

11/03/2021

James Malters
727 Oxford St.
Worthington, MN 56187

Mr. Malters,

In regards to the follow up question asked by the SD Public Utilities commission:

“In order to accommodate a safe turn radius at the end of a field for an agricultural application aircraft, what is Mr. Christensen recommending as an appropriate setback for a wind turbine from the property line to safely spray that field. Please explain and provide supporting calculations.”

I recommend a setback for a wind turbine no less than 0.8 miles from the end of field.

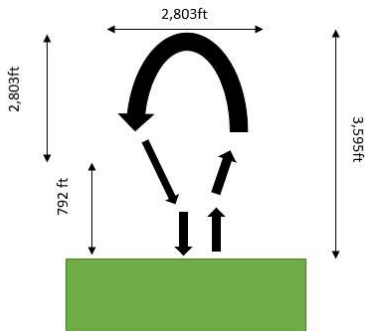
The calculations used to support the 0.8-mile setback include:

A straight out or teardrop/lightbulb pattern leaving the field including a climb, a 180° turn back on target = 3,595ft lateral distance from end of field.

Four seconds to climb and space for lateral distance = 792ft

Then 180° turn = 2,803ft radius

Lateral distance (792ft) +turn (2,803ft) = 3,595ft lateral distance from end of field = 0.68 miles
*15% margin of error = 0.782 mile, rounded up to 0.8-mile minimum setback from obstacles, such as wind turbines.



Calculation:

-Assuming no obstacles, at the end of field, approximately four seconds to climb (135MPH= 198fps*4 sec) = 792ft

-A radius turn is equal to the velocity squared (V²) divided by 11.26 times the tangent of the bank angle as described in the *Pilot Handbook of Aeronautical Knowledge* (2016):

$$R = \frac{V^2}{11.26 \times \text{tangent of bank angle}}$$

V= 135mph

Air Tractor 502 working speed *Air Tractor AT-502
FAA Approved Flight Manual*. (1987).

Tangent bank angle = 30°

$$\frac{18,225}{11.26 \times 0.57735} = 2,803\text{ft radius}$$

Based on the standard Air Tractor 502 (smaller size compared to Air Tractor 802), a setback of 0.8 miles is required with minimal margin of error. This would not take into consideration a faster working speed, non-standard atmospheric days, tailwinds, or pilot error outside of a marginal 15% addition to the calculation. Additionally, this calculation does not add any safety distance margin for the turbulence (which can be considerable) coming off the blades of the turbines.

Based on the provided calculation, I recommend a setback for a wind turbine no less than 0.8 miles from the end of field.

Respectfully,



Cody Christensen, Ed.D.
Airline Transport Pilot
FAA Gold seal flight instructor

Works Cited

Pilots Handbook of Aeronautical Knowledge. (2016). (FAA-H-8083-25B)
https://www.faa.gov/regulations_policies/handbooks_manuals/aviation/

Air Tractor AT-502 FAA Approved Flight Manual. (1987). Air Tractor, INC. Olney, Texas.