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By Email

07 February 2022

The Honourable Richard Wynne MP
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Parliament of Victoria
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Dear Minister,

AusALPA COMMENTS ON THE AVIATION SAFETY CONDITIONS IN PLANNING PERMIT *PA1700266-3 GOLDEN PLAINS WIND FARM*

The Australian Airline Pilots' Association (AusALPA) is the Member Association for Australia and a key member of the International Federation of Airline Pilot Associations (IFALPA) which represents over 100,000 pilots in 100 countries. We represent more than 7,100 professional pilots within Australia on safety and technical matters. Our membership places a very strong expectation of rational, risk and evidence-based safety behaviour on our government agencies and processes. We regard our participation in the safety-related work of the Australia's government agencies as essential to ensuring that our policy makers get the best of independent safety and technical advice.

Safeguarding Australia's aviation infrastructure

Although it is hard to ignore the parallels with the iconic Australian movie *The Castle*, our primary concern in relation to the Craigwood aeroplane landing area (ALA) and the Golden Plains Wind Farm is with aviation safety as the underpinning philosophy of Australia's airport safeguarding framework.

While many might dismiss ALAs as being out of scope for airport safeguarding, AusALPA views the way in which the relevant agencies apply the safeguarding principles as a key indicator of agency culture and a pointer to how more significant infrastructure decisions have and may be made in other circumstances.

Our abiding concern is that planning decisions affecting current and future aviation infrastructure are, for all practical purposes, irreversible. We are highly conscious of the intersection of private, community, State and national interests in these types of decisions and we accept that the best of balanced outcomes will not always preserve utility for all stakeholders. However, we are passionate advocates for transparency of government decision-making and for the ability of the public to scrutinise the materials upon which decision-makers rely when granting and enforcing planning and development permits.

AusALPA, like the Australian Energy Infrastructure Commissioner, is concerned about the quality of expert advice that proponents provide[1]. While there are some concerns about both the age and the quality of Guideline D of the National Airports Safeguarding Framework (NASF), our focus is much more about the current level of adoption and implementation of the NASF by the States and Territories.

We hope, in discussing the Craigwood situation, to provide you with sound operational advice, background and context to assist you as the responsible authority in making your decision. We also hope that we can encourage you to take a more fulsome approach to implementing the whole of the NASF into Victorian law.

Constraints on our submission

AusALPA has no pre-existing connections with any of the stakeholders of Planning Permit PA1700266-3 for the Golden Plains Wind Farm. We have no commercial, political or industrial interests in any of the parties.

We are grateful to Mrs Kathy Woods for alerting us to the situation and for providing relevant information to us. In formulating our comments, we are reliant on that information and additional information available publicly on the internet. We recognise that there is a range of other communications of which we are unaware, but we do not expect that the matters of principle which we will discuss will be significantly affected.

THE CRAIGWOOD ALA

Craigwood ALA is a 743x60m runway, surveyed to CASA Code 1 standards with the relevant markings and a windsock. It has been allocated an ICAO aerodrome designator: YCGW. We are advised that it is well maintained and in regular use. It is not certified and not required to be so. While clearly at the smallest scale of aerodromes, it nonetheless forms part of the local aviation infrastructure and has identifiable utility to both the landholder and the immediate local community.

AusALPA believes that every element of Australia's aviation infrastructure should be safeguarded to preserve both current and future use. We acknowledge that Planning Victoria and he Department of Environment, Land, Water and Planning (DEWLP) have a similar position, at least to the extent that the Planning Permit contains Condition 78:

> 78. Prior to turbines WTG215, WTG216 and WTG217 being constructed, an aircraft safety assessment prepared by a suitably qualified person must be submitted which demonstrates that the existing operations conducted from the airstrip at 1944 Wingeel Road, Barunah Park will be able to continue safely without significant impact from the turbines, to the satisfaction of the responsible authority, unless an alternative arrangement is agreed between the parties to the satisfaction of the responsible authority.

In our preliminary enquiries, we were advised that the strongly preferred solution of DEWLP is for "an alternative arrangement" by way of some form of financial compensation for the cessation of flight operations, thus rendering Condition 78 moot. It also became very clear that the consequential loss of utility to the landholder and the immediate local community militates against DELWP's preferred "solution".

If we take Condition 78 at face value, then the most appropriate available pathway seems to be preserving the safety of existing operations to the most practical extent. We then asked whether relocation or realignment of the runway (at the expense of the

[1] See https://www.aeic.gov.au/observations-and-recommendations/use-selection-experts

wind farm proponent) was practical. However, it appears that the runway siting already optimises the local geomorphology to provide a relatively dry runway when the surrounding farmland is too wet to sustain normal agricultural machinery operations. This has the advantage that aerial application can continue relatively unabated in such circumstances as well as to support occasional access for private aircraft. In drier times, the ALA can support local aerial firefighting operations. There is clearly a mix of public as well as private benefit to be retained.

