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RE: Concerns with the comparison of drift made between manned agricultural aircraft and unmanned aerial spray systems (UASS).

The National Agricultural Aviation Association (NAAA) wishes to express concerns related to the way UASS drift data submitted by the Unmanned Aerial Pesticide Application System Task Force's (UAPASTF) was compared to estimated drift from manned agricultural aircraft. NAAA understands and supports the need for accurate drift data for UASS; the concern is based on the potential negative impacts an inaccurate comparison between UASS and manned agricultural aircraft could have on aerial applications overall. Since both manned aerial applications and UASS applications currently rely on having a singular approval for aerial application during pesticide registration and registration review, the inaccurate comparison could result in the loss of pesticides available to both aerial applicators using manned agricultural aircraft and UASS.

U.S. Aerial Application Industry Background

NAAA represents the interests of the 1,560 aerial application industry owner/operators and 2,028 non-operator agricultural pilots throughout the United States licensed as commercial applicators that use aircraft to enhance the production of food, fiber and bio-energy; protect forestry; protect waterways and ranchland from invasive species; and provide services to agencies and homeowner groups for the control of mosquitoes and other health-threatening pests.

Within agriculture and other pest control situations, manned aerial application is an important method for applying pesticides, because it permits large areas to be covered rapidly and is by far the fastest application method of crop inputs, when it matters most. More than any other application method, manned aerial application capitalizes on the often limited windows of suitable spraying weather and allows for timely treatment of pests while they are in critical developmental stages, often over terrain that is too wet or otherwise inaccessible for terrestrial applications. It also treats above the crop canopy, thereby not disrupting the crop and damaging it. Aerial application has greater productivity, accuracy, speed, and is unobtrusive to the crop compared to ground application[1]. Although the average aerial application company is comprised of only six employees and two aircraft, as an industry these small businesses treat nearly 127 million acres of U.S. cropland each season, which is about 28% of all cropland used for crop production in the U.S. In addition to the cropland acres, aerial applicators annually apply to 5.1

[1] Kováčik, L., and A. Novák, 2020. "Comparison of Aerial Application vs. Ground Application." *Transportation Research Procedia* 44 (2020) 264–270.

million acres of forest land, 7.9 million acres of pasture and rangeland, and 4.8 million acres for mosquito control and other public health concerns.

While there are alternatives to making aerial applications of pesticides, aerial application has several advantages. In addition to the speed and timeliness advantage aerial application has over other forms of application, there is also a yield difference. Driving a ground sprayer through a standing crop results in a significant yield loss. Research from Purdue University[2] found that yield loss from ground sprayer wheel tracks varied from 1.3% to 4.9% depending on boom width. While this study was conducted in soybeans, similar results could be expected in other crops as well. Data from a Texas A&M University economics study[3] and the 2019 NAAA industry survey[4] were used to calculate that the aerial application industry is directly responsible for the production of 1.69 billion bushels of corn, 199 million bushels of wheat, 548 million pounds of cotton, 295 million bushels of soybeans, and 3.33 billion pounds of rice annually that would be lost every year without the aerial application of pesticides. The value in additional crop yield that the aerial application industry brings to farmers, input suppliers, processors, and agricultural transportation and storage industries for corn, wheat, cotton, soybean, and rice production in the U.S. is estimated to be about $37 billion[5].

Research summarized by the University of Minnesota[6] describes how soil compaction from ground rigs can negatively affect crop yields due to nitrogen loss, reduced potassium availability, inhibition of root respiration due to reduced soil aeration, decreased water infiltration and storage, and decreased root growth. Aerial application offers the only means of applying a crop protection product when the ground is wet and when time is crucial during a pest outbreak. A study on the application efficacy of fungicides on corn applied by ground, aerial, and chemigation applications[7] further demonstrates that aerial application exceeds ground and chemigation application methods in terms of yield response. The aerial application of crop protection products results in greater harvest yields of crops. This in turn results in less land being used for agricultural production, preserving more wetlands for natural water filtration, forest ecosystems for carbon sequestration and habitat for threatened and endangered species.

