

09/02/2021

James Malter
727 Oxford St.
Worthington, MN 56187

Mr. Malter,

My name is Dr. Cody Christensen, I serve in a professional capacity as the only tenured aviation faculty member in South Dakota wherein my role at South Dakota State University, I am tasked with teaching, service, and research related to aviation education. My primary role within the university is teaching new pilots, commercial pilots, and advanced systems in aviation operations. I have been a licensed pilot for over twenty years, a FAA Goal Seal flight instructor for 15 years, and hold certificates in both single and multiengine aircraft including an Air Transport Pilot (ATP) certificate. I am answering your questions as a former airline captain for a small regional airline operating into and out of the Midwest, including South Dakota and the area depicted in Hughes County.

This letter is in request to addressing agricultural flight operations around wind turbines, specifically around T112N, R074W section 10, and 11 in Hughes County, SD. Three main considerations must be factored when addressing the pilot perspective of operations around obstacles. Those three factors include margin of safety, operation of aircraft, and aircraft performance factors associated with the flight.

The first main consideration when evaluating an operating area, whether that be a field to spray or a ground-based maneuver designated by the Federal Aviation Administration (FAA) for training such as an Eight on Pylon, is the margin of safety. The margin of safety when obstacles are present in a field decreases options in the event of an emergency such as a powerplant failure or stall/spin situation. From personal experience I know that operating directly behind or in between wind turbines creates considerable turbulence that can lead to loss of control events- a leading cause of aircraft accidents in the United States. Additionally, flying with known obstacles increases workload because the pilot must evaluate the proper course of action with little to no room for error. The margin of safety decreases as the height and number of obstacles increases.

The second consideration when operating around obstacles that are unavoidable is that of operation of aircraft including pilot training and pilot response. Professional agricultural pilots knowingly take considerable, calculated risks related to obstacles other pilots do not take. They are responsible for flying between 3-12 feet above the ground, making multiple low passes, multiple takeoff and landings, and operating to the max capacity of the aircraft. Doing

this operation on a zero wind, cool day, with no elevation or obstacles take precision and professional skills few possess. Adding additional obstacles that decrease the margin of safety and decrease the reaction time a pilot has to react to unforeseen situations such as mechanical issues, bird strikes, wire strikes, wind changes, and product issues decreases the safety of the operation.

The final major concern when operating around obstacles is the aircraft performance, including climb rate, turn radius, and environmental conditions. The climb rate of a standard Air Tractor 502, a common midlevel agricultural application aircraft, is 664 feet per minute and a typical working speed of 135mph. Every second the airplane is traveling approximately 198 feet per second while on target. At the end of a field the pilot would turn off the spray and begin a climb, followed shortly by a climbing turn usually away from the spray pass to complete a course reversal to realign for the next spray pass. In a normal situation with no obstacles, ending the spray and the initial climb out might all occur within five to eight seconds, resulting in a straight-line distance of almost $\frac{1}{4}$ mile. The turnaround for ag operators, generally considered a 45° downwind turn, followed by a 225° course reversal to come back on target requires a $30\text{-}45^\circ$ turn to do a back-to-back turn. The time of the course reversal is approximately 25 seconds, resulting in close to one mile of total distance traveled per swath. Assuming a 30° bank, the calculated turn radius of an aircraft going 135mph is 2,119 feet and the diameter of the turn is 0.8 miles. It should be noted that for an Air Tractor 502, it is close to one mile to make a turn, but for an Air Tractor 802, currently the largest single engine commercially used ag application airplane, that distance increases to 1.82 miles to complete a turn.

As early discussed, an Air Tractor 502 climb rate is 664 feet per minute or approximately 11 feet per second (fps) climb rate. Considering at the end of the field, an applicator pulls up into a climb, it would take 18 seconds (200ft/ 11fps) to clear a 200 foot obstacle located at the end of a field. Using a working speed of 135MPH or 198fps the aircraft would travel forward 3,564ft (198fps*18 sec to climb) to clear a 200ft obstacle. If a 600-foot obstacle was considered, it would take 54 seconds to outclimb the obstacle and would travel forward over two miles (198fps *54sec= 10,800ft). Even assuming the pilot slowed to 111mph (best rate of climb at max weight) the distance covered is still 1.6 miles (162fps *54 sec). This assumes the pilot adds max power, performs a perfect climb, the airplane performs perfect, and the field conditions were conducive to a climb (sea level, standard atmosphere, low humidity, calm or head winds prevailing). Anything less than perfect conditions would decrease the climb rate and make the field in question non flyable.

The other option would be instead of pulling up to climb over an obstacle to fly around it, below it, or through the blade arc or guy-wire, all of which are not prudent options, especially considering any abnormal operations. Additionally, the turbulence created by the wind turbines would have a direct and immediate impact on the pilot operating downwind of the turbine.

In reviewing the plat map of 112N, R 074W, section 10 and 11 in Hughes County, SD I am most concerned about the placement of towers 8, 9, 14, &15 within the sections and any

towers that are adjacent such as #20-22 as they are well within a normal margin of safety for a typical pilot to safety spray that area. Based on the map and field layout, an east/west swath pattern would prevail and the presence of wind turbines or any obstacle at the end of those fields, especially on two sides, would be detrimental to safety. In my opinion, I would advise against a pilot maneuvering in the field presented with obstacles in the placement suggested.

Respectfully,

A handwritten signature in black ink, appearing to read 'Cody Christensen', with a stylized flourish at the end.

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