Pipe Expansion Loop Leg Length (Guided Cantilever)

Thermal growth of a pipe run and the leg length of an expansion loop, L-bend or Z-bend needed to absorb it, by the guided cantilever method.

Method: Guided cantilever method (M.W. Kellogg, Design of Piping Systems)

Input parameters

Unit system: SI

Parameter	Value	Unit
Pipe outside diameter	168.30	mm
Straight run between anchors	60.000	m
Mean coefficient of thermal expansion	12.000	µm/(m·K)
Temperature change from installation	200.00	K
Modulus of elasticity	200.00	GPa
Allowed displacement stress range (your design value) Take it from the piping code you work to.	150.00	MPa

Calculated results

Parameter	Value	Unit
Thermal growth of the run	144.00	mm
Leg length to take all the growth (L-bend or Z-bend)	9.8459	m
Length of each of the two legs of a U-loop at mid-run	6.9621	m

Notes for this case

- Guided cantilever: a quick, usually conservative check that ignores bend flexibility and assumes the leg ends stay parallel. A flexibility analysis decides for critical lines.

Formula and method

$$\Delta = \alpha \, \Delta T \, L_r$$

$$L = \sqrt{\frac{3 E D_o \Delta}{S_A}}, \quad L_{loop} = \sqrt{\frac{3 E D_o (\Delta/2)}{S_A}}$$

Variables

D_o	Pipe outside diameter	m
L_r	Straight run between anchors	m
α	Mean coefficient of thermal expansion	1/K
ΔT	Temperature change from installation	K
E	Modulus of elasticity	Pa
S_A	Allowed displacement stress range (your design value)	Pa
Δ	Thermal growth of the run	m
L	Leg length to take all the growth (L-bend or Z-bend)	m
L_{loop}	Length of each of the two legs of a U-loop at mid-run	m

Method and standards

The guided cantilever method treats each leg perpendicular to the growth as a beam fixed against rotation at both ends; the bending stress for the imposed deflection must stay within the allowed displacement stress range.

Assumptions and limits

- Guided cantilever; bend flexibility ignored (conservative).

- Allowed stress range from your code.
- The U-loop result is the length of each leg only; the loop width (the run between the legs) and stress intensification at the bends are not considered.

References

- Guided cantilever method (M.W. Kellogg, Design of Piping Systems)

Report details

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Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/mechanical/piping/pipe-expansion-loop

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Reopens the calculator with the inputs of this report.