Bare Reactor Critical Size and Geometric Buckling

Critical buckling and the critical radius, side or height of a bare sphere, cube or cylinder from k-infinity and the migration area, by modified one-group theory.

Method: Modified one-group diffusion theory for bare reactors

Input parameters

Unit system: SI

Parameter	Value	Unit
Core shape	Sphere	
Infinite multiplication factor	1.1200	
Migration area	300.00	cm²
Cylinder height-to-diameter ratio (0.924 gives the least volume)	1.0000	
Extrapolation distance (about 2.13 D)	0	cm

Calculated results

Parameter	Value	Unit
Critical buckling (per cm²)	4.0000e-04	
Critical radius (sphere, cylinder) or side (cube)	157.08	cm
Critical volume	16.235	m³
Non-leakage probability 1/(1 + M²B²)	89.286	%

Notes for this case

• Modified one-group diffusion: k∞/(1 + M²B²) = 1 with B² = π²/R̃² (sphere), 3π²/ã² (cube) or (2.405/R̃)² + (π/H̃)² (cylinder), R̃ = R + d. The H/D ratio is applied to the extrapolated dimensions. A reflector reduces the critical size.

Formula and method

$$B^2 = \frac{k_\infty - 1}{M^2}, \quad R_{sphere} = \frac{\pi}{B} - d, \quad B^2_{cyl} = \left(\frac{2.405}{\widetilde{R}}\right)^2 + \left(\frac{\pi}{\widetilde{H}}\right)^2$$

Variables

$\mathrm{geometry}$	Core shape	-
k_∞	Infinite multiplication factor	-
M^2	Migration area	m²
H/D	Cylinder height-to-diameter ratio (0.924 gives the least volume)	-
d	Extrapolation distance (about 2.13 D)	m
B^2	Critical buckling (per cm²)	-
R	Critical radius (sphere, cylinder) or side (cube)	m
H	Critical height (cylinder)	m
V	Critical volume	m³
P_{NL}	Non-leakage probability 1/(1 + M²B²)	-

Method and standards

Modified one-group critical equation.

Assumptions and limits

- Homogeneous bare core; one energy group.

References

Modified one-group diffusion theory for bare reactors

Report details

Report reference	FCC-F867-S15Y (the same inputs always give the same reference)
Generated	23 November 2026, 17:35 UTC
Calculator	Bare Reactor Critical Size and Geometric Buckling
Method last reviewed	17 November 2026
Software release	FireCAD Calc, release of 22 November 2026
Release checks	3 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/boilers-power-plant/nuclear-power/bare-reactor-critical-size

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.