The Texas A&M[5] study revealed that the total area of cropland needed to replace the yield lost if aerial application was not available for corn, wheat, soybean, cotton, and rice production is 27.4 million acres, an area roughly the size of Tennessee. Aerial applicators seed 3.8 million acres of cover crops annually[5]. This means that aerial applicators are responsible for helping to sequester 1.9 million metric tons of CO2 equivalent annually, which, according to the EPA, would be the equivalent of removing approximately 412,000 cars with carbon-combustion engines from the roads each year.

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[2] Hanna, S., S. Conley, J. Santini, and G. Shaner. 2007. "Managing Fungicide Applications in Soybean." Purdue University Extension Soybean Production Systems SPS-103-W. https://www.extension.purdue.edu/extmedia/sps/sps-103-w.pdf
[3] Dharmasena, S. 2020. "How Much is the Aerial Application Industry Worth in the United States?" Research presented at the 2020 Ag Aviation Expo, Savannah, GA. https://www.agaviation.org/education/aerial-application-technology-research-sessions/
[4] National Agricultural Aviation Association. May 2019. "2019 NAAA Aerial Application Industry Survey: Operators." https://www.agaviation.org/wp-content/uploads/2024/04/NAAA-2019-Operator-Survey.pdf
[5] Dharmasena, S. 2021. "Value of the Agricultural Aerial Application Industry in the United States" Research presented at the 2021 Ag Aviation Expo, Savannah, GA. https://www.agaviation.org/education/aerial-application-technology-research-sessions/
[6] University of Minnesota. "Soil Compaction." Accessed April 29, 2021. https://extension.umn.edu/soil-management-and-health/soil-compaction
[7] Thomas, D. 2009. Unpublished research results submitted to EPA. https://www.agaviation.org/wp-content/uploads/2023/06/2009-Fungicide-Efficacy-Results.pdf

The aerial application industry is also actively involved in education and research efforts to improve the accuracy and safety of aerial applications. The National Agricultural Aviation Research and Education Foundation (NAAREF) is a non-profit organization dedicated to promoting research, technology transfer and advanced education among aerial applicators, allied industries, government agencies and academic institutions. NAAREF's Professional Aerial Applicators' Support System (PAASS) program is a four-hour course offered annually at all state and regional agricultural aviation association conventions. The curriculum is brand new every year and a minimum of one hour of PAASS is focused on environmental professionalism. This ensures aerial applicators are kept up to date on the latest information related to making accurate applications and drift mitigation. Nozzle selection, buffer zones, inversions, precision application technology, dissection of real-life drift incidents, and proper spray boom setup are some of the environmental professionalism topics that have been covered in PAASS.

Five years after PAASS became part of the aerial application annual curriculum in 1999, there was a 26% drop in drift incidents according to the Association of American Pest Control Officials' drift surveys. In addition, ag aircraft accidents have also significantly declined. From 1999 to 2010, the accident rate per 100,000 hours flown dropped by 21.6% compared to pre-PAASS accident rates. From 2011 to 2019, the accident rate dropped even more—30.8%—compared to pre-PAASS accident rates. Each year, we continue to see a drop in our accident rate since pre-PAASS days, but now it declines more incrementally. While aviation safety is the domain of the FAA and not the EPA, the reduction in accidents proves PAASS has had, and continues to have, a significant positive impact on the aerial application industry.

Another NAAREF program is Operation SAFE (Self-regulating Application & Flight Efficiency). The primary component of Operation SAFE. is a fly-in clinic. At a SAFE fly-in, aerial applicators have their aircraft calibrated and application patterns (both liquid and dry) measured and evaluated for accuracy and uniformity. Spray droplet size is also measured at a fly-in to ensure the agricultural aircraft is creating the droplet size required by the labels for products to be applied by the aircraft. Many of the concepts used to mitigate the risk of drift from agricultural aircraft have originated from ideas first tested at Operation SAFE fly-ins.

NAAA has created a professional certification program for the aerial application industry named Certified Aerial Applicator (CAA). To be certified under CAA, aerial applicators must take the PAASS program annually and Operation S.A.F.E. biennially, in addition to belonging as a member to their state/regional agricultural aviation association and the NAAA. CAA professionals are also required to take and be tested on additional aviation safety and environmental stewardship curriculum offered on-line through a learning management system software managed by NAAA. The purpose of CAA is to enhance professionalism in the aerial application industry as our statistics show that those who participate in our educational programs are safer from both an aviation and environmental perspective.

