

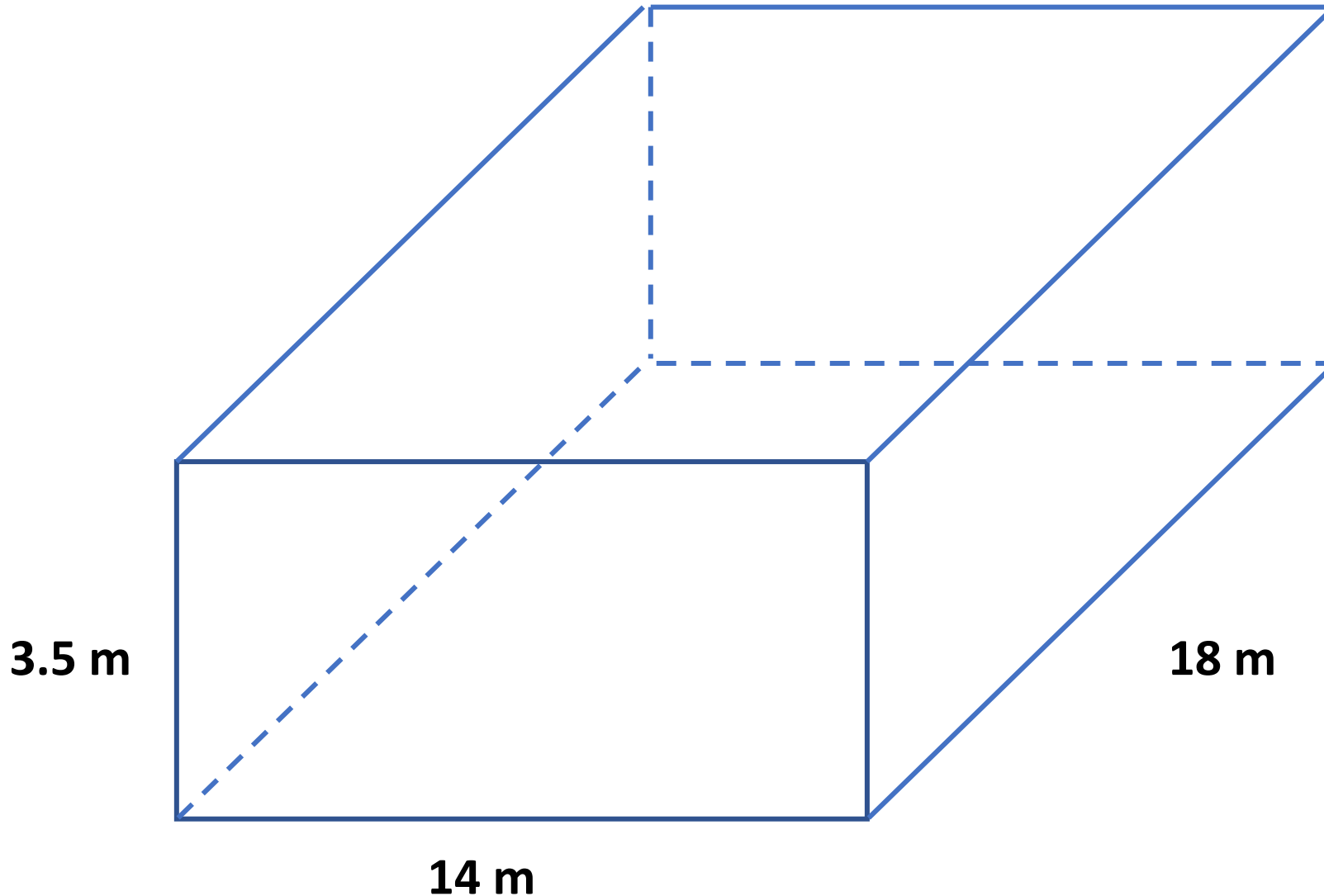
Sizing of an air terminal device

Room: $A_f = 14 \times 18 = 252 \text{ m}^2$

$V = 14 \times 18 \times 3.5 = 882 \text{ m}^3$

Occupants: 60 persons

Ventilation rate: 10 l/(s px)



$$\dot{V} = 10 \times 60 = 600 \text{ l/s}$$

$$\dot{V} = 600 \times 3.6 = 2160 \text{ m}^3/\text{h}$$

$$n = 2160 / 882 = 2.45 \text{ h}^{-1}$$

Let us consider the following peak power:

