Calculation of the reduction factor

UNE EN ISO 13789

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Calculation of the reduction factor

1. CALCULATION METHOD

$$b = \frac{H_{ue}}{H_{iu} + H_{ue}}$$

where:

H_{iu} heat loss coefficient from the heated space to the unheated space

H_{ue} heat loss coefficient from the unheated space to the external environment

H_{iu}, H_{ue} includes the heat losses due to transmission and ventilation

$$H_{iu} = L_{iu} + H_{V,iu}$$

$$H_{ue} = L_{ue} + H_{V,ue}$$

Where:

$$L_{iu} = L_{Diu} + L_{siu}$$

$$L_{ue} = L_{Due} + L_{sue}$$

where:

$$L_D = \sum_i A_i U_i + \sum_k l_k \psi_k$$

Where:

A_i area of the element 'i' of the building (m²)

U_i thermal transmission coefficient of the element 'i' of the building

l_k length of the linear thermal bridge 'k' (m)

Ψ_k linear thermal transmission coefficient of the thermal bridge 'k'

L_s heat loss coefficient due to the floor in steady state, calculated in accordance with the UNE EN ISO 13370 code (W/K)

$$H_{V,iu} = \rho c \dot{V}_{iu}$$

$$H_{V,ue} = \rho c \dot{V}_{ue}$$

where:

ρ air density (kg/m³)

c specific heat capacity of the air (J/(kg·K))

ρc conventional value for the heat capacity of the air (1200 J/(m³·K))

V_{ue} air consumption between the unheated space and the external environment (m³/h)

V_{iu} air consumption between the heated and the unheated space (m³/h)

Where:

$$\dot{V}_{iu} = 0$$

$$\dot{V}_{ue} = V_u n_{ue}$$

where:

V_u air volume in the unheated space (m³)

n_{ue} air flow rate between the heated space and the external environment (v/h)

Calculation of the reduction factor

2. UNHEATED ROOMS

Space	Reduction factor
Z05_S01_Lift	0.26
Z05_S02_Risers	0.22
Z05_S03_Lift	0.20
Z05_S04_Risers	0.15
Z05_S05_Lift	0.20
Z05_S06_Risers	0.15
Z05_S07_Lift	0.32
Z05_S08_Risers	0.74
Z05_S09_Stairs	0.89
Z05_S10_Technical room	0.92

Calculation of the reduction factor

3. SPACE Z05_S01_LIFT

Calculation of the thermal coupling coefficient between the heated space and the unheated space (L_{iu})

Partitions in contact with unheated space or adjacent buildings	Area (m²)	U (W/(m²·K))	U·A (W/K)
Z05_S01_W02	10.44	0.39	4.07
Z05_S01_W01	5.17	0.39	2.01
		TOTAL	6.08

Thermal coupling coefficient between the heated space and the unheated space (L_{iu}) (W/K) | 6.08 |

Calculation of the thermal coupling coefficient between the unheated space and the external environment (L_{ue})

Paving in contact with the external environment of the unheated space	Area (m²)	U (W/(m²·K))	U·A (W/K)
Z05_S01_F01	2.35	0.29	0.69
		TOTAL	0.69

Thermal coupling coefficient between the unheated space and the external environment (L_{ue}) (W/K) | 0.69 |

Calculation of the heat loss due to transmission and ventilation between the heated space and the unheated space (H_{iu})

$H_{V,iu}$ | 0.00 |

+

L_{iu} | 6.08 |

=

Heat losses due to transmission and ventilation (H_{iu}) (W/K) | 6.08 |

Calculation of the heat losses due to transmission and ventilation between the unheated space and the external environment (H_{ue})

$H_{V,ue}$ (V_u = 8.71 m³; n_{ue} = 0.50v/h) | 1.45 |

+

L_{ue} | 0.69 |

=

Heat losses due to transmission and ventilation (H_{ue}) (W/K) | 2.14 |

Reduction factor
$$b = \frac{H_{ue}}{H_{iu} + H_{ue}} = 0.26$$

Calculation of the reduction factor

4. SPACE Z05_S02_RISERS

Calculation of the thermal coupling coefficient between the heated space and the unheated space (L_{iu})

Partitions in contact with unheated space or adjacent buildings	Area (m²)	U (W/(m²·K))	U·A (W/K)
Z05_S02_W01	8.21	0.39	3.20
Z05_S02_W02	1.96	0.39	0.76
		TOTAL	3.96

