumps, no need for emergency generators

Seismically Robust

- System is submerged in a pool of water below ground in an earthquake resistant building
- Reactor pool attenuates ground motion and dissipates energy

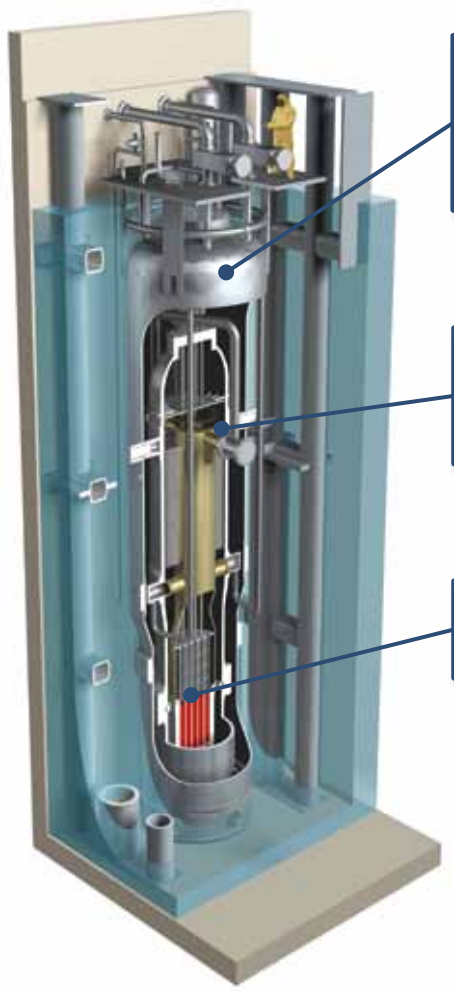
Simple and Small

- Reactor is 1/20th the size of large reactors
- 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

45 MWe Reactor Module



High-strength stainless steel containment ***10 times pressure*** of a typical PWR containment

Water volume to thermal power ratio is ***4 times larger resulting in better cooling***

Reactor core has ***only 5% of the fuel*** of a large reactor

Large Pool of Water Holds Reactor Modules

NuScale nuclear power reactors are housed inside ***high strength steel containment vessels*** and submerged in 4 million gallons of water below ground level inside the Reactor Building.

The Reactor Building is ***designed to withstand earthquakes, floods, tornados, hurricane force winds, and aircraft impacts.***

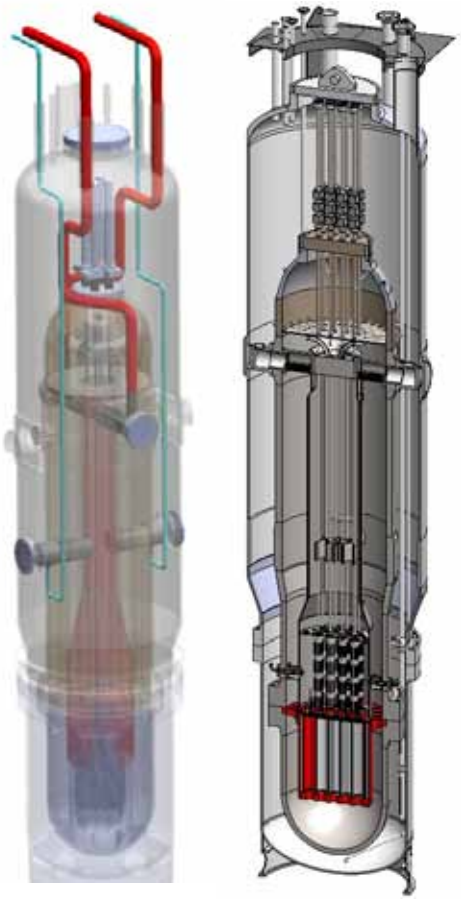
12-module, 540 MWe NuScale Plant

*Reactor and containment are submerged in underground steel-lined concrete pool with **30-day supply of cooling water**.*

*Any hydrogen released is trapped in containment vessel with **little to no oxygen available to create a combustible mixture**.*