Expert advice

AusALPA notes that Golden Plains Wind Farm Management Pty Ltd (GPWF) relied on two expert reports from Chiron Aviation Consultants[2][3] to support GPWF's assertion that "*the 215 WTG layout will have no impact on the continued safe operation of the airstrip at 1944 Wingeel Road*"[4].

The author of the reports states that he is an ex-Air Traffic Controller and that his area of expertise is airspace and air traffic management. While he has experience in other aviation-related activities, he makes no claim to be a pilot or to have practical operational experience in flying aircraft. His formal training in risk management appears to be limited to completing a course titled *Understanding Risk Management* conducted by Emergency Management Australia[5], the relevance of which to assessing aircraft operational risk is unknown to us.

The assessment required by condition 78 is, at the very least, an operational risk assessment that, in our view, requires practical experience in flying aircraft and fully assessing the changes in existing operational risks brought about by constructing 230m high obstacles within the vicinity of an existing aerodrome.

Our concern is that the Chiron Aviation Impact Assessment only covers some of the issues with varying adequacy, while ignoring the professional advice of the association that represents aerial application operators, applying a "compliance over principle" approach to obstacles and, perhaps most critically, failing to properly explore the risks associated with the wind turbines' turbulent wake.

This latter shortcoming in the Amendment Report is particularly surprising, given that the author appeared as an expert witness for the Corangamite Shire Council in *Naroghid Wind Farm Pty Ltd v Minister for Planning [2019] VCAT 800*, a case in which turbine wake turbulence affecting an ALA was a key issue that led VCAT to refusing to grant a wind farm permit. The closest turbine in the proposed Naroghid Wind Farm was 2.5km from the runway, significantly further than is proposed to affect the Craigwood ALA.

AAAA Windfarm and Tall Structures Policies

The Aerial Application Association of Australia (AAAA) was formed in 1958 and has a long history of advocating for change in the safety culture of aerial application. Membership of the AAAA consists primarily of operators of agricultural aircraft. There

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2 Final Report, Golden Plains Wind Farm Aviation Impact Statement, Qualitative Risk Assessment and Obstacle Lighting Review, Chiron Aviation Consultants, 20 April 2018.

3 Final Report, Golden Plains Wind Farm Aviation advice, Amendment of Planning Permit, 215 turbine layout and increased rotor diameter to 165m, Chiron Aviation Consultants, 19 November 2020.

4 See https://goldenplainswindfarm.com.au/permit-amendment/

5 See Annexure B, Expert Witness Statement of Ian Jennings in the matter of Golden Plains Wind Farm, Planning Panels Victoria, 20 July 2018

are currently approximately 130 active operators in Australia of which over 75% are financial members of the Association. AAAA members control over 90% of application aircraft in use[6].

AAAA is regarded by CASA specifically and the Commonwealth Government more generally as the peak body for aerial application policy and risk management. AusALPA and AAAA have participated in many important policy and standards developments activities for CASA over the last decade or two.

AusALPA notes that some of the documents submitted to DEWLP refer to the AAAA policies relating to windfarms and tall structures. However, those references are invariably included without refutation or any critical analysis. Contextually, we find that most unusual given that the documents submitted by the windfarm proponents and their agents invariably argue a contrarian view to that of the AAAA.

The Windfarm Policy was published in March 2011 and the Tall Structures Policy was published in February 2017[7]. AusALPA has confirmed[8] that both of these policies are current and reflect the associated risks, with no prospect of being revised or rescinded in the foreseeable future. The key messages are:

> Windfarms and their pre-construction wind monitoring towers are a direct threat to aviation safety – and especially aerial application.

and

> Tall structures—such as radio masts—are a direct threat to aviation safety – and especially aerial application. In an already hazardous low-level environment, tall structures impose additional operational costs onto aerial applicators in addition to increased risk.

The Windfarm Policy states:

> As a result of the overwhelming safety and economic impact of windfarms and supporting infrastructure on the sector, AAAA opposes all windfarm developments in areas of agricultural production or elevated bushfire risk.

The Tall Structures Policy is couched similarly but is highly conditional on a range of stakeholder consultation and agreements that are rarely contemplated by proponents.

AusALPA understands that proponents will not agree that windfarms, wind monitoring towers and other tall structures are a "direct threat to aviation safety". However, we do not believe that these policies can be ignored.

We strongly recommend that DEWLP be very careful about placing too much weight on safety and operational risk advice from the usual collection of consultants paid to make the proponents case over the advice of the professional association of aerial application operators.

