Air Outlet Throw and Terminal Velocity (Free Jet)

Outlet velocity, centreline velocity at a distance, and throw to 0.75, 0.5 and 0.25 m/s for a grille or diffuser from flow, effective area and its throw constant.

Method: ASHRAE Handbook—Fundamentals (2017); ch. 20 (Room air distribution: free-jet centreline velocity $v_x/v_0 = K\sqrt{A_0}/x$)

Input parameters

Unit system: SI

Parameter	Value	Unit
Air flow through the outlet	540.00	m³/h
Effective (core × free area) outlet area	0.020000	m²
Throw constant of the outlet	5.0000	
Distance from the outlet	3.0000	m

Calculated results

Parameter	Value	Unit
Outlet velocity	7.5000	m/s
Centreline velocity at x	1.7678	m/s
Throw to 0.75 m/s	7.0711	m
Throw to 0.50 m/s	10.607	m
Throw to 0.25 m/s	21.213	m

Notes for this case

• Fully developed region of an isothermal free jet: $v_x = Kv_0\sqrt{A_0}/x$. K is about 5–6 for compact jets from grilles and nozzles and 1–2 for radial ceiling diffusers (makers' data). Surface (Coanda) attachment lengthens throw by about 40 %; buoyancy changes it for heated or cooled air.

Formula and method

$$v_x = \min\left(v_0,\ \frac{Kv_0\sqrt{A_0}}{x}\right),\quad T_{v_t} = \frac{Kv_0\sqrt{A_0}}{v_t}$$

Variables

$\dot{V}$	Air flow through the outlet	m³/s
A_0	Effective (core × free area) outlet area	m²
K	Throw constant of the outlet	-
x	Distance from the outlet	m
v_0	Outlet velocity	m/s
v_x	Centreline velocity at x	m/s
$T_{0.75}$	Throw to 0.75 m/s	m
$T_{0.50}$	Throw to 0.50 m/s	m
$T_{0.25}$	Throw to 0.25 m/s	m

Method and standards

Free-jet decay.

Assumptions and limits

- Isothermal jet; fully developed region. Distances within about $K\sqrt{A_0}$ of the outlet are flagged, and v_x is capped at v_0 there.
- Terminal velocities are 0.75, 0.5 and 0.25 m/s in every unit system; US data at 150, 100 and 50 fpm (0.762, 0.508, 0.254 m/s) give throws about 1.6 % shorter.

References

• ASHRAE Handbook—Fundamentals (2017)
• ch. 20 (Room air distribution: free-jet centreline velocity $v_x/v_0 = K\sqrt{A_0}/x$)

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/ducts/diffuser-throw

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.