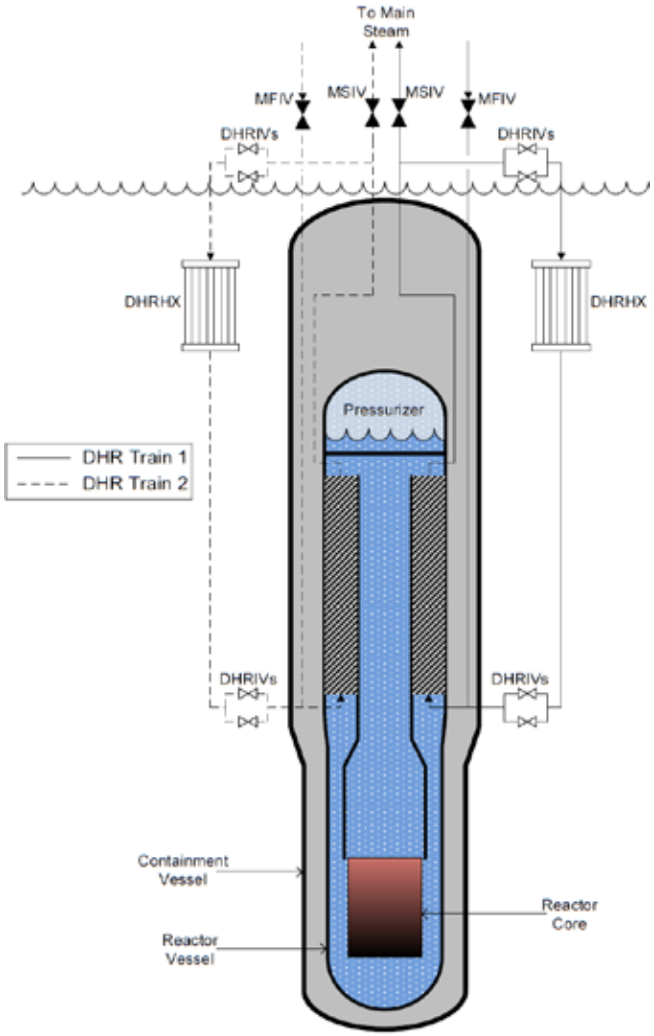
High Pressure Containment

- Pressure Capability - Equilibrium pressure between reactor and containment following any LOCA is always below containment design pressure
- Insulating Vacuum
  - Significantly reduces convection heat transfer during normal operation.
  - ELIMINATES SUMP SCREEN BLOCKAGE ISSUE (GSI-191). No insulation on reactor vessel.
  - Improves steam condensation rates during a LOCA by eliminating air.
  - Prevents combustible hydrogen mixture in the unlikely event of a severe accident (i.e., little or no oxygen).
  - Eliminates corrosion and humidity problems inside containment.



Decay Heat Removal Using Steam Generators

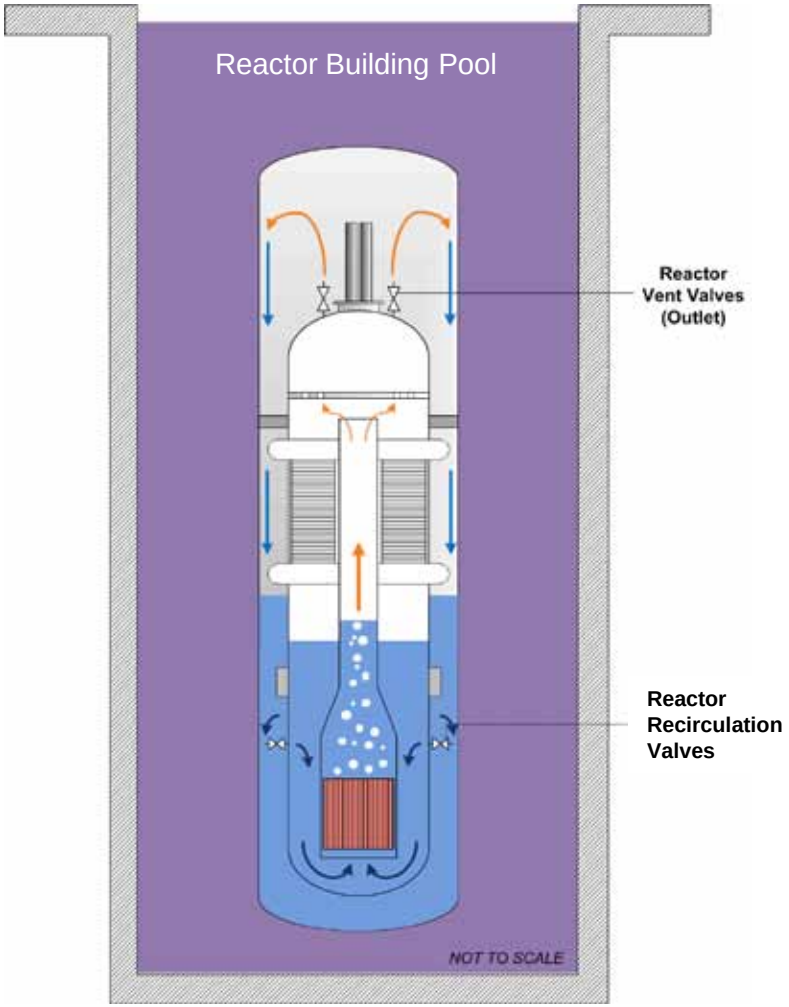
- Two independent single-failure-proof trains
- Closed loop system
- Two-phase natural circulation and condensation operation
- DHRS heat exchangers nominally full of water
- Primary coolant natural circulation is maintained
- Feedwater Accumulators provide built-in liquid reservoir for steam generator tubes.
- Pool provides a three day cooling supply for decay heat removal