NAAA Concerns with UAPASTF Drift Data

NAAA questions the validity of UAPASTF's comparison of drift from unmanned aerial spray systems (UASS) to drift from aerial applications made with manned aircraft in their April 8, 2026 public announcement[8]. First, in their public announcement, UAPASTF compared field-measured UASS drift data to the Tier 1 AgDRIFT aerial model. The Tier 1 AgDRIFT aerial model is based on outdated parameter inputs. In their Ecological Mitigation Support Document

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[8] https://uapastf.com/wp-content/uploads/2026/04/UAPASTF-Public-Notice-04-08-26.pdf

to Support Endangered Species Strategies Version 2.0 (dated April 2025) and released in conjunction with the final Insecticide Strategy, EPA acknowledged the inaccuracy of the Tier 1 AgDRIFT model. They switched to the Tier 3 AgDRIFT model for estimating the drift from manned aerial applications and adopted parameter inputs more reflective of modern aerial applications. Parameter changes included the type of aircraft and associated swath width and number of passes, default droplet size, swath width displacement, atmospheric stability, and height for wind speed measurement. All comparisons of drift between aerial applications and another application platform should use the Tier 3 AgDRIFT model with parameter inputs taken from EPA's Ecological Mitigation Support Document.

A second concern is that UAPASTF should have been aware of the inaccuracy of this comparison. An earlier research summary[9] examining the drift potential for UASS used the Tier 1 AgDRIFT model for comparing drift from UASS to manned agricultural aircraft, but these works were conducted and presented before EPA's April 2025 change to the Tier 3 model. While this earlier comparison to the AgDRIFT Tier 1 aerial model is understandable, considering it occurred before EPA officially made the change to Tier 3, NAAA is concerned that in their recent announcement[8] UAPASTF once again compared drift from UASS and manned agricultural aircraft using an outdated drift model no longer used by the EPA. This time, however, the comparison was made a year after EPA made the switch to Tier 3 public. There are also concerns with making a comparison between field data and dispersion models such as AgDRIFT and AGDISP. For example, while both AgDRIFT and AGDISP account for the loss of spray due to evaporation, there is no indication in any of UAPASTF's publicly available documents that evaporation of spray droplets is accounted for in their results. Another possible distinction is if UAPASTF accounted for fine droplets still aloft past the maximum downwind distance reported of 492 feet.

A third concern relates to the area sprayed for drift estimates from AgDRIFT compared to the area sprayed for drift measurements in UAPASTF's drift trials. While the April 8, 2026, public announcement[8] did not provide details about how the drift data was collected, UAPASTF presentations to the American Society of Agricultural and Biological Engineers[10], the American Chemical Society ACS)[11,12], and the Society of Environmental Toxicology and Chemistry[13] all indicate three or four passes were made by the UASS. No swath widths were provided in these presentations, nor was the total width of the area sprayed by either the drone or ground sprayer provided. The above references all list the DJI T30 as the UASS platform used in the drift trials. According to the one of the presentations given at ACS[12], the widest effective swath width achieved by the T30 (using a fine droplet size) during preparatory spray pattern testing was 7 m (~23 ft). Assuming a 23-foot swath width per pass and four passes, NAAA assumes the UASS covered a total of 92 feet for each replicate in the drift trials.

NAAA also found no reference that detailed how the drift measurements from the field trials were extrapolated to estimate the amount of drift predicted if areas wider than 92 feet were sprayed. In AgDRIFT, for both Tier 1 aerial and Tier 3 aerial with EPA's parameters, the total width of the sprayed area is 1,200 feet. This means UAPASTF compared the amount of drift

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[9] Bonds, J.A.S., N. Pai, S. Hovinga, K. Stump, R. Haynie, S. Flack, and Travis Bui. 2024. "Spray Drift, Operator Exposure, Crop Residue and Efficacy: Early Indications for Equivalency of Uncrewed Aerial Spray Systems with Conventional Application Techniques. *Journal of the ASABE*. Vol. 67(1): 27-41

