Six-Factor Formula: k-Infinity, k-Effective and Reactivity

Infinite and effective multiplication factors from the four factors and the fast and thermal non-leakage probabilities, with reactivity in pcm and in dollars.

Method: Four-factor and six-factor formulas of thermal reactor physics

Input parameters

Unit system: SI

Parameter	Value	Unit
Reproduction factor (neutrons per thermal absorption in fuel)	1.8400	
Fast fission factor	1.0300	
Resonance escape probability	80.000	%
Thermal utilisation factor	75.000	%
Fast non-leakage probability	97.000	%
Thermal non-leakage probability	99.000	%
Delayed neutron fraction (U-235 0.0065)	0.65000	%

Calculated results

Parameter	Value	Unit
Infinite multiplication factor	1.1371	
Effective multiplication factor	1.0920	
Reactivity (k − 1)/k	0.084229	
Reactivity (pcm)	8,422.9	
Reactivity in dollars	12.958	
Total non-leakage probability	96.030	%

Notes for this case

- k∞ = ηεpf and k_eff = k∞ P_FNL P_TNL; reactivity ρ = (k − 1)/k (1 pcm = 10^{-5}).
- Supercritical: the neutron population grows; a positive reactivity below β gives a delayed-neutron controlled rise.
- Reactivity at or above β: prompt critical.

Formula and method

$$k_\infty = \eta \varepsilon p f, \quad k_{eff} = k_\infty P_{FNL} P_{TNL}, \quad \rho = \frac{k_{eff} - 1}{k_{eff}}$$

Variables

η	Reproduction factor (neutrons per thermal absorption in fuel)	-
ε	Fast fission factor	-
p	Resonance escape probability	-
f	Thermal utilisation factor	-
P_{FNL}	Fast non-leakage probability	-
P_{TNL}	Thermal non-leakage probability	-
β	Delayed neutron fraction (U-235 0.0065)	-
k_∞	Infinite multiplication factor	-
k_{eff}	Effective multiplication factor	-
ρ	Reactivity (k − 1)/k	-

ρ_{pcm}	Reactivity (pcm)	-
ρ/β	Reactivity in dollars	-
P_{NL}	Total non-leakage probability	-

Method and standards

Six-factor formula.

Assumptions and limits

- Thermal reactors; factor values come from lattice data or calculations.

References

Four-factor and six-factor formulas of thermal reactor physics

Report details

Report reference	FCC-BS85-DBA0 (the same inputs always give the same reference)
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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/four-six-factor-formula

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.