Safety Valve Outlet Reaction Force (Momentum)

Reaction force at an open-discharge safety valve outlet from the relieving mass flow, the exit velocity, exit static pressure and the outlet area (momentum balance).

Method: Momentum balance F = ṁ v_e + (p_e − p_a) A_e (the same physics as published reaction-force methods; no code tables)

Input parameters

Unit system: SI

Parameter	Value	Unit
Relieving flow	30.000	t/h
Exit velocity	450.00	m/s
Exit static pressure (absolute)	4.0000	bar
Atmospheric pressure	1.0132	bar
Outlet bore	150.00	mm

Calculated results

Parameter	Value	Unit
Outlet area	0.017671	m²
Momentum term	3.7500	kN
Pressure term	5.2780	kN
Reaction force	9.0280	kN

Notes for this case

- Exit velocity and pressure come from the valve's choked-flow conditions; apply a dynamic load factor for supports.
- Continuity check: flow, velocity and bore imply an exit density of 1.05 kg/m³; it should match the steam at the exit pressure and temperature.

Formula and method

$$F = \dot{m} v_e + (p_e - p_a) A_e$$

Variables

$\dot{m}$	Relieving flow	kg/s
v_e	Exit velocity	m/s
p_e	Exit static pressure (absolute)	Pa
p_a	Atmospheric pressure	Pa
d_e	Outlet bore	m
A_e	Outlet area	m²
F_m	Momentum term	N
F_p	Pressure term	N
F	Reaction force	N

Method and standards

Steady momentum balance on a control volume around the open outlet: the reaction is the momentum flux of the jet plus the excess of exit static pressure over atmospheric acting on the outlet area. A note gives the exit density implied by continuity (ṁ = ρ v A) and flags it when it exceeds dry saturated steam at the exit pressure.

Assumptions and limits

- Steady discharge.
- Flow, velocity, exit pressure and bore are your inputs and are not solved together; check them against the valve's choked-flow data. Only the continuity note links them.

References

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Report details

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Release checks	2 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/boiler-pressure-parts/safety-valve-reaction-force

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.