Debates about flying between pylons and under rotating turbines and making high angle of bank heavy weight turns just after take-off from non-pilots or even the few risk-takers prepared to offer their personal perspectives are, in our view, the antithesis of rational risk-based analysis. There is a big difference between safely operating aircraft in the vicinity of natural obstacles that otherwise constrain where agricultural activities may reasonably be conducted and managing the risk in the presence of 230m man-made obstacles superimposed on otherwise unconstrained agricultural land.

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6 See https://aaaa.org.au/mission-and-history/ (accessed 28 Jan 22)

7 See https://aaaa.org.au/policies/

8 Personal communication, CEO AAAA, 27 Jan 22

The proponents "operational advice" always seem to argue that, if the tower and the wind turbine can be seen, a pilot won't hit it. We do not agree that that is always true.

In fact, we believe that there are some clear lessons for aerial application operations to be seen from the Red Bull Air Racing events that cannot be ignored. In short, if you choose to fly close enough to a pylon to achieve the desired outcome, there is a very high risk that there will be a collision with either the pylon or the ground/water – despite the fact that both are in clear view. The Red Bull air races may be much more frenetic than aerial application but the common characteristics are repetitive operations in close proximity to the ground and obstacles that seek to maximise efficiency and minimise time on task.

Of course, the obstacle that cannot normally be seen is the turbine-induced turbulent wake, which we will address separately. This combination of visible and invisible obstacles lies at the heart of the AAAA's risk management and accident reduction activities, underpinning the policy outcomes. It should not be glossed over.

Compliance over principle

A common thread throughout the aviation impact assessments of various windfarm and near-airport development proposals is what we call the 'compliance approach' – if there is no law proscribing a particular action, then that action is available with minimal (if any) regard to the consequences. In this case, the law in question is that which applies to aerodromes.

Aerodromes in Australia are not regulated by CASA unless the aerodrome operator wants to have a terminal instrument flight procedure (TIFP), to conduct certain air transport operations or otherwise volunteers to be regulated. There is now only one type of regulated aerodrome, a *certified* aerodrome, and the relevant rules are found in Part 139 of the Civil Aviation Safety Regulations (CASRs). Although the new Flight Operations rules that came into force on 02 December 2021 require certain steps to be taken to ensure the availability and serviceability of aerodromes that are not certified, those rules do not impose any specific rules about the physical characteristics of non-certified aerodromes (simply described as ALAs).

Craigwood is not currently certified and therefore not subject to any applicable aviation regulatory standards.

While a proponent pursuing a compliance approach might say that the matter ends there, AusALPA prefers a much more principled approach that explores the deliberate absence of mandatory standards for ALAs and whether that absence prevents the adoption on safety rounds of the standards that might otherwise apply.

To us, an equally important consideration is the impact that a current decision may have for future land use options. If the proposal goes ahead, will the presence of the three wind turbines prevent Craigwood from any possibility of becoming a certified aerodrome in the future?

<u>Deregulation of ALAs</u>

The reason that there are no relevant regulatory standards is to provide the greatest operational flexibility for Australian civil aviation operations[9]. There has long been recognition that ALAs may not be capable of complying with standards typical of certified aerodromes due to a range of pre-existing issues of topography, vegetation

[9] Acceptable Means of Compliance and Guidance Material, *General operating and flight rules*, Part 91 of CASR, Dec 21, p56

and obstacles. The underlying regulatory principle, as we understand it, is that the physical standards that might otherwise apply to an aerodrome of similar characteristics, while not legally prescribed, should be replicated to the greatest extent practicable on the basis that those physical standards have been devised to minimise the risk to flight operations.

The often quoted guidance material set out in CAAP 92-1(1), now withdrawn, was a reduced version of parts of the Obstacle Limitation Surfaces (OLS) for a Code 1 non-instrument runway in accordance with Chapter 7 of the Manual of Standards for CASR Part 139 ("Part 139 MOS"). It is important to understand that the advice in the CAAP was for recommended minimum physical characteristics of landing areas, i.e., a starting point rather than a constraint.

In keeping with the site flexibility philosophy outlined above and the likelihood that the airspace volume may either not be physically available or otherwise severely compromised, the ALA guidance does not include the airspace normally protected for circuit operations at certified runways.

Critically, the conscious regulatory decision to deregulate ALAs in aviation law has never been intended to provide developers with *carte blanche* to do things that interfere with safe flight operations or significantly exacerbate existing operational risks.

AusALPA is strongly opposed to the creation of man-made obstacles in places that in different circumstances would not be permitted both for obvious safety reasons and by laws designed to minimise the relevant risks.

Standards that might otherwise apply

Craigwood has no pre-existing natural or man-made obstacles that would prevent it from complying with the OLS standards for a certified Code 1 non-instrument runway.

Those OLS standards contain additional surfaces to the usually discussed approach and take-off surfaces, known as the inner horizontal and conical surfaces. Although not presently required by the aviation rules, that OLS airspace for a certified aerodrome is nonetheless currently available at Craigwood – as is the minimised operational risk associated with that standard.

