Control Valve Actuator Thrust and Spring Check

Thrust to close a globe valve against shut-off pressure, packing friction and seat load, and the spring thrust a diaphragm actuator gives at bench set.

Method: Force balance on an unbalanced globe valve plug and a spring–diaphragm actuator (Lipták, Instrument Engineers' Handbook, 4th ed. (CRC Press), vol. 2, control valve actuators)

Input parameters

Unit system: SI

Parameter	Value	Unit
Shut-off pressure drop	10.000	bar
Seat (port) diameter	50.000	mm
Packing friction	400.00	N
Seat load per mm of seat circumference (N/mm)	20.000	
Effective diaphragm area	645.00	cm²
Bench-set pressure at the seating end	1.0000	bar

Calculated results

Parameter	Value	Unit
Unbalance (fluid) force	1,963.5	N
Seat load	3,141.6	N
Required thrust	5,505.1	N
Available spring thrust at seating	6,450.0	N
Thrust margin	1.1716	

Notes for this case

• Unbalanced single-seat plug, flow tending to open. Spring-to-close actuators seat with the spring force at the lower bench-set pressure. Seat load sets the leakage class: larger loads for tighter shut-off (take values from the valve maker). Stem area and flow-to-close effects are not modelled.

Formula and method

$$F_{req} = \Delta p_{so}\,\frac{\pi d_s^2}{4} + F_p + f_s \pi d_s, \quad F_{av} = p_b A_d$$

Variables

Δp_{so}	Shut-off pressure drop	Pa
d_s	Seat (port) diameter	m
F_p	Packing friction	N
f_s	Seat load per mm of seat circumference (N/mm)	-
A_d	Effective diaphragm area	m²
p_b	Bench-set pressure at the seating end	Pa
F_{unb}	Unbalance (fluid) force	N
F_{seat}	Seat load	N
F_{req}	Required thrust	N
F_{av}	Available spring thrust at seating	N
F_{av}/F_{req}	Thrust margin	-

Method and standards

Force balance.

Assumptions and limits

- The page warns when the thrust margin is below 1 (the actuator cannot seat the plug).
- Flow tending to open the plug is assumed; the stem area (which adds p_1 × stem area against closing) and flow-to-close arrangements (where the fluid helps closure but can slam the plug) are not modelled.
- Unbalanced plug; spring-to-close.

References

• Force balance on an unbalanced globe valve plug and a spring–diaphragm actuator (Lipták, Instrument Engineers' Handbook, 4th ed. (CRC Press), vol. 2, control valve actuators)

Report details

Report reference	FCC-52G1-EGHT (the same inputs always give the same reference)
Generated	17 November 2026, 19:34 UTC
Calculator	Control Valve Actuator Thrust and Spring Check
Method last reviewed	13 November 2026
Software release	FireCAD Calc, release of 17 November 2026
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/instrumentation/control-valves/valve-actuator-thrust

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.