Boron Dilution and Boration by Feed and Bleed

Time and water volume to dilute (or borate) the reactor coolant boron concentration by feed and bleed with perfect mixing, and the reactivity added.

Method: Well-mixed tank feed and bleed balance

Input parameters

Unit system: SI

Parameter	Value	Unit
Initial boron concentration (ppm)	1,200.0	
Target boron concentration (ppm)	1,100.0	
Coolant system volume	280.00	m³
Feed (and bleed) rate	20.000	m³/h
Boric acid feed concentration for boration (ppm)	7,000.0	
Boron worth (pcm per ppm, negative)	-9.0000	

Calculated results

Parameter	Value	Unit
Time to reach the target	73.090	min
Feed volume needed	24.363	m³
Reactivity change (pcm)	900.00	

Notes for this case

- Well-mixed volume with equal feed and bleed: dilution with pure water gives C = C₁e^(−Qt/V); boration with feed C_b gives C_b − C = (C_b − C₁)e^(−Qt/V). Mixing delays and density differences are ignored; inadvertent dilution is a design-basis event.

Formula and method

$$t = \frac{V}{Q}\ln\frac{C_1}{C_2}\ \text{(dilution)}, \quad t = \frac{V}{Q}\ln\frac{C_b - C_1}{C_b - C_2}\ \text{(boration)}$$

Variables

C_1	Initial boron concentration (ppm)	-
C_2	Target boron concentration (ppm)	-
V	Coolant system volume	m³
Q	Feed (and bleed) rate	m³/s
C_b	Boric acid feed concentration for boration (ppm)	-
α_B	Boron worth (pcm per ppm, negative)	-
t	Time to reach the target	s
V_f	Feed volume needed	m³
$\Delta\rho$	Reactivity change (pcm)	-

Method and standards

Feed and bleed.

Assumptions and limits

- Perfect mixing; equal feed and bleed rates.

References

Well-mixed tank feed and bleed balance

Report details

Report reference	FCC-W3X8-PEA5 (the same inputs always give the same reference)
Generated	23 November 2026, 17:35 UTC
Calculator	Boron Dilution and Boration by Feed and Bleed
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/boron-dilution-feed-and-bleed

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.