Importantly, those additional surfaces enclose the typical obstacle-free airspace that is most familiar to pilots conducting normal circuit operations, i.e., using a range of geographic and vertical cues to manage the aeroplane's energy state and trajectory to safely land or take-off.

This expanded airspace is relevant to how Craigwood is currently used.

Despite some submissions to the contrary, the Woods confirmed to DEWLP on 05 March 2021 that the ALA is used by aircraft flown by other than aerial application pilots. Those pilots are not trained for low level operations in the presence of obstacles and are not flying relatively high performance aircraft. In most cases, they normally fly in airspace that is free of obstacles and that allows them to transition from a safe height into an approach to land.

As discussed above, the additional airspace was not described in CAAP 92-1(1), which deliberately concentrated only on the approach and take-off paths. However, the additional circuit airspace and its relationship to the approach and take-off paths can be easily seen from the following diagram[10]:

[10] see Figure 7.07-1 of the Part 139 MOS or Figure 1 in CASA Advisory Circular 139.E-05v1.0

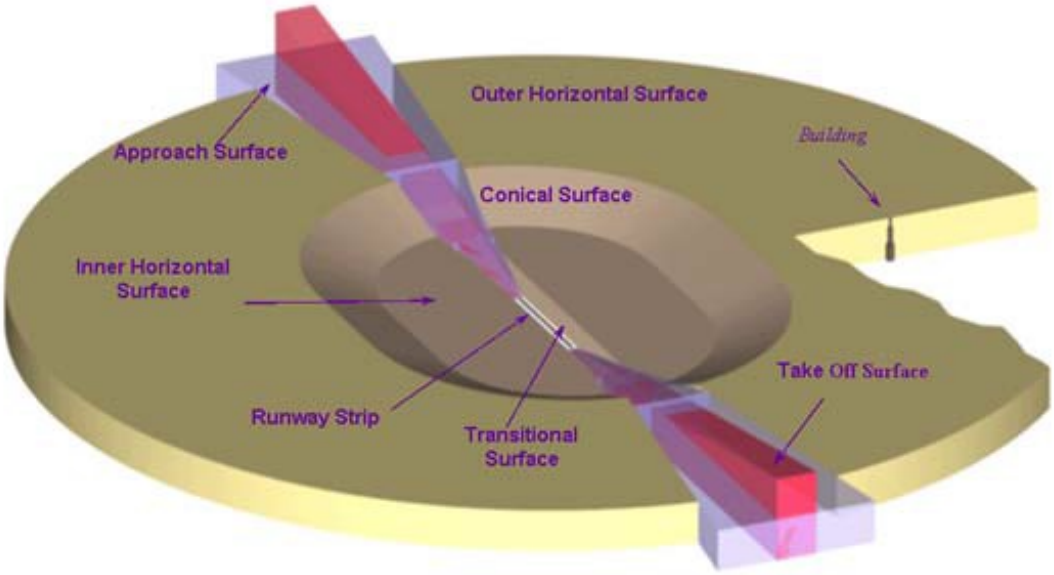


Figure 7.07-1 Relationship of outer horizontal, conical, inner horizontal and transitional surfaces, with an example obstacle (illustrates matters)

The Outer Horizontal surface, which has a radius of 15km and a height of 150m is not relevant to a Code 1 non-instrument aerodrome. The relevant airspace for this discussion is the depression in the middle, comprising the Inner Horizontal and the Conical surfaces. The Inner Horizontal has a radius of 2000m from each runway end with tangents parallel with the runway and is 45m above the runway; and the Conical Surface has an outward slope of 5% extending in height for an additional 35m, thereby extending the airspace by a further 700m.

Contextually, the furthest edge of the Conical surface at 2700m from the runway end is almost double the distance to WTG 215 and about three and one half times the distance to the other two towers. The best depiction of the effect on the airspace for normal circuit operations would be to take the example obstacle (labelled as “building”), increase its height by 150% then place three of them around the take-off surface at 37%, 43% and 72% of the distance of the Inner Horizontal surface from the end of the runway.

AusALPA also notes that most of the proponents’ experts, when referring to the wind turbines as obstacles, only mention the towers while conveniently downplaying the width that comes from the 165m diameter blades rotating during normal power generation.

