Calorimetric (Secondary Heat Balance) Reactor Thermal Power

Reactor thermal power from a secondary heat balance of the steam generators: feedwater flow and temperature, steam pressure and moisture, blowdown, pump heat.

Method: Secondary-side calorimetric heat balance

Input parameters

Unit system: SI

Parameter	Value	Unit
Total feedwater flow	6,120,000	kg/h
Feedwater temperature	227.00	°C
Steam pressure at the generator outlet	6.9000	MPa
Steam quality (1 − moisture carry-over)	99.750	%
Blowdown flow	18,000	kg/h
Reactor coolant pump heat	16.000	MW
Primary heat losses and letdown corrections	2.0000	MW

Calculated results

Parameter	Value	Unit
Steam enthalpy	2,770.1	kJ/kg
Feedwater enthalpy	977.13	kJ/kg
Steam generator duty	3,040.5	MW
Reactor (core) thermal power	3,026.5	MW

Notes for this case

• Q_SG = (ṁ_fw − ṁ_bd)(h_s − h_fw) + ṁ_bd(h_f − h_fw); core power = Q_SG − pump heat + primary losses. Feedwater flow measurement is the largest uncertainty (venturi fouling, or ultrasonic correction). Water and steam properties from IAPWS-IF97.

Formula and method

$$\dot{Q}_{SG} = (\dot{m}_{fw} - \dot{m}_{bd})(h_s - h_{fw}) + \dot{m}_{bd}(h_f - h_{fw}), \quad \dot{Q}_{core} = \dot{Q}_{SG} - \dot{Q}_{pump} + \dot{Q}_{loss}$$

Variables

$\dot{m}_{fw}$	Total feedwater flow	kg/s
T_{fw}	Feedwater temperature	K
p_s	Steam pressure at the generator outlet	Pa
x	Steam quality (1 − moisture carry-over)	-
$\dot{m}_{bd}$	Blowdown flow	kg/s
$\dot{Q}_{pump}$	Reactor coolant pump heat	W
$\dot{Q}_{loss}$	Primary heat losses and letdown corrections	W
h_s	Steam enthalpy	J/kg
h_{fw}	Feedwater enthalpy	J/kg
$\dot{Q}_{SG}$	Steam generator duty	W
$\dot{Q}_{core}$	Reactor (core) thermal power	W

Method and standards

Secondary heat balance.

Assumptions and limits

- Steady state; all steam generators lumped.

References

Secondary-side calorimetric heat balance

Report details

Report reference	FCC-DCVC-YQWC (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/calorimetric-reactor-thermal-power

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Reopens the calculator with the inputs of this report.