[10] https://uapastf.com/wp-content/uploads/2025/09/UAPASTF-Update-on-Off-target-Movement-Studies-Conducted-Globally-ASABE2025-Rajeev-Sinha.pdf

[11] https://uapastf.com/wp-content/uploads/2025/09/Frank-Donaldson-UAPASTF_ACS2025.pdf

[12] https://uapastf.com/wp-content/uploads/2025/09/T.Dupuis_ACS-2025-Pattern-Testing.pdf

[13] https://uapastf.com/wp-content/uploads/2025/09/Jane-Tang-UAPASTF-technical-Overview_SETAC_2025.pdf

generated by spraying an area 92 feet wide (UASS) to the amount of drift generated by spraying an area 1,200 feet wide (manned aerial). Additionally, failure to sample drift from a single swath pass of the UASS in addition to sampling drift for four swath passes goes against the recommendations in UAPASTF Recommendations for Conducting UAV Field Drift Trials[14].

The last concerns relate to spray droplet size. The T30 can be fitted with conventional hydraulic nozzles of the applicator's choice. According to the ASABE presentation[10], three different ground sprayer nozzle types from TeeJet were tested to create fine, medium, and coarse spray droplet spectrums. The airspeed of the T30 (maximum 15 mph) suggests that the droplet size data and classification from TeeJet may be appropriate, as high clearance ground sprayers, for which the TeeJet nozzles are designed, have similar maximum operating speeds while spraying. However, what is not accounted for when using TeeJet's droplet classification charts is the impact the air flow created by the rotors has on the physical movement of the spray droplets and the geometry of the spray pattern[15].

The relevancy of spray droplet size from the data submitted compared to the expected spray droplet size from UASS currently prevalent is also a concern. While the T30 was a common UASS platform at the time, it has since been mostly replaced with larger UASS with greater payload capacity. A key difference (besides payload capacity) between the T30 and newer UASS models is the switch from hydraulic nozzles on the T30 to rotary atomizers. While it appears that UASS rotor wash doesn't significantly impact droplet size with traditional hydraulic nozzles[15], these results should not be assumed to be the same for the rotary atomizers, which have become the dominant type of atomizer used in modern UASS. As with the hydraulic nozzles designed for ground sprayers, there is currently no spray nozzle model available for UASS operators to determine what their droplet size is when using rotary atomizers. Manned agricultural aircraft operators can use the USDA-ARS Aerial Application Technology Research Unit (AATRU) Atomization Models to determine the droplet size created by their spray system setup; no such tool currently exists for UASS. Rotary atomizer settings on the UASS controllers provide an option for setting the desired droplet size, but the droplet size actually generated does not seem to match what the controller was set to create[16]. In order to provide both safe and effective applications, UASS operators <u>must</u> be able to accurately select the droplet size created by the UASS to match label requirements. Not only is the T30 now outdated in terms of nozzle type, but the droplet size created by the now commonly used rotary atomizers appears to be much smaller than what the manufacturers suggest.

Another key difference between the T30 and the more recent T100 is the comparative weight of the UASS. The maximum takeoff weight for the T30 is 172 lb.; for the T100 it is 386 lb. This is a substantial increase in weight, which will also result in stronger wake vortices created by the T100[17]. The strength and spatial distribution of wake vortices influences both spray deposition and drift potential, as the wake vortices push spray downwards and outwards into the canopy but also push spray upwards into the atmosphere. NAAA is not aware of any published research on the wake vortices created by UASS documenting their impact on spray distribution that has resulted in meaningful mitigations available to UASS operators for reducing the drift potential of

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[14] https://uapastf.com/wp-content/uploads/2024/09/UAV-Spray-Drift-Field-Trial-Recommendations-1.1-for-UAPASTF-Website-Posting-Sept-2024.pdf
[15] B. K. Fritz and T. Butts, "Influence of UAV Rotor Wash on Spray Droplet Atomization: Implications for Pesticide Application and Environmental Risk," in Pesticide Formulation and Delivery Systems: 43rd Volume, Creating Certainty in an Uncertain World, ed. Danny Brown (West Conshohocken, PA: ASTM International, 2025), 65–78
[16] https://www.agaviation.org/wp-content/uploads/2025/05/6.-Fixed-Wing-and-Drone-Comparisonspdf.pdf
[17] https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_90-23G.pdf

their aircraft. Furthermore, the aircraft EPA selected for their Tier 3 AgDRIFT model is the AT-802, the largest agricultural aircraft in both production and use in the U.S. Being the heaviest agricultural aircraft also means it will have the strongest wake vortices of all manned agricultural aircraft. In order to accurately measure or model the drift potential from UASS for the purposes of conducting worst-case scenario risk assessments, the heaviest UASS in production should be used. Commonality of the UASS should be considered to ensure the UASS selected for study is prevalent in the marketplace, as is the case with the AT-802.