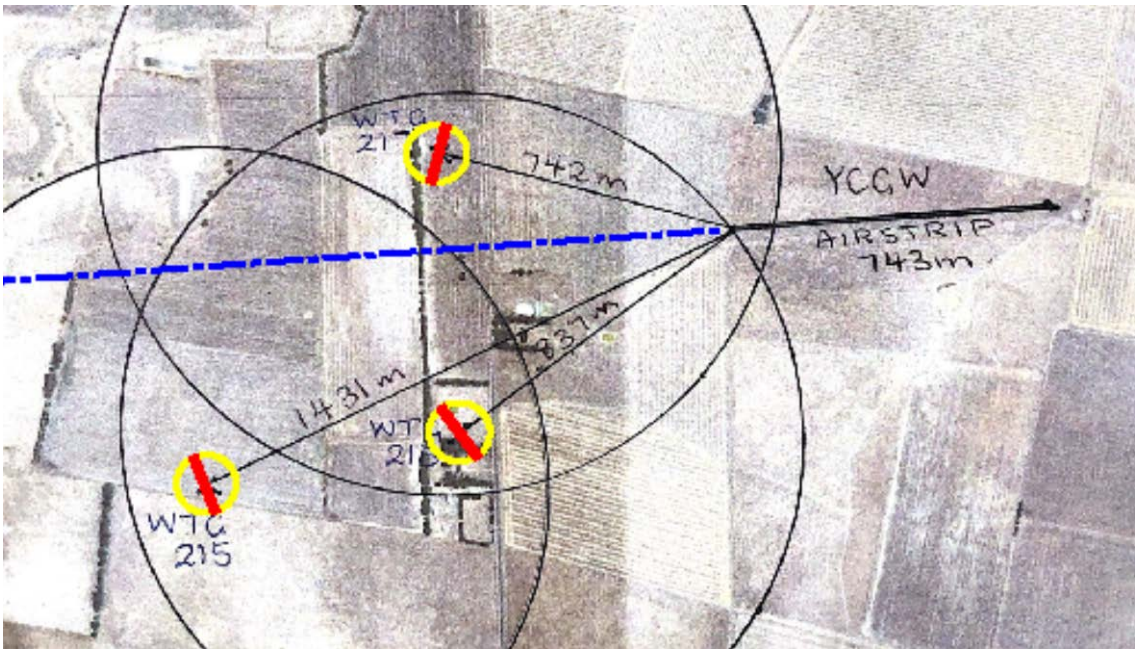
Future certification

Craigwood could never gain certified status if the three wind turbines are built. They would be unacceptable penetrations of the required OLS.

Notwithstanding, even if future certification is not sought, there seems little dispute that normal circuit operations flown by average general aviation pilots cannot safely be conducted into or through the physical obstacles that the three turbines represent.

Risks for aerial application pilots

The proposed wind turbines as obstacles have to be avoided laterally – they are too tall and, depending upon the wind direction, too wide and too close to the runway to even contemplate a vertical option. With the exception of early turns, the inter-tower spacing of around 700m (or, at worst, 545m between blades) does permit a choice of flight paths with apparently adequate clearance. While the main detriment is to efficient operations, physical risk is increased simply because there are now obstacles to avoid that previously did not exist. This is the layout:



THE TURBULENT WAKE OF WIND TURBINES

AusALPA is most concerned about the way in which developers and their agents and consultants broadly trivialise turbulence created by human intervention in the natural environment. While the source of the turbulence may be different and the nature of the turbulent wake may be different, say between buildings versus wind farms, the end result for pilots remains very much the same: excessive turbulence can lead to loss of control close to the ground and the increased likelihood of an accident.

For the absence of doubt, AusALPA does not blindly consider all turbulence to be a safety risk. We are committed to a scientific approach to assessing the expected risk from known turbulent wakes and to detecting all reasonably likely sources of turbulent wakes.

It is particularly unfortunate that at the advent of the wind farm industry there was not a lot of research into the characteristics of the turbulent wakes of wind turbines generally. In the absence of specific research in relation to the intersection of wind power generation and aviation, it seems to us that there was much more speculation than science about the risk of turbulent wakes. When it comes to speculation, it then seems to follow that if you repeat something often enough, it gains some level of credence despite a lack of supporting evidence and, worst of all, dissipates interest in further focused enquiry.

In March 2015, the NSW Rural Fire Service made a submission to the Senate Select Committee on Wind Turbines[11] that included the following:

> The NSW RFS has worked with other fire fighting agencies within the Australasian Fire and Emergency Services Council (AFAC) in developing a national position on wind turbines (see attached).
>
> This position paper concluded that wind turbines **are not expected** to pose **increased** risks due to wind turbulence or the moving blades. Local wind speeds and direction are already highly variable across landscapes affected by turbulence from ridge lines, tall trees and buildings. [emphasis added]

The attached position paper[12] actually states:

> Aerial fire fighting operations will treat the turbine towers similar to other tall obstacles. Pilots and Air Operations Managers will assess these risks as part of routine procedures. **Risks due to wake turbulence and the moving blades should also be considered**. Wind turbines **are not expected** to pose **unacceptable** risks.
>
> Wind farms are not expected to adversely **affect fire behaviour** in their vicinity. Local wind speeds and direction are already highly variable across landscapes affected by turbulence from ridge lines, tall trees and buildings. [emphasis added]

In our view, the submission significantly misquotes the Position Paper in a number of ways, yet it is the submission that is quoted in the Committee Report. There is no evidence (if any) as to what the RFS "expectation" was based upon, yet the quote appears to be commonly used in proponents' documentation to dismiss further consideration of the aviation consequences of turbine wake turbulence[13]. Rarely is it noted in planning discussions that turbine shutdown is a common feature of bushfire plans, which, while minimising risk to aerial firefighting, is essentially irrelevant to the proper consideration of turbine wake turbulence in <u>normal operating modes</u>.

