Cold Room Pull-Down Time

Time for a refrigeration plant to cool a room's product from a start to a target temperature against wall heat gain, and the lowest temperature the plant can hold.

Method: Lumped energy balance mc dT/dt = −Q_r + UA(T_a − T) (heat transfer definitions)

Input parameters

Unit system: SI

Parameter	Value	Unit
Product mass (plus equivalent of structure)	5,000.0	kg
Product specific heat (above freezing)	3.6000	kJ/(kg·K)
Refrigeration capacity	20.000	kW
Room heat gain coefficient	0.20000	kW/K
Ambient temperature	35.000	°C
Start temperature	30.000	°C
Target temperature	2.0000	°C

Calculated results

Parameter	Value	Unit
Lowest temperature the plant can hold	-65.000	°C
Time constant mc/UA	25.000	h
Pull-down time	8.7296	h

Notes for this case

• Lumped capacity with constant capacity and wall gain UA(t_a − t). Capacity actually falls as the room cools (lower suction pressure); use the capacity at the target temperature for a conservative answer. Sensible cooling only (no freezing).

Formula and method

$$t = \frac{mc}{UA} \ln \frac{Q_r - UA(t_a - t_0)}{Q_r - UA(t_a - t_1)}$$

Variables

m_p	Product mass (plus equivalent of structure)	kg
c_p	Product specific heat (above freezing)	J/(kg·K)
Q_r	Refrigeration capacity	W
UA	Room heat gain coefficient	W/K
t_a	Ambient temperature	K
t_0	Start temperature	K
t_1	Target temperature	K
t_{min}	Lowest temperature the plant can hold	K
$\mathcal{T}$	Time constant mc/UA	s
t	Pull-down time	s

Method and standards

Lumped transient balance.

Assumptions and limits

- Uniform product temperature.
- Constant refrigeration capacity: real capacity falls as the room cools, so the actual pull-down is slower; enter the capacity at the target temperature for a conservative time.

References

- Lumped energy balance mc dT/dt = −Q_r + UA(T_a − T) (heat transfer definitions)

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/hvac/refrigeration/cold-room-pull-down

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.