Subcritical Multiplication and Approach to Criticality

Source multiplication, neutron count rate ratio and reactivity for two subcritical states, and the inverse multiplication used to approach criticality safely.

Method: Subcritical multiplication of a neutron source

Input parameters

Unit system: SI

Parameter	Value	Unit
Multiplication factor in state 1	0.95000	
Multiplication factor in state 2	0.98000	
Count rate in state 1 (counts per second)	120.00	Hz

Calculated results

Parameter	Value	Unit
Subcritical multiplication 1/(1 − k_1)	20.000	
Subcritical multiplication 1/(1 − k_2)	50.000	
Expected count rate in state 2	300.00	1/s
Inverse multiplication ratio (approaches 0 at criticality)	0.40000	
Reactivity in state 1 (pcm)	-5,263.2	
Reactivity in state 2 (pcm)	-2,040.8	

Notes for this case

• With an independent source, the neutron population is multiplied by M = 1/(1 − k); count rates scale with M. Plotting CR_1/CR against rod position or fuel loaded and extrapolating to zero predicts the critical point (1/M plot). Point-reactor model; detector position effects ignored.

Formula and method

$$M = \frac{1}{1-k}, \quad \frac{CR_2}{CR_1} = \frac{1-k_1}{1-k_2}$$

Variables

k_1	Multiplication factor in state 1	-
k_2	Multiplication factor in state 2	-
CR_1	Count rate in state 1 (counts per second)	1/s
M_1	Subcritical multiplication 1/(1 − k_1)	-
M_2	Subcritical multiplication 1/(1 − k_2)	-
CR_2	Expected count rate in state 2	1/s
CR_1/CR_2	Inverse multiplication ratio (approaches 0 at criticality)	-
ρ_1	Reactivity in state 1 (pcm)	-
ρ_2	Reactivity in state 2 (pcm)	-

Method and standards

Subcritical multiplication.

Assumptions and limits

- Point model; fixed source and detector efficiency.

References

Subcritical multiplication of a neutron source

Report details

Report reference	FCC-M6TQ-WB0V (the same inputs always give the same reference)
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Calculator	Subcritical Multiplication and Approach to Criticality
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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/subcritical-multiplication

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.