Importantly, the AFAC replaced the Position Paper with a new Guideline in October 2018[14] that clarified the advice to emergency services in relation to turbulence in the firefighting context. There is no longer any commentary about the "expected" level of risk, just a firm requirement to include in risk management plans the case-by-case risks due to wake turbulence and moving blades

AusALPA's assessment of the somewhat repetitive and recycled advice from proponents is that there is a persistent tendency to trivialise the risk associated with the turbulent wake of wind turbines. We believe that there is clear evidence that neither of the two main characteristics of wind turbine wakes, the velocity (momentum) deficit and the increased turbulence intensity, are trivial and that they each and together can severely compromise aircraft handling.

We recommend that DEWLP would gain a great deal of insight by examining the approach taken in NASF Guideline B *Managing the Risk of Building Generated Windshear and Turbulence at Airports* as well as the associated explanatory material, since there are major similarities in the risks to aircraft from these two different situations.

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11 NSW RFS, Submission 97, Select Committee on Wind Turbines Inquiry into the application of regulatory governance and economic impact of wind turbines, 06 March 2015

12 AFAC, Position: *Wind Farms and Bushfire Operations* V2.0, 30 October 2014

13 There seems to be a consistent thread of that approach by the principal of Chiron, both at Chiron and at Ambidji

14 AFAC, Guideline: *Wind Farms and Bushfire Operations* V3.0, 25 October 2018

CASA Advisory Circular 139.E-05v1.0

CASA published AC 139.E-05v1.0 *Obstacles (including wind farms) outside the vicinity of a CASA certified aerodrome* in May 2021. Craigwood is not subject to Part 139 of CASRs, but the AC includes advice to:

- persons involved in the design, construction and operation of wind farms and monitoring masts
- proponents of wind farms and wind monitoring masts
- planning authorities
- aerodrome and aircraft landing area operators
- the Civil Aviation Safety Authority (CASA).

While CASA has not identified the research upon which it has relied, the AC sets out important advice to the target audience:

> 2.2.6.4 Turbulence is a risk to aircraft and aerodrome operations. Studies have proven that for wind turbines of less than 30 m Rotor Diameter (RD) the wake vortices will impact aircraft located up to 5 RD downwind and 2 RD vertically. Turbulence is site specific and information on wake vortices for different turbines may be available from the turbine manufacturer. Wind farm operators should be aware that depending on size, wind turbines may create turbulence noticeable up to 16 RD from the turbine. The level of turbulence and the potential impact on aircraft and aerodrome operations at this distance is not known with certainty.
>
> 2.2.6.5 Planning authorities should consider wake vortices when assessing the location of wind turbines in proximity to an aerodrome, airstrip and associated circuit patterns. The risk to the safety of air navigation from wind turbine turbulence should be mitigated to an acceptable level of safety particularly during critical phases of flight such as landing and taking off. Mitigation may include relocation of turbines away from the aerodrome or airstrip sensitive areas, such as the take off and approach areas, reduction in size of the turbines in question or removal of turbines that may cause a turbulence hazard.

AusALPA suggests that, while there has been virtually no investment in specific studies to examine the consequences for aviation, there are more than sufficient indicators available in the research conducted by the wind farm industry on optimal siting and power generation strategies. These are necessary because the turbulent wake affects the ability of downstream turbines to generate power as well as creating structural fatigue issues for the downstream tower infrastructure, particularly the rotors.

The characteristics of the turbine wake that create these challenges for the power industry are the same as those that affect aircraft flying through the wake of buildings next to runways, the subject of NASF Guideline B.

The nature of the wake

There is an abundance of research material now available on the nature of the wake from wind turbines[15]. Much of the research focuses on providing physical evidence for, and validation of, various wake models[16]. These models will become important in the

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15 See for example Porte-Agel F., Bastankhah M. and Shamsoddin S., 2019, "Wind-Turbine and Wind-Farm Flows: A Review", *Boundary-Layer Meteorology* (2020) 174:1–59, Springer

16 See for example Krishnamurthy R. et al, 2017, "Offshore Wind Turbine Wake characteristics using Scanning Doppler LIDAR", *Energy Procedia* 137 (2017) 428–442, Elsevier

consideration of aviation safety aspects as they will support extrapolation of both the physical and modelled data into the consequences for wake encounters by aircraft, thereby providing greater certainty for both industries. We will present some of the findings to illustrate why planning decision-makers need to fully consider the risk.

