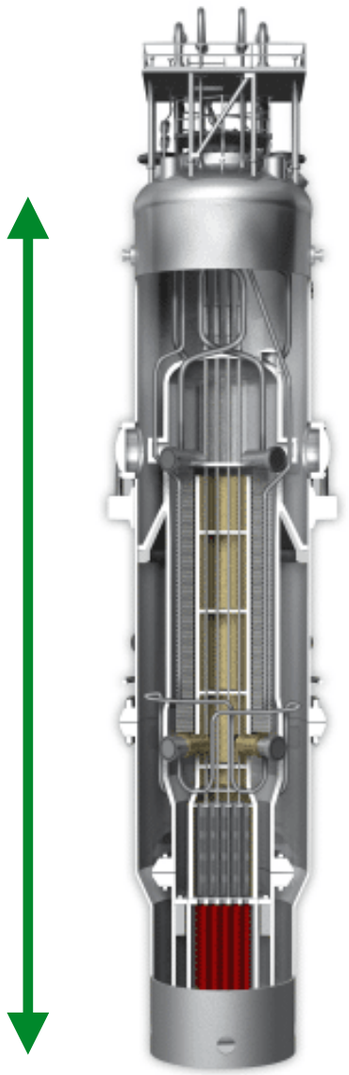
Integral PWRs



Nuscale

Steam generators, pumps, control rod drive mechanisms and pressuriser are located inside primary vessel

The height of the vessel is increased

- Reduces risk for LOCA - no large pipes that can rupture, fewer vessel penetrations.
- Passive full power/decay heat removal by natural convection
- Commercial operational experience: Otto Hahn
- Examples of commercial designs: NuScale, Westinghouse-SMR, Nuward, SMART, ACP-100

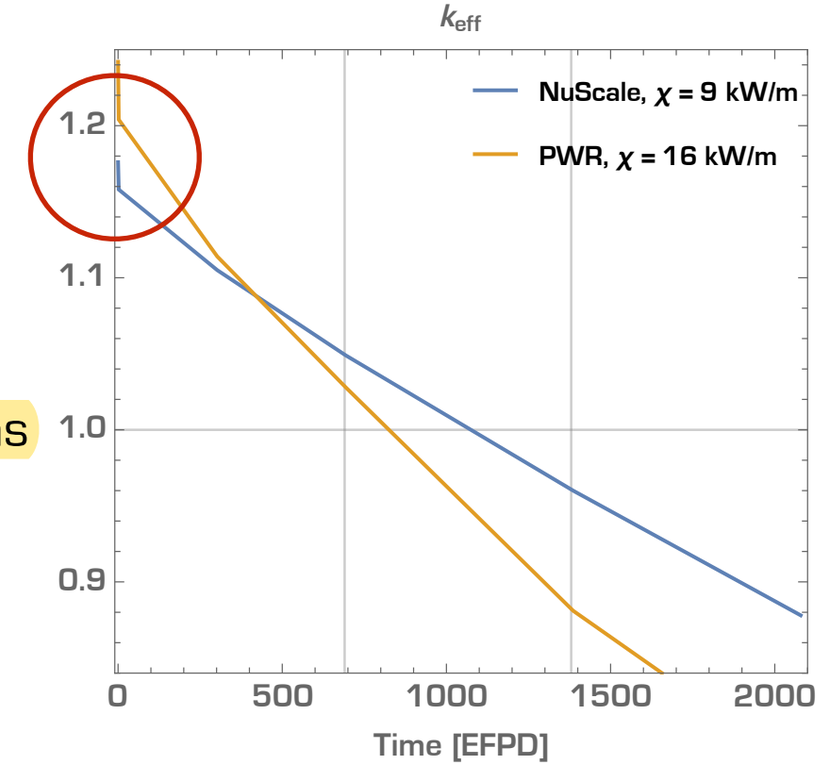
Fuel economy of integral PWRs

Fuel height is reduced to decrease pressure drop and increase natural convection.