$$P_{\text{heat,sp}} = 10 \text{ W/m}^3 \longrightarrow P_{\text{heat}} = 10 \times 882 \cong 9 \text{ kW}$$

$$P_{\text{cool,sp}} = 50 \text{ W/m}^2 \longrightarrow P_{\text{cool}} = 50 \times 252 \cong 13 \text{ kW}$$

$$\Delta t_{\text{heat}} = \frac{P_{\text{heat}}}{\dot{m} c_p} = \frac{9000 \times 3600}{2160 \times 1.2 \times 1007} = 12.4^\circ\text{C} \longrightarrow t_{\text{imm,heat}} = 32.5^\circ\text{C}$$

$$\Delta t_{\text{cool}} = \frac{P_{\text{cool}}}{\dot{m} c_p} = \frac{13000 \times 3600}{2160 \times 1.2 \times 1007} = 17.9^\circ\text{C} \longrightarrow t_{\text{imm,cool}} \text{ too low}$$

There are 2 options 

- Increase ventilation rate (recirculation)
- Decrease P_{cool}

Let us increase the ventilation rate. Let us fix $\Delta t_{\text{cool}} = 10^\circ\text{C}$

$$\dot{m} = \frac{P_{\text{cool}}}{\Delta t_{\text{cool}} c_p} = \frac{13000}{10 \times 1007} = 1.29 \text{ kg/s} =$$

$$\dot{V} = \frac{1.29 \times 3600}{1.2} = 3870 \text{ m}^3/\text{h}$$

$$n = \frac{3870}{882} = 4.4 \text{ 1/h}$$

$$\dot{V}_{\text{recirculation}} = 3870 - 2160 = 1710 \text{ m}^3/\text{h}$$

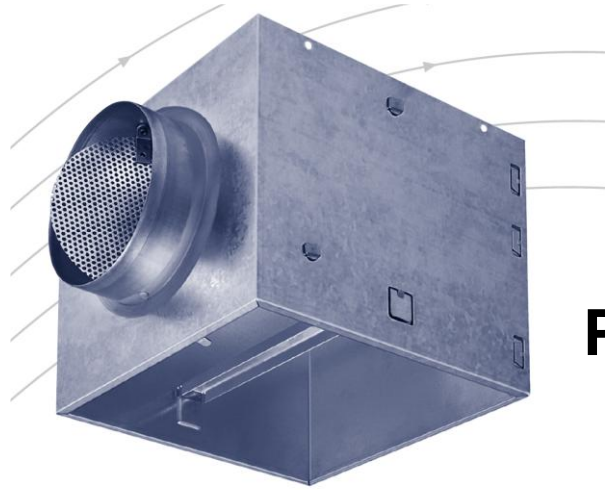
Case 1: Ceiling air distribution

There are different possible choices:

- 390 m³/h → 3870/390 = 10 air inlets
- 645 m³/h → 3870/645 = 6 air inlets
- 970 m³/h → 3870/970 = 4 air inlets