NuScale Power™

Decay Heat Removal Using the Containment

- Provides a means of removing core decay heat and limits containment pressure by:
  - Steam Condensation
  - Convective Heat Transfer
  - Heat Conduction
  - Sump Recirculation
- Reactor Vessel steam is vented through the reactor vent valves (flow limiter).
- Steam condenses on containment.
- Condensate collects in lower containment region.
- Reactor Recirculation Valves open to provide recirculation path through the core.
- Provides +30 day cooling followed by indefinite period of air cooling.



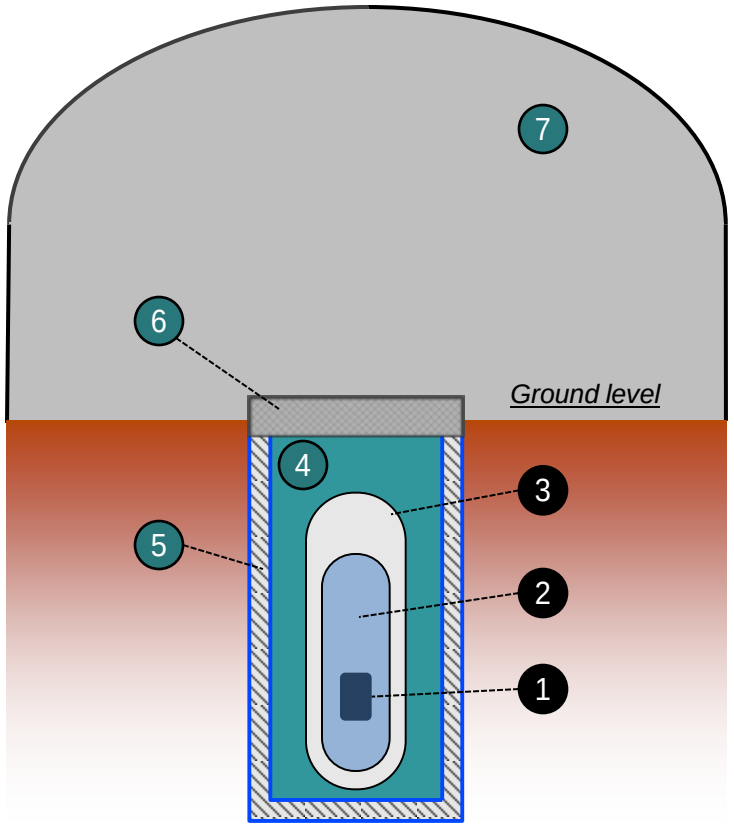
Added Barriers Between Fuel and Environment