Thermal coupling coefficient between the heated space and the unheated space (L_{iu}) (W/K) | 3.96 |

Calculation of the thermal coupling coefficient between the unheated space and the external environment (L_{ue})

Paving in contact with the external environment of the unheated space	Area (m²)	U (W/(m²·K))	U·A (W/K)
Z05_S02_F01	1.41	0.29	0.41
		TOTAL	0.41

Linear thermal bridges between the unheated space and the external environment	Length (m)	Y (W/(m·K))	Y·l (W/K)
Z05_S02_TB01	3.403	-0.05	-0.17
		TOTAL	-0.17

Thermal coupling coefficient between the unheated space and the external environment (L_{ue}) (W/K) | 0.24 |

Calculation of the heat loss due to transmission and ventilation between the heated space and the unheated space (H_{iu})

$H_{V,iu}$ | 0.00 |

+

L_{iu} | 3.96 |

=

Heat losses due to transmission and ventilation (H_{iu}) (W/K) | 3.96 |

Calculation of the heat losses due to transmission and ventilation between the unheated space and the external environment (H_{ue})

$H_{V,ue}$ (V_u = 5.21 m³; n_{ue} = 0.50v/h) | 0.87 |

+

L_{ue} | 0.24 |

=

Heat losses due to transmission and ventilation (H_{ue}) (W/K) | 1.11 |

Calculation of the reduction factor

$$b = \frac{H_{ue}}{H_{iu} + H_{ue}} = 0.22$$

Reduction factor

5. SPACE Z05_S03_LIFT

Calculation of the thermal coupling coefficient between the heated space and the unheated space (L_{iu})

Partitions in contact with unheated space or adjacent buildings	Area (m²)	U (W/(m²·K))	U·A (W/K)
Z05_S03_W02	10.44	0.39	4.07
Z05_S03_W01	3.11	0.39	1.21
Z05_S03_W03	1.58	0.39	0.62
		TOTAL	5.90

Thermal coupling coefficient between the heated space and the unheated space (L_{iu}) (W/K) | 5.90

Calculation of the thermal coupling coefficient between the unheated space and the external environment (L_{ue})

Thermal coupling coefficient between the unheated space and the external environment (L_{ue}) (W/K) | 0.00

Calculation of the heat loss due to transmission and ventilation between the heated space and the unheated space (H_{iu})

$H_{V,iu}$ | 0.00

+

L_{iu} | 5.90

=

Heat losses due to transmission and ventilation (H_{iu}) (W/K) | 5.90

Calculation of the heat losses due to transmission and ventilation between the unheated space and the external environment (H_{ue})

$H_{V,ue}$ (V_u = 8.71 m³; n_{ue} = 0.50v/h) | 1.45

+

L_{ue} | 0.00

=

Heat losses due to transmission and ventilation (H_{ue}) (W/K) | 1.45

Reduction factor

$$b = \frac{H_{ue}}{H_{iu} + H_{ue}} = 0.20$$

6. SPACE Z05_S04_RISERS

Calculation of the thermal coupling coefficient between the heated space and the unheated space (L_{iu})

Partitions in contact with unheated space or adjacent buildings	Area (m²)	U (W/(m²·K))	U·A (W/K)
Z05_S04_W01	3.81	0.39	1.48
Z05_S04_W02	6.36	0.39	2.48
		TOTAL	3.96

Thermal coupling coefficient between the heated space and the unheated space (L_{iu}) (W/K) | 3.96 |

Calculation of the thermal coupling coefficient between the unheated space and the external environment (L_{ue})

Linear thermal bridges between the unheated space and the external environment	Length (m)	Y (W/(m·K))	Y·l (W/K)
Z05_S04_TB01	3.403	-0.05	-0.17
		TOTAL	-0.17

Thermal coupling coefficient between the unheated space and the external environment (L_{ue}) (W/K) | -0.17 |

Calculation of the heat loss due to transmission and ventilation between the heated space and the unheated space (H_{iu})

$H_{V,iu}$

| 0.00 |

+

L_{iu}

| 3.96 |

=

Heat losses due to transmission and ventilation (H_{iu}) (W/K)

| 3.96 |

Calculation of the heat losses due to transmission and ventilation between the unheated space and the external environment (H_{ue})