Let us consider an air inlet of 645 m³/h → 6 air inlets

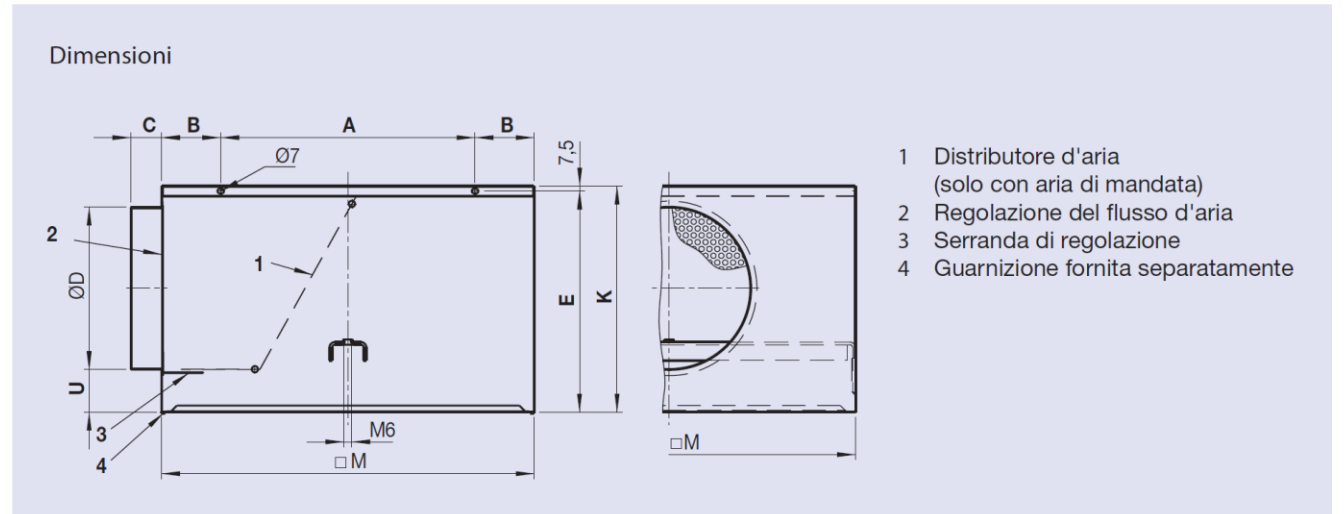
Sketch of the system



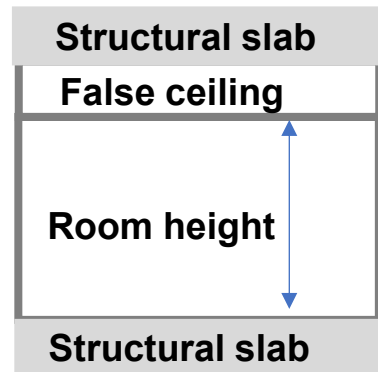
Plenum



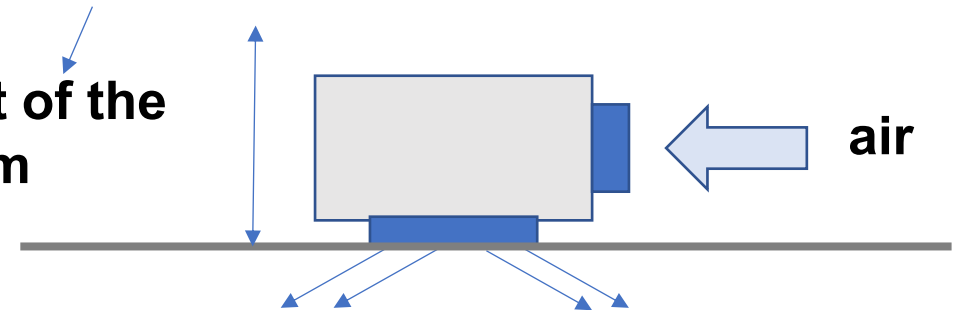
**Terminal
(air vent)**

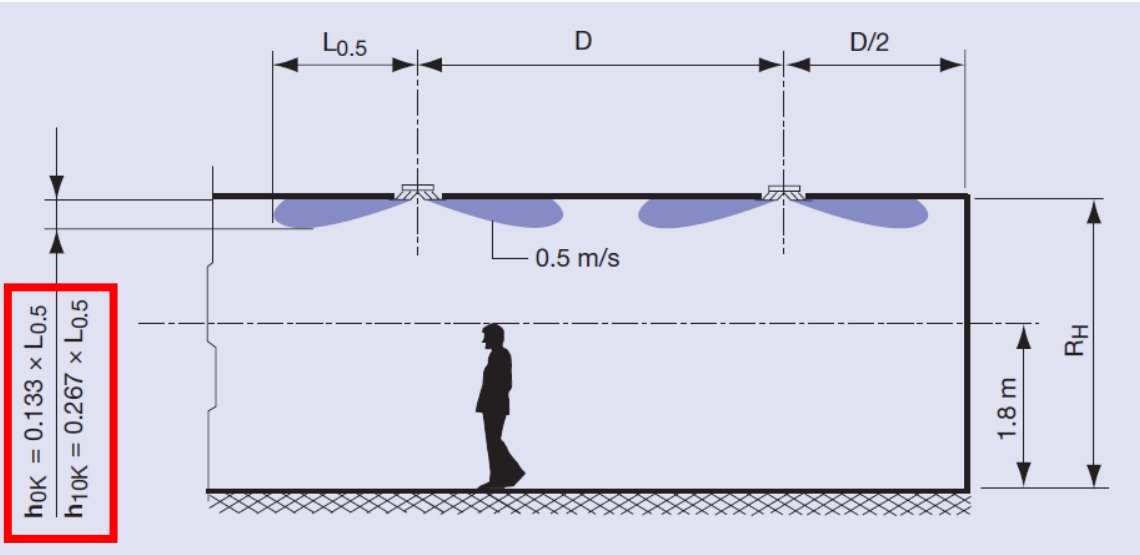


ND	M [mm]	K [mm]	E (K-7.5) [mm]	ØD [mm]	U [mm]	A [mm]	B [mm]	C [mm]	Weight [kg]
AKH08	216	250	242.5	158	60	116	50	~50	~2.5
AKH09	266	250	242.5	158	60	166	50	~50	~2.8
AKH01	290	250	242.5	158	60	190	50	~50	~3.5
AKH02	372	295	287.5	198	65	272	50	~50	~4.5
AKH03	476	295	287.5	198	65	296	90	~50	~6.0
AKH04	567	345	337.5	248	75	387	90	~48	~8.1