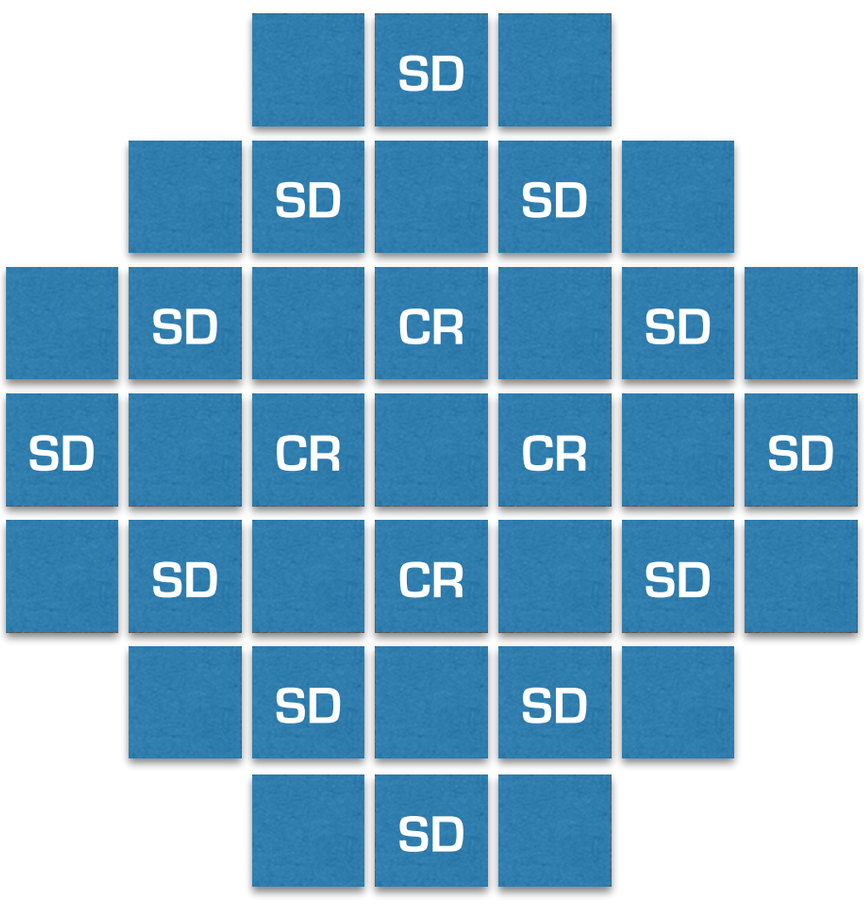
The number of fuel assemblies are reduced to achieve the desired power and improve transportability of the vessel.

NuScale: 37 PWR assemblies with 2.00 m height. Total 9.25 tons of fuel.

- Neutron leakage increases
- Reactivity decreases: lower burn-up
- Power density reduced to 10 kW/m
- Fuel cycle length increased to 24 months
- Total fuel residence time: 6 years
- Fuel average burn-up: 44 GWd/ton



iPWR core design: NuScale



NuScale core with 37 SA

Four types of fuel assemblies

1) SA without burnable absorber

2) SA with Gd_2O_3 absorber

3) SA with spider assembly control rods (CR)

4) SA with shut-down rods (SD)