Conventional Designs

1. Fuel Pellet and Cladding
2. Reactor Vessel
3. Containment

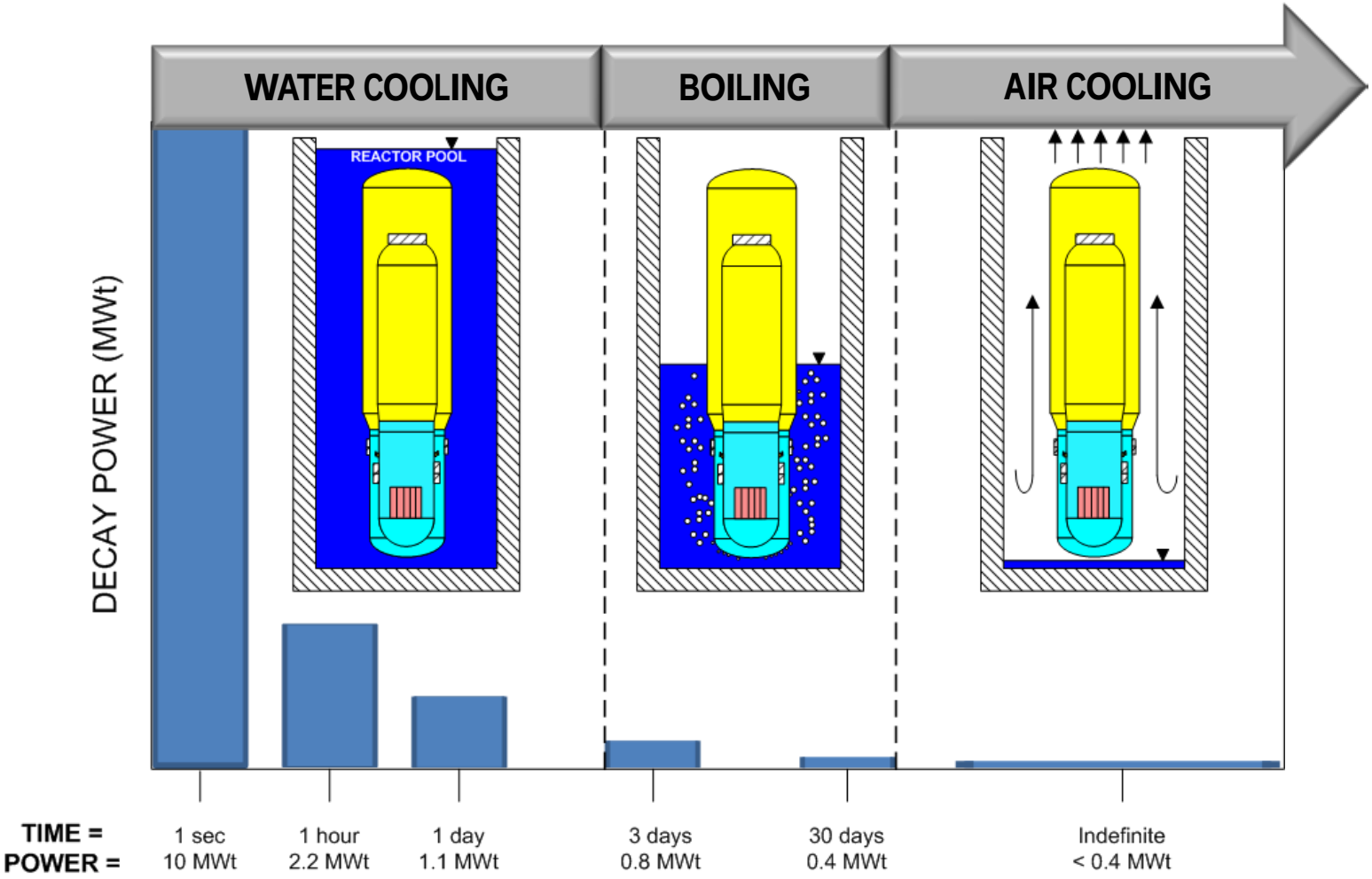
NuScale's Additional Barriers

4. Water in Reactor Pool (4 million gallons)
5. Stainless Steel Lined Concrete Reactor Pool
6. Biological Shield Covers Each Reactor
7. Reactor Building



