Wind Turbine Wake Deficit (Jensen / Park Model)

Wind speed and power deficit at a turbine downstream of another by the Jensen (Park) top-hat wake model, with the wake diameter and overlapping equal wakes.

Method: Jensen (Park) wake model

Input parameters

Unit system: SI

Parameter	Value	Unit
Thrust coefficient of the upstream turbine	0.80000	
Downstream distance	500.00	m
Rotor diameter	100.00	m
Wake decay constant (0.075 onshore, 0.04–0.05 offshore)	0.075000	
Number of equal overlapping wakes	1.0000	

Calculated results

Parameter	Value	Unit
Axial induction (1 − √(1 − C_T))/2	0.27639	
Wake diameter at X	175.00	m
Wind speed ratio in the wake	0.81950	
Velocity deficit	18.050	%
Power ratio of the downstream turbine (below rated)	55.036	%
Spacing in rotor diameters	5.0000	

Notes for this case

• Jensen (Katic) model: U_X/U₀ = 1 − (1 − √(1 − C_T))/(1 + 2kX/D)², a top-hat wake growing linearly; overlapping equal wakes add as the root sum of squares of their deficits. Full overlap assumed; part-wake and turbulence effects are not modelled.

Formula and method

$$\frac{U_X}{U_0} = 1 - \frac{1 - \sqrt{1 - C_T}}{(1 + 2kX/D)^2}, \quad D_X = D + 2kX$$

Variables

C_T	Thrust coefficient of the upstream turbine	-
X	Downstream distance	m
D	Rotor diameter	m
k	Wake decay constant (0.075 onshore, 0.04–0.05 offshore)	-
n	Number of equal overlapping wakes	-
a	Axial induction (1 − √(1 − C_T))/2	-
D_X	Wake diameter at X	m
U_X/U_0	Wind speed ratio in the wake	-
$1 - U_X/U_0$	Velocity deficit	-
$(U_X/U_0)^3$	Power ratio of the downstream turbine (below rated)	-
X/D	Spacing in rotor diameters	-

Method and standards

Top-hat wake model.

Assumptions and limits

- Full wake overlap; neutral atmosphere; below rated wind speed for the power ratio.

References

Jensen (Park) wake model

Report details

Report reference	FCC-H3D4-27WQ (the same inputs always give the same reference)
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Release checks	3 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/environmental/wind-power/jensen-wake-model-deficit

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.