Three axial enrichment zones

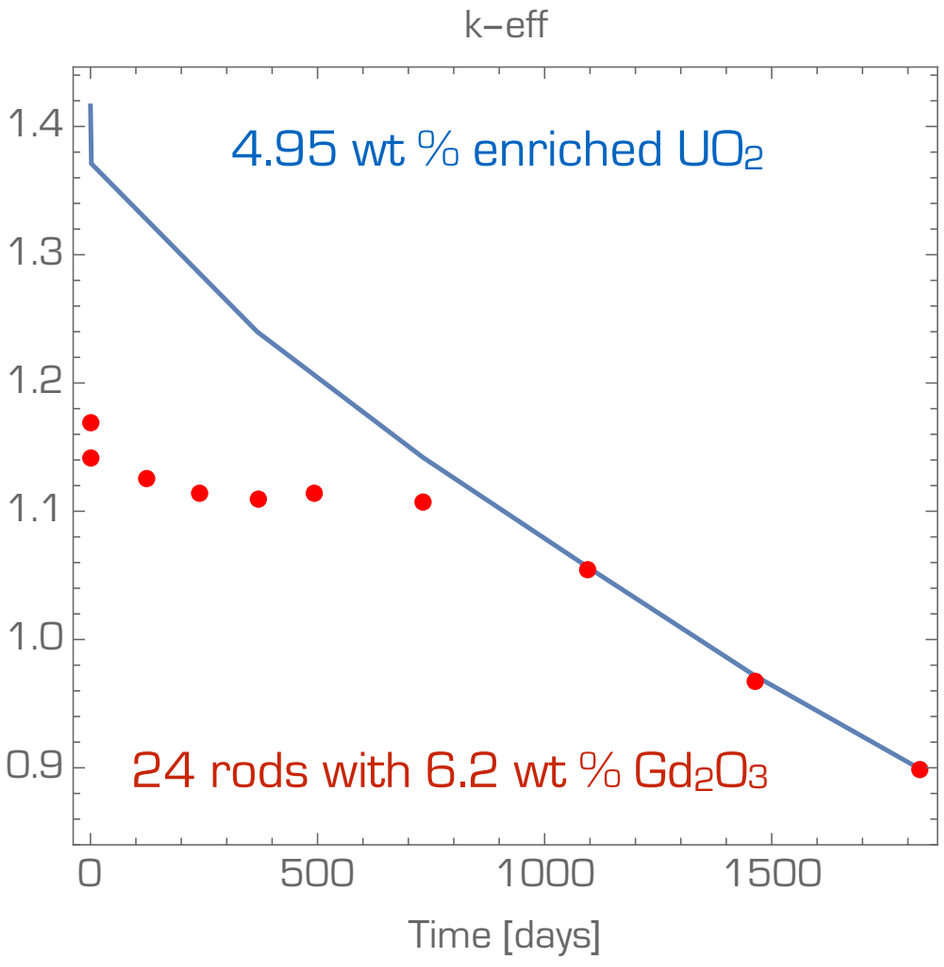
1) 1.87%

2) 4.05% (UO_2 assembly) / 4.55% (Gd_2O_3 poisoned assembly)

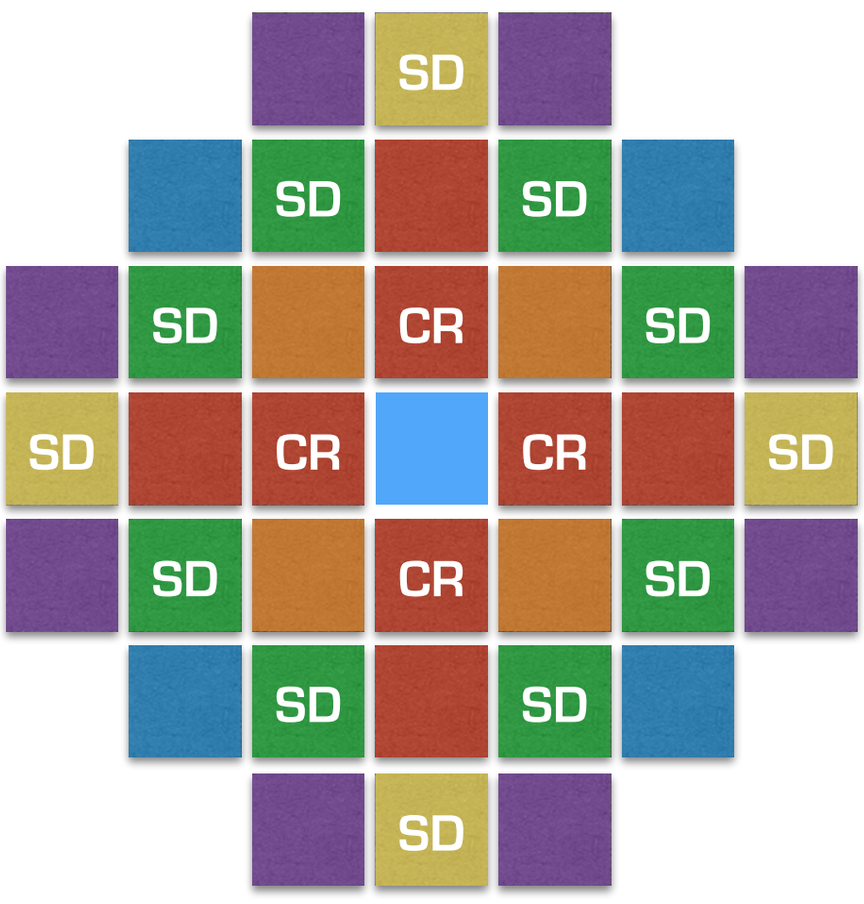
3) 1.87%

Burnable poisons

- Burnable poisons/absorbers are used in LWRs to reduce reactivity at Beginning of Cycle, thus permitting to increase overall enrichment for the same control rod worth.



NuScale fuel loading scheme



NuScale core with 37 SA

24 month reloading scheme

- 2.60% UO_2, fresh fuel
- 4.05% UO_2, fresh fuel
- 4.55% UO_2, Gd_2O_3 absorber, fresh fuel
- 4.05% UO_2, first reload
- 4.55% UO_2, Gd_2O_3 absorber, first reload
- 4.05% UO_2, second reload
- 4.55% UO_2, Gd_2O_3 absorber, second reload

NuScale design parameters

Item	Value
Thermal/electric power	200 MW_{th}/77 MW_e
Core inlet/outlet temperature	265/321 °C
Operating pressure	14 MPa
Primary system coolant flow rate	666 kg/s
No of fuel assemblies	37
Active fuel length	2.00 m
Rod length	2.16 m
Fuel mass	9250 kg UO_2
Fuel average/peak burn-up	44/62 MWd/kg
Refuelling cycle	24 months
Reactor vessel height/diameter	17.7/2.7 m
Containment vessel height/diameter	23.1/4.3 m

NuScale passive safety approach