The identified wind turbine wake characteristics include the length and width of the wake, wake meandering, velocity deficit and turbulence intensity under various atmospheric conditions.

There are two very common photos of wake length and width:

The first photo is of the Horns Rev 1 installation in the Danish North Sea in 2008. The rotor diameter is 80m and the turbine spacing is about 500m. The wake shown is essentially that of the first row of turbines only, as the wind was about cut-in speed of

around 7.5 kts. Most of the more distant turbines were not rotating. The wake expansion is exaggerated in the low wind, compared with the much tighter wakes shown in the second photo from 2016 for the Horns Rev II installation with the wind around 25-28 kts and all turbines rotating near rated power.

While more dramatic, the wakes in the first photo do not represent any risk to aviation, simply because the ambient wind velocity is too low to create velocity deficits and turbulence intensity of any significance. However, that is not the case for the wakes in the second photo. An aircraft flying through the wake along a trajectory that had a path length of 100m from the edge to the centre of the wake would encounter a velocity deficit of 7kt or more, the hard limit for windshear in Guideline B, whenever the velocity deficit was greater than about 25%. To put that in perspective, consider the following indicative observations from the Krisnamurthy paper[17]:

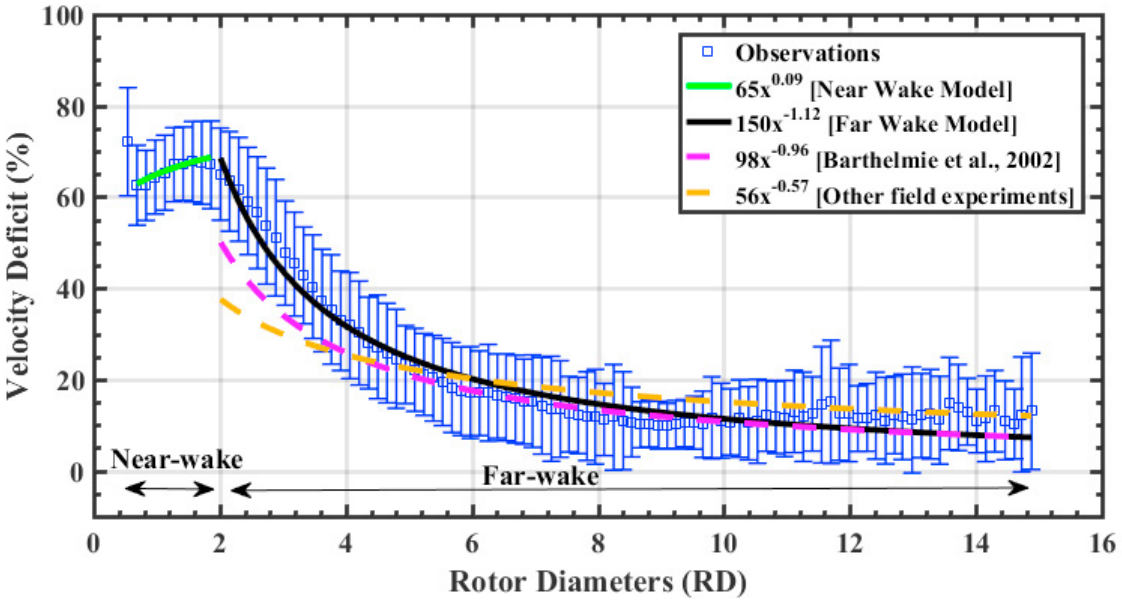

Fig. 9. Average wind turbine wake velocity deficit, 252 samples, as a function of normalized downwind distance (in Rotor Diameter [RD]) from the wind turbine. The error bars indicate one standard deviation of all the samples. Various other proposed models from existing literature are shown as reference.

While this figure conveniently shows 25% at 5 RD, the actual result will depend upon a number of other considerations such as the stability of the atmospheric boundary layer (ABL) and the turbulence intensity of the inbound flow.

Importantly, a wake encounter in aircraft is further complicated by the distribution of turbulence, as distinct from velocity deficit/windshear. Sandia National Laboratories published a paper in 2017[18] that explored improvements to the modelling of wakes:

> Bladetip vortices and wake shear layer cause high turbulence areas near the edge of wakes that are potentially damaging and more dangerous to downwind turbines than the velocity deficits of the center wake [17, 18]. Turbine wake definition should include these vortices and the high turbulent region of the velocity shear layer due to their damage potential. High turbulence areas from bladetip vortices and wake

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17 Ibid.