**Height of the
plenum**

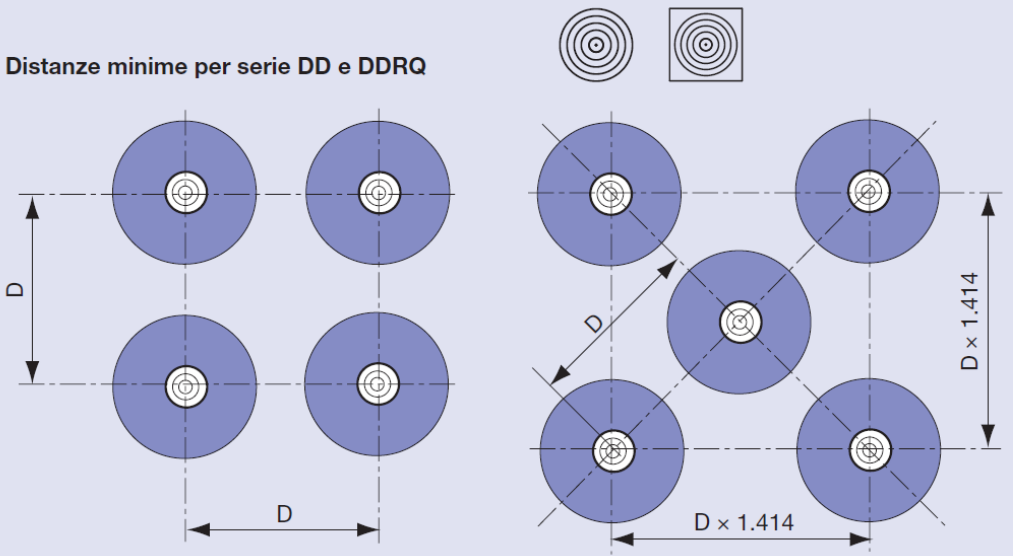


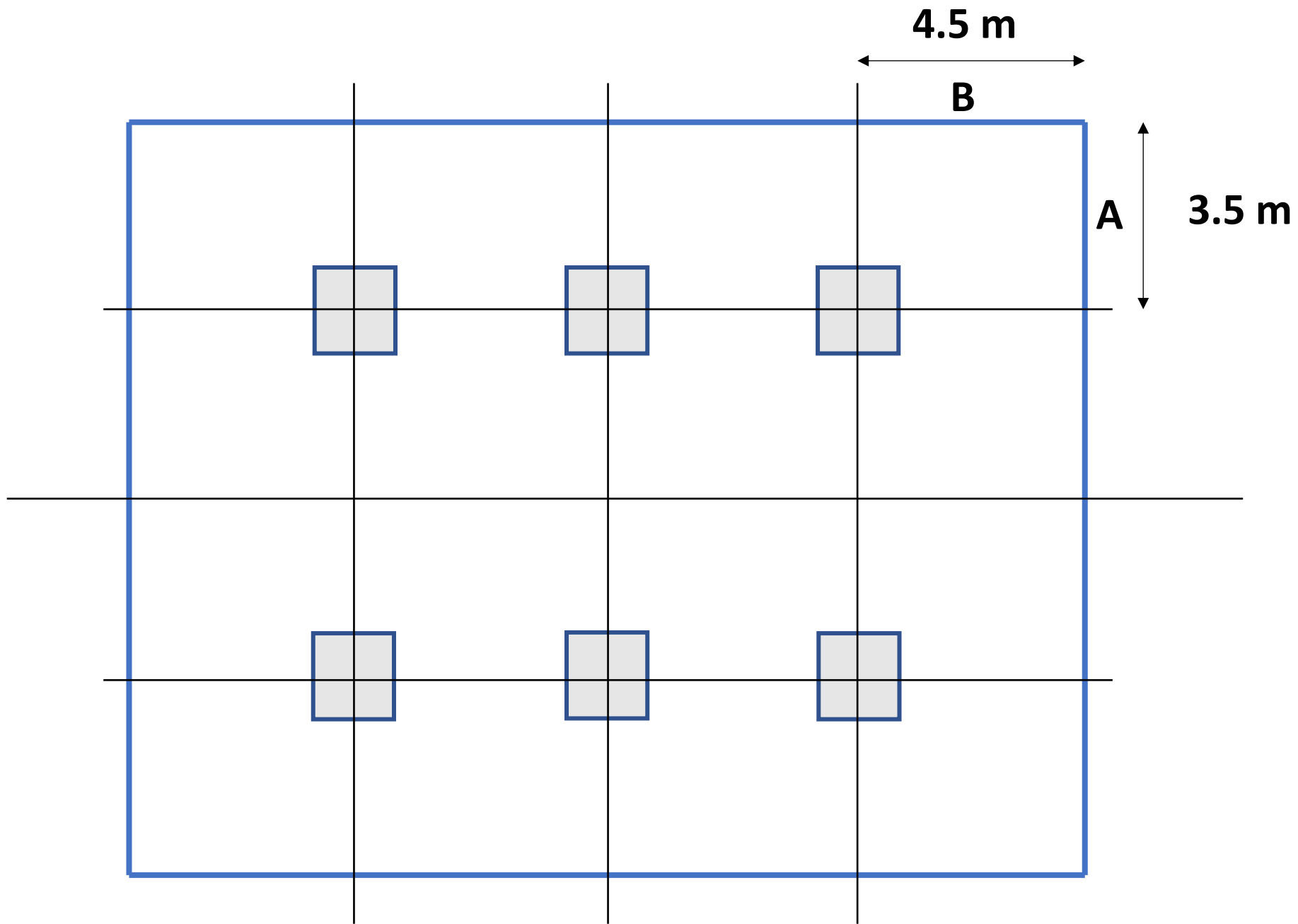


Definizioni

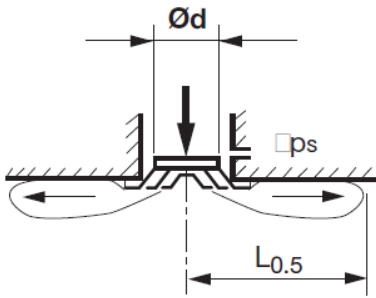
A	m ²	Area nominale del diffusore
A _{eff}	m ²	Sezione libera effettiva
A ₀	m ²	Area nominale di riferimento
Ød	mm	La misura del diffusore per diffusore a soffitto circolare
□a	mm	La misura del diffusore per diffusore a soffitto quadrato
b	mm	Larghezza del getto per diffusore a soffitto quadrato
D	m	Distanza tra due diffusori
f	Hz	Frequenze centrali di ottava
h _{0K}	m	Spessore del getto (dal soffitto) con getto d'aria isotermico
h _{10K}	m	Spessore del getto (dal soffitto) con flusso di aria fredda Δt =10 K(-)
L	m	Distanza (con una velocità finale di 0,5 m/s nell'asse di gittata)
L _w	dB	Livello di potenza acustica
L _{wA0}	dB(A)	Livello di potenza acustica rispetto all'area nominale di riferimento A ₀
ΔL _w	dB	Correzione "livello di potenza acustica" [dB(A)] in funzione della misura del diffusore
Δps	Pa	Perdita di pressione statica
r _{ØF}	-	Rapporto A"/A con diffusore a soffitto piatto, circolare = circa 0,33 = circa 33%
r _{ØF}	-	Rapporto A"/A con diffusore a soffitto conico, circolare = circa 0,73 = circa 73%
r _{□F}	-	Rapporto A"/A con diffusore a soffitto piatto, quadrato = circa 0,32 = circa 32%
r _{□F}	-	Rapporto A"/A con diffusore a soffitto conico, quadrato = circa 0,575 = circa 57,5%
RH	m	Altezza del locale
v _{eff}	m/s	Velocità effettiva di direzione del getto
‡	m ³ /h	Scala di portata