In an attempt to make UASS efficient, manufacturers continue to increase the size and hopper capacity of their UASS offerings. In the five years between the release in the U.S. of the T30 (2021) and the T100 (2026), the maximum takeoff weight more than doubled. This trend is expected to continue, which means any drift data collected or modeled for UASS will be out of date in only a few years. UAPASTF's press release suggests they may be seeking separate risk assessments and label language from manned aerial applications, so it may become necessary for EPA to place a maximum weight restriction on UASS in order to preserve worst case scenario risk assessments.

A smaller droplet size significantly increases the risk of drift – this has been well documented in numerous research papers, which is why increasing droplet size is always the top recommendation for reducing the risk of drift for all application platforms, both ground and aerial. NAAA Operation SAFE analysts have measured and evaluated the spray patterns and droplet sizes for UASS where the droplet size measured during testing was much finer than the droplet size selected by the operator on the UASS's control system. A recent example (Appendix A) from 2026 found the T50 UASS created a fine droplet size despite being set to create a coarse droplet size. Furthermore, artificial collectors used at Operation SAFE pattern testing clinics typically collect and measure a coarser droplet size than that modeled by AATRU spray atomization models, as demonstrated in Appendix B. In this example, the droplet category measured on the flightline was coarse, whereas the model classified the spray droplet spectrum for the same nozzle setup and operational parameters as medium. This occurs because both the droplet collection system on the flightline and the image processing at a SAFE clinic are not as effective at measuring finer droplets as the laser diffraction system used in AATRU's wind tunnel. Thus, it is very likely the droplet size created by the T50 is actually even smaller than what was measured at the SAFE fly-in (Appendix A).

Because the T50 (or other UASS) is not currently part of either the AgDRIFT or AGDISP models, a comparison to show the impact a fine droplet size has on aerial applications was conducted using AgDRIFT and fixed wing data. Tier 3 aerial with EPA's parameters estimates the fraction of material applied at 200 feet downwind to be 0.0290. Changing the droplet size to fine, with all other parameters held constant, the estimated fraction of material applied at 200 feet downwind increases to 0.0812. This is a 2.8x increase in drift deposits compared to the medium droplet size, and a 1.8x increase from the Tier 1 model.

To address all of these concerns, NAAA recommends EPA utilize the expertise of Dr. Brad Fritz with the USDA-ARS AATRU. Dr. Fritz is a recognized expert in measuring drift and has conducted numerous drift trials himself. He has worked with both manned and unmanned agricultural aircraft and is the current lead researcher for the AATRU aerial atomization models. Dr. Fritz is also quite familiar with the AgDRIFT model and currently serves on the Technical Oversight Committee for the AGDISP Modernization Project (AMP). His expertise is acknowledged and respected by both the manned and unmanned agricultural aviation communities, making him an ideal candidate to determine what constitutes a fair comparison of drift between different application platforms.

Regarding AGDISP, the need for UAPASTF to conduct and submit drift trials in order to assist EPA with risk assessments is a reminder of the importance of AMP. Once completed, UASS can be added to the modernized version of AGDISP so that all risk assessments can be based on equitable drift estimates for all application platforms. Until spray nozzle models have been updated to include all commercial UASS nozzle offerings, and until UASS have been evaluated thoroughly and added to the AgDRIFT and AGDISP or comparable models, it may be safer for the environment and bystanders to have a separate label section for UASS that is based on risk assessments conducted using the Tier 1 model. This action would be at a minimum as it is obvious the drift risk is greater than Tier I predictions.

Thank you for your time and consideration of these concerns.

Sincerely,

Scott Bretthauer

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