Fuel Rod Fission Gas Release and Plenum Pressure

Fission gas produced and released in a fuel rod over its life and the resulting rod internal pressure from the helium fill, free volume and gas temperature.

Method: Ideal-gas balance of fission gas release

Input parameters

Unit system: SI

Parameter	Value	Unit
Average linear heat rate	18.000	kW/m
Fuel stack length	3.6600	m
Time at power	1,500.0	d
Stable xenon plus krypton atoms per fission	0.25000	
Fraction of the gas released to the free volume	5.0000	%
Plenum and gap free volume	12.000	cm³
Helium fill pressure at 20 °C	2.0000	MPa
Gas temperature in operation	326.85	°C

Calculated results

Parameter	Value	Unit
Fissions in the rod	2.6645e+23	
Fission gas released (mol)	0.005531	
Helium fill (mol)	0.009847	
Helium pressure hot	4.0935	MPa
Rod internal pressure	6.3927	MPa

Notes for this case

• Ideal gas in a fixed free volume: fissions = q'Lt/200 MeV; released gas = y f N_f/N_A. Free volume shrinks with pellet swelling and clad creep-down, which raises the pressure further; design limits keep rod pressure below the coolant pressure.

Formula and method

$$N_f = \frac{\bar{q}' L t}{E_f}, \quad n_{fg} = \frac{y f N_f}{N_A}, \quad p = \frac{(n_{He} + n_{fg}) R T_g}{V}$$

Variables

$\bar{q}'$	Average linear heat rate	W/m
L	Fuel stack length	m
t	Time at power	s
y	Stable xenon plus krypton atoms per fission	-
f	Fraction of the gas released to the free volume	-
V	Plenum and gap free volume	m³
p_0	Helium fill pressure at 20 °C	Pa
T_g	Gas temperature in operation	K
N_f	Fissions in the rod	-
n_{fg}	Fission gas released (mol)	-
n_{He}	Helium fill (mol)	-

p_{He}	Helium pressure hot	Pa
p	Rod internal pressure	Pa

Method and standards

Rod gas inventory.

Assumptions and limits

- Ideal gas; constant free volume and power.

References

Ideal-gas balance of fission gas release

Report details

Report reference	FCC-5KNZ-F0SM (the same inputs always give the same reference)
Generated	23 November 2026, 17:35 UTC
Calculator	Fuel Rod Fission Gas Release and Plenum Pressure
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/fuel-rod-plenum-pressure

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.