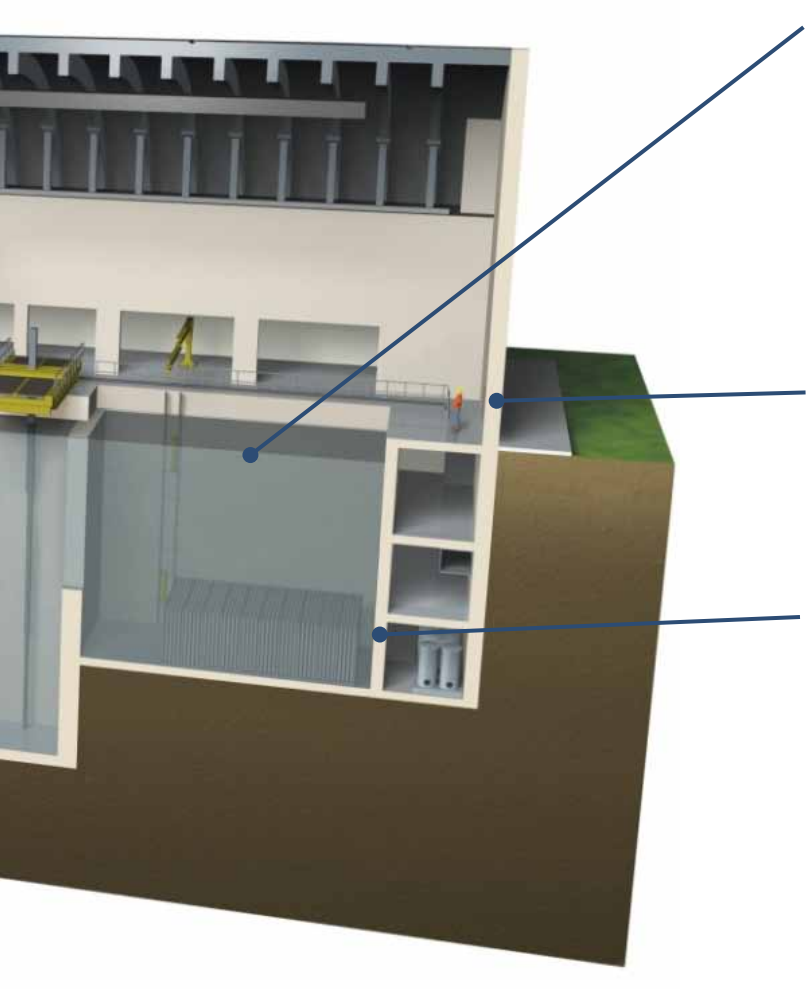
Stable Long Term Cooling

Reactor and Nuclear Fuel Cooled Indefinitely Without Pumps or Power



NuScale Power™

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.

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.***

Comparison of NuScale to Fukushima-Type Plant

Fukushima	NuScale Plant	NTTF
Reactor and Containment		
Safety Emergency Diesel Generators Required	Safety Emergency Diesel Generators Not Required	4
External Supply of Water Required	Containment immersed in 30 day supply of water	4
Coolant Supply Pumps Required	Not Required	4
Forced flow of water required for long term cooling	Long term (Beyond 30 days) cooling by natural convection to air	4
Spent Fuel Pool		
Water Cooling of Spent Fuel	Extended Cooling Capability *4 times the water of conventional spent fuel pools per MW power*	*7*
Elevated Spent Fuel Pool	Deeply Embedded Spent Fuel Pool	7
Limited Access to Back-up Supply of Water	Accessible Back-up Supplies of Water	7

Implications of Fukushima on NuScale

- No major impact to the NuScale design is currently anticipated.
  - The NuScale design fully addresses decay heat removal for prolonged station blackout.
- As a result of the Fukushima event, NuScale will
  - add long term air-cooling test to NuScale Integral System Test Matrix and SIET decay heat removal tests to demonstrate effectiveness of passive air-cooling with an empty reactor building pool.
  - review Spent Fuel Pool Cooling capability under air-cooled conditions.
  - examine role of “Island Mode” operation for multi-module plant.
  - confirm adequacy of existing seismic design basis for NuScale (0.5g ZPA) and ensure efforts are consistent with ongoing industry efforts.
  - review NRC recommendations when they become available and determine applicability to NuScale.