Distanze minime per serie DD e DDRQ





**Minimum
distance D = 3.5 m**

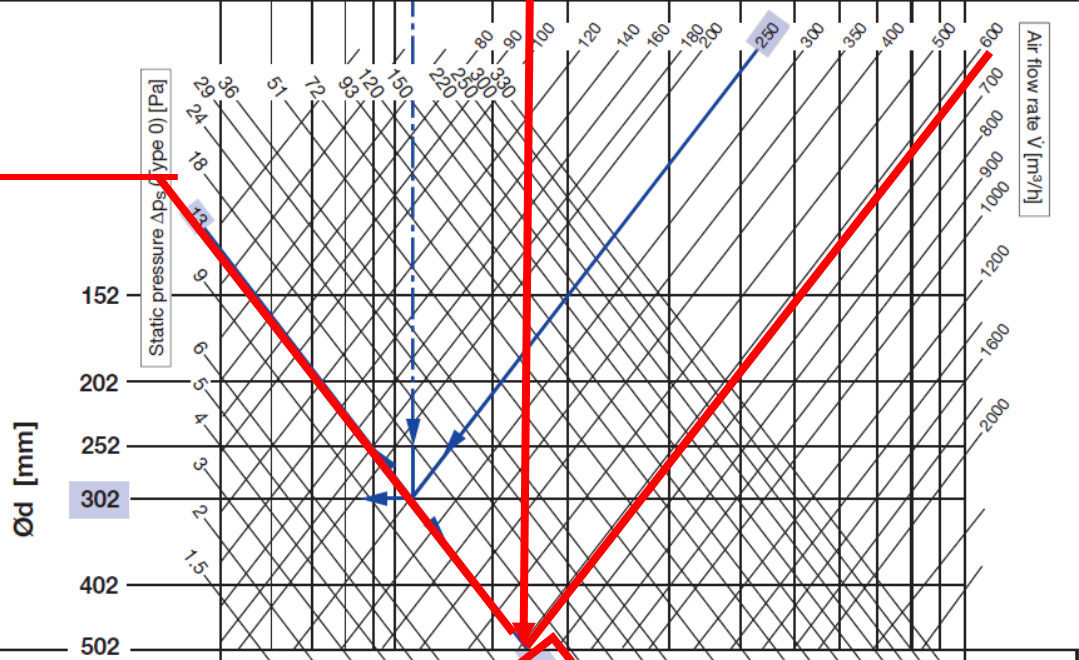


Sezione trasversale libera eff.: ~33%

Room height R_H [m]	Min. distance D as a function of room height R_H [m]
2.25 - 2.50	1.5 2 3 4 5 6 7 8 9 10 15
2.51 - 2.80	1.5 2 3 4 5 6 7 8 9 10 15
2.81 - 3.20	1.5 2 3 4 5 6 7 8 9 10 15
3.21 - 3.75	1.5 2 3 4 5 6 7 8 9 10 15
3.76 - 4.50	1 1.5 2 3 4 5 6 7 8 9 10 15

Distance to a final velocity of 0.5 m/s = $L_{0.5}$	[m]
0.5	1 1.5 2 3 4 5 6 7 8 9 10