$H_{V,ue}$ (V_u = 5.21 m³; n_{ue} = 0.50v/h)

| 0.87 |

+

L_{ue}

| -0.17 |

=

Heat losses due to transmission and ventilation (H_{ue}) (W/K)

| 0.70 |

Reduction factor
$b = \dfrac{H_{ue}}{H_{iu} + H_{ue}}$ = 0.15

7. SPACE Z05_S05_LIFT

Calculation of the thermal coupling coefficient between the heated space and the unheated space (L_{iu})

Partitions in contact with unheated space or adjacent buildings	Area (m²)	U (W/(m²·K))	U·A (W/K)
Z05_S05_W02	10.44	0.39	4.07
Z05_S05_W01	3.06	0.39	1.19
Z05_S05_W03	1.58	0.39	0.62
		TOTAL	5.88

Thermal coupling coefficient between the heated space and the unheated space (L_{iu}) (W/K)   **5.88**

Calculation of the thermal coupling coefficient between the unheated space and the external environment (L_{ue})

Thermal coupling coefficient between the unheated space and the external environment (L_{ue}) (W/K)   **0.00**

Calculation of the heat loss due to transmission and ventilation between the heated space and the unheated space (H_{iu})

$H_{V,iu}$ 0.00

+

L_{iu} 5.88

=

Heat losses due to transmission and ventilation (H_{iu}) (W/K)   **5.88**

Calculation of the heat losses due to transmission and ventilation between the unheated space and the external environment (H_{ue})

$H_{V,ue}$ (V_u = 8.71 m³; n_{ue} = 0.50v/h)   1.45

+

L_{ue} 0.00

=

Heat losses due to transmission and ventilation (H_{ue}) (W/K)   **1.45**

Reduction factor

$$b = \frac{H_{ue}}{H_{iu} + H_{ue}} = 0.20$$

8. SPACE Z05_S06_RISERS

Calculation of the thermal coupling coefficient between the heated space and the unheated space (L_{iu})

Partitions in contact with unheated space or adjacent buildings	Area (m²)	U (W/(m²·K))	U·A (W/K)
Z05_S06_W01	3.78	0.39	1.47
Z05_S06_W02	6.25	0.39	2.43
		TOTAL	3.91

Thermal coupling coefficient between the heated space and the unheated space (L_{iu}) (W/K) | 3.91 |

Calculation of the thermal coupling coefficient between the unheated space and the external environment (L_{ue})

Linear thermal bridges between the unheated space and the external environment	Length (m)	Y (W/(m·K))	Y·l (W/K)
Z05_S06_TB01	3.403	-0.05	-0.17
		TOTAL	-0.17

Thermal coupling coefficient between the unheated space and the external environment (L_{ue}) (W/K) | -0.17 |

Calculation of the heat loss due to transmission and ventilation between the heated space and the unheated space (H_{iu})

$H_{V,iu}$ | 0.00 |

+

L_{iu} | 3.91 |

=

Heat losses due to transmission and ventilation (H_{iu}) (W/K) | 3.91 |

Calculation of the heat losses due to transmission and ventilation between the unheated space and the external environment (H_{ue})

$H_{V,ue}$ (V_u = 5.21 m³; n_{ue} = 0.50v/h) | 0.87 |

+

L_{ue} | -0.17 |

=

Heat losses due to transmission and ventilation (H_{ue}) (W/K) | 0.70 |

Reduction factor
$$b = \frac{H_{ue}}{H_{iu} + H_{ue}} = 0.15$$

Calculation of the reduction factor

9. SPACE Z05_S07_LIFT

Calculation of the thermal coupling coefficient between the heated space and the unheated space (L_{iu})

Partitions in contact with unheated space or adjacent buildings	Area (m²)	U (W/(m²·K))	U·A (W/K)
Z05_S07_W01	6.45	0.39	2.51
Z05_S07_W02	5.18	0.39	2.02
		TOTAL	4.53

Thermal coupling coefficient between the heated space and the unheated space (L_{iu}) (W/K) $\boxed{4.53}$

Calculation of the thermal coupling coefficient between the unheated space and the external environment (L_{ue})

Partitions in contact with the external environment of the unheated space	Area (m²)	U (W/(m²·K))	U·A (W/K)
Z05_S07_W03	2.80	0.28	0.79
		TOTAL	0.79

Thermal coupling coefficient between the unheated space and the external environment (L_{ue}) (W/K) $\boxed{0.79}$

Calculation of the heat loss due to transmission and ventilation between the heated space and the unheated space (H_{iu})

$H_{V,iu}$ | 0.00 |

+

L_{iu} | 4.53 |

=

Heat losses due to transmission and ventilation (H_{iu}) (W/K) | 4.53 |

Calculation of the heat losses due to transmission and ventilation between the unheated space and the external environment (H_{ue})

$H_{V,ue}$ (V_u = 7.78 m³; n_{ue} = 0.50v/h) | 1.30 |

+

L_{ue} | 0.79 |

=

Heat losses due to transmission and ventilation (H_{ue}) (W/K) | 2.09 |

Reduction factor

$$b = \frac{H_{ue}}{H_{iu} + H_{ue}} = 0.32$$

10. SPACE Z05_S08_RISERS

Calculation of the thermal coupling coefficient between the heated space and the unheated space (L_{iu})

Partitions in contact with unheated space or adjacent buildings	Area (m²)	U (W/(m²·K))	U·A (W/K)
Z05_S08_W02	2.93	0.39	1.14
		TOTAL	1.14

Thermal coupling coefficient between the heated space and the unheated space (L_{iu}) (W/K)   1.14

Calculation of the thermal coupling coefficient between the unheated space and the external environment (L_{ue})

Partitions in contact with the external environment of the unheated space	Area (m²)	U (W/(m²·K))	U·A (W/K)
Z05_S08_W01	5.29	0.28	1.50
Z05_S08_W03	3.19	0.28	0.90
		TOTAL	2.40

Thermal coupling coefficient between the unheated space and the external environment (L_{ue}) (W/K)   2.40

Calculation of the heat loss due to transmission and ventilation between the heated space and the unheated space (H_{iu})

$H_{V,iu}$

0.00

+

L_{iu}

1.14

=

Heat losses due to transmission and ventilation (H_{iu}) (W/K)

1.14

Calculation of the heat losses due to transmission and ventilation between the unheated space and the external environment (H_{ue})

$H_{V,ue}$ (V_u = 4.75 m³; n_{ue} = 0.50v/h)

0.79

+

L_{ue}

2.40

=

Heat losses due to transmission and ventilation (H_{ue}) (W/K)

3.19

Reduction factor
$$b = \frac{H_{ue}}{H_{iu} + H_{ue}} = 0.74$$

Calculation of the reduction factor

11. SPACE Z05_S09_STAIRS

Calculation of the thermal coupling coefficient between the heated space and the unheated space (L_{iu})

Paving over unheated space	Area (m²)	U (W/(m²·K))	U·A (W/K)
Z05_S09_F01	6.68	0.46	3.08
		TOTAL	3.08

Thermal coupling coefficient between the heated space and the unheated space (L_{iu}) (W/K)   3.08

Calculation of the thermal coupling coefficient between the unheated space and the external environment (L_{ue})

Partitions in contact with the external environment of the unheated space	Area (m²)	U (W/(m²·K))	U·A (W/K)
Z05_S09_W01	11.09	0.28	3.13
Z05_S09_W02	4.72	0.28	1.33
Z05_S09_W04	9.48	0.28	2.68
Z05_S09_W05	3.23	0.28	0.91
		TOTAL	8.06

Roofs of the unheated space in contact with the external environment	Area (m²)	U (W/(m²·K))	U·A (W/K)
Z05_S09_F02	9.54	0.24	2.31
		TOTAL	2.31

Openings of the unheated space in contact with the external environment	Area (m²)	U (W/(m²·K))	U·A (W/K)
Z05_S09_W04_G1	1.62	2.03	3.30
		TOTAL	3.30

Linear thermal bridges between the unheated space and the external environment	Length (m)	Y (W/(m·K))	Y·l (W/K)
Z05_S09_TB01	3.312	0.50	1.66
Z05_S09_TB02	1.000	0.05	0.05
Z05_S09_TB03	2.345	0.05	0.12
Z05_S09_TB04	2.345	0.05	0.12
Z05_S09_TB05	2.345	-0.05	-0.12
Z05_S09_TB06	2.345	-0.05	-0.12
Z05_S09_TB07	1.345	0.05	0.07
Z05_S09_TB08	2.011	0.50	1.01
Z05_S09_TB09	4.744	0.50	2.37
Z05_S09_TB10	4.790	0.50	2.40
Z05_S09_TB11	1.377	0.50	0.69
		TOTAL	8.23