$\Delta p = 15 \text{ Pa}$



$L_{0.5} = 1.8 \text{ m}$

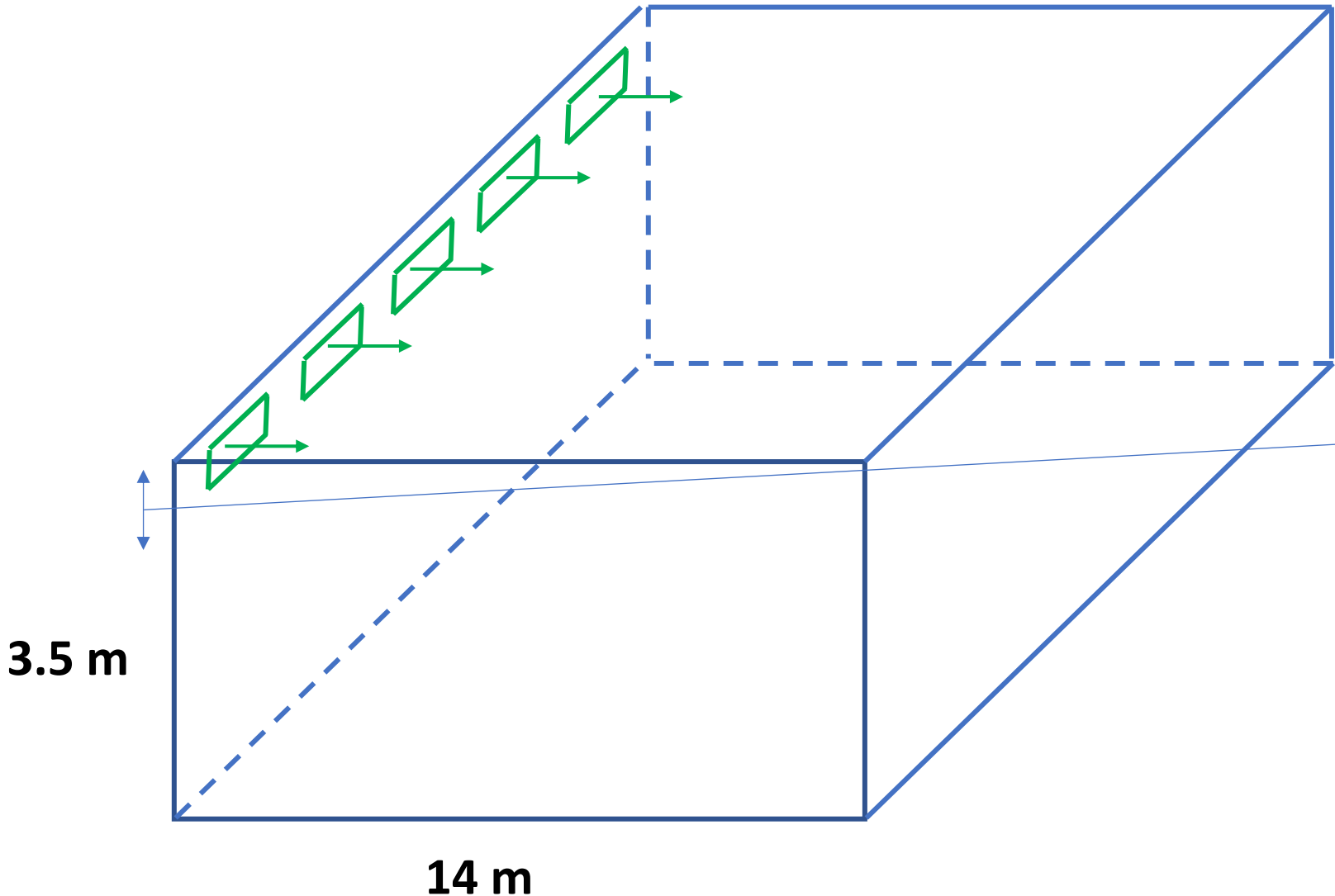
$$h_{0K} = L_{0.5} \times 0.133 = 1.8 \times 0.133 = 0.25 \text{ m}$$

$$h_{10K} = L_{0.5} \times 0.267 = 1.8 \times 0.267 = 0.5 \text{ m}$$

Blow out velocity v_{eff}	1 1.2 1.4 1.6 1.8 2 2.5 3 3.5 4 4.5 5 6 7 8 9 10 12 14	[m/s]
Sound power level L_W , type F 0 ¹⁾ Ød = 302 mm	<20 20 22 24 26 28 30 32 34 35 38 42 45 48 52 56 58 63 65	[dB(A)]
Sound power level L_W , type F 5 ¹⁾ 100%, Ød = 302 mm	<20 22 25 28 30 32 34 36 39 42 45 47 50 54 58 60 64 66	[dB(A)]
Sound power level L_W , type F 5 ¹⁾ 50%, Ød = 302 mm	26 30 33 36 42 46 48 53 54 56 60 62	[dB(A)]