Calculation of the reduction factor

Thermal coupling coefficient between the unheated space and the external environment (L_{ue}) (W/K) $\boxed{21.90}$

Calculation of the heat loss due to transmission and ventilation between the heated space and the unheated space (H_{iu})

$H_{V,iu}$

0.00

+

L_{iu}

3.08

=

Heat losses due to transmission and ventilation (H_{iu}) (W/K)

3.08

Calculation of the heat losses due to transmission and ventilation between the unheated space and the external environment (H_{ue})

$H_{V,ue}$ (V_u = 22.36 m³; n_{ue} = 0.50v/h)

3.73

+

L_{ue}

21.90

=

Heat losses due to transmission and ventilation (H_{ue}) (W/K)

25.62

$$\boxed{\begin{array}{c} \text{Reduction factor} \\ b = \dfrac{H_{ue}}{H_{iu} + H_{ue}} \; = \; 0.89 \end{array}}$$

12. SPACE Z05_S10_TECHNICAL ROOM

Calculation of the thermal coupling coefficient between the heated space and the unheated space (L_{iu})

Paving over unheated space	Area (m²)	U (W/(m²·K))	U·A (W/K)
Z05_S10_F02	5.50	0.46	2.53
		TOTAL	2.53

Thermal coupling coefficient between the heated space and the unheated space (L_{iu}) (W/K) $\boxed{2.53}$

Calculation of the reduction factor

Calculation of the thermal coupling coefficient between the unheated space and the external environment (L_{ue})

Partitions in contact with the external environment of the unheated space	Area (m²)	U (W/(m²·K))	U·A (W/K)
Z05_S10_W02	2.02	0.28	0.57
Z05_S10_W03	1.93	0.28	0.55
Z05_S10_W04	3.38	0.28	0.95
Z05_S10_W05	5.89	0.28	1.67
Z05_S10_W06	5.91	0.28	1.67
Z05_S10_W07	4.99	0.28	1.41
		TOTAL	6.82

Roofs of the unheated space in contact with the external environment	Area (m²)	U (W/(m²·K))	U·A (W/K)
Z05_S10_F03	9.46	0.24	2.29
		TOTAL	2.29

Openings of the unheated space in contact with the external environment	Area (m²)	U (W/(m²·K))	U·A (W/K)
Z05_S10_W05_G1	1.56	2.03	3.17
Z05_S10_W05_G2	1.62	2.03	3.30
		TOTAL	6.47

Linear thermal bridges between the unheated space and the external environment	Length (m)	Y (W/(m·K))	Y·l (W/K)
Z05_S10_TB01	0.825	0.50	0.41
Z05_S10_TB02	1.000	0.05	0.05
Z05_S10_TB03	2.345	-0.05	-0.12
Z05_S10_TB04	2.345	-0.05	-0.12
Z05_S10_TB05	2.345	0.05	0.12
Z05_S10_TB06	2.345	0.05	0.12
Z05_S10_TB07	2.345	0.05	0.12
Z05_S10_TB08	0.862	0.50	0.43
Z05_S10_TB09	0.984	0.50	0.49
Z05_S10_TB10	1.590	0.50	0.79
Z05_S10_TB11	3.872	0.50	1.94
Z05_S10_TB12	2.130	0.50	1.07
Z05_S10_TB13	2.521	0.50	1.26
		TOTAL	6.56

Thermal coupling coefficient between the unheated space and the external environment (L_{ue}) (W/K)　$\boxed{22.14}$

Calculation of the heat loss due to transmission and ventilation between the heated space and the unheated space (H_{iu})

Calculation of the reduction factor

$H_{V,iu}$

0.00

+

L_{iu}

2.53

=

Heat losses due to transmission and ventilation (H_{iu}) (W/K)

2.53

Calculation of the heat losses due to transmission and ventilation between the unheated space and the external environment (H_{ue})

$H_{V,ue}$ (V_u = 22.18 m³; n_{ue} = 1.00v/h)

7.39

+

L_{ue}

22.14

=

Heat losses due to transmission and ventilation (H_{ue}) (W/K)

29.53

Reduction factor
$b = \dfrac{H_{ue}}{H_{iu} + H_{ue}}$ = 0.92