Noise

Air distribution from one side

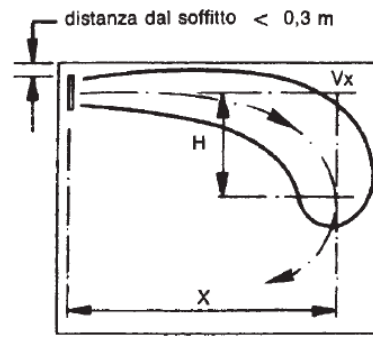


Let us consider 5 inlets

For exploiting the Coanda effect the vents have to be installed at maximum 0.3 m from the ceiling

Volume flow rate per inlet

$$Q_k = 3870/5 = 775 \text{ m}^3/\text{h}$$



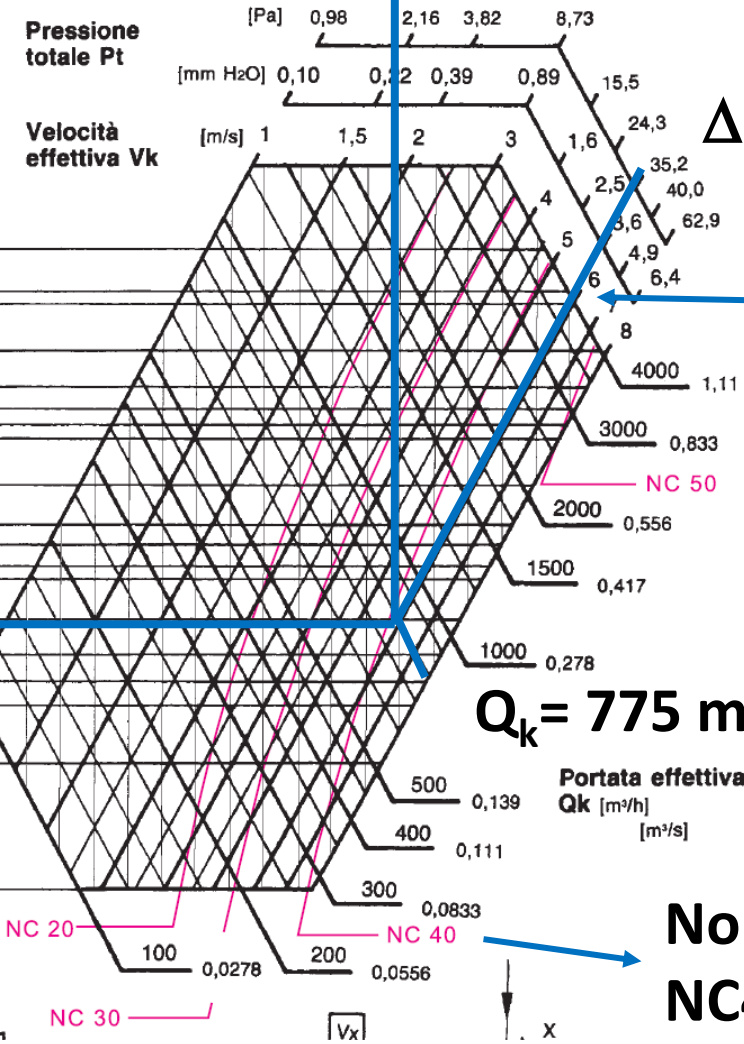
Vx [m/s]	GITTATA X [m]					
0,75	1,5	2	5	10	14	
0,50	2	3	5	10	20	
0,25	3	4	5	10	20	30 40

X = 14 m

SCELTA DELLA GRANDEZZA

1000	1000	800	600	500	400	300	200
800	600	500	400	300	200	150	100
600	500	400	300	200	150	100	75
500	400	300	200	150	100	75	50
400	300	200	150	100	75	50	30
300	200	150	100	75	50	30	20
200	150	100	75	50	30	20	10
100	150	100	75	50	30	20	10

FATTORI DI CORREZIONE PER DEFLESSIONI ALETTE DIVERSE DA 0°



Δp = 35 Pa

vk = 6 m/s

Q_k = 775 m³/h

Noise level NC40