18 Panossian N, Herges T and Maniaci D, 2017, *Wind Turbine Wake Definition and Identification Using Velocity Deficit and Turbulence Profile*, SAND2017-13530C, Sandia National Laboratories, Albuquerque, NM

shear layer have been observed in simulated, wind tunnel, and full scale tests [19-24]. Because of both turbulence from bladetip vortices and the facilitation of wake entrainment from freestream turbulence [22, 25], wake definitions must consider turbulence.

The paper provides an example LIDAR scan taken from the Scaled Wind Farm Technology (SWiFT) Facility, located in Lubbock, Texas of a 32.1 m hub height and a 27 m rotor diameter turbine:

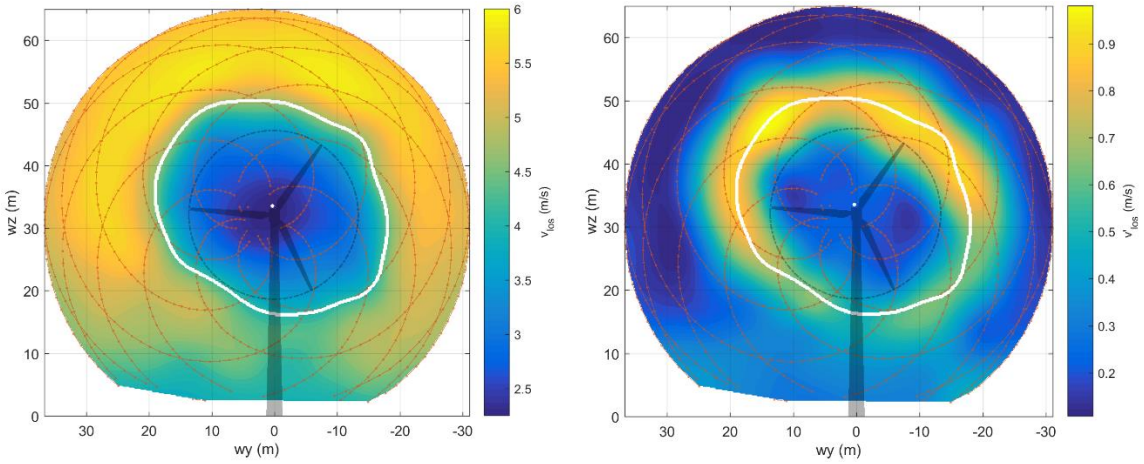
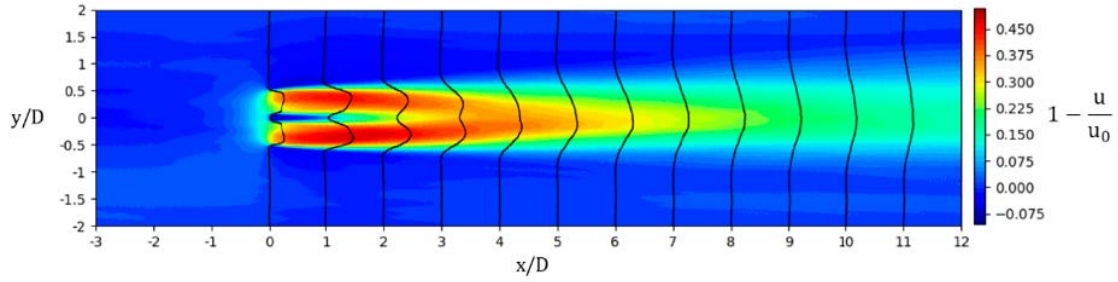
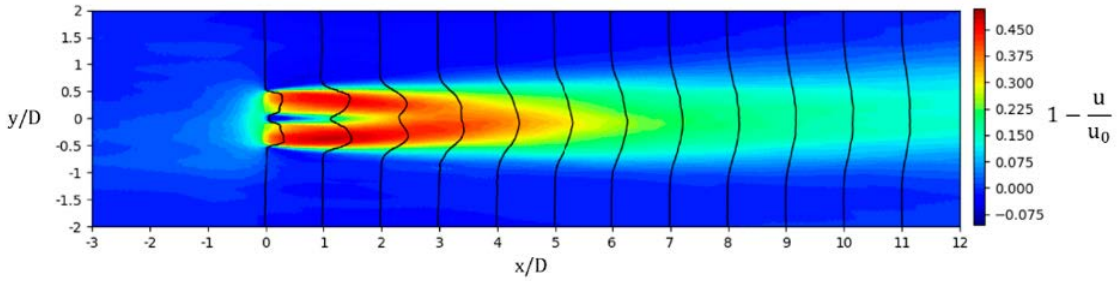


Figure 1: Example DTU SpinnerLidar scan at 2.5 RD downstream during a stable 6 m/s inflow with 0.08 TI and power-law velocity profile exponent, α, of 0.2, (left) line-of-sight velocity v_{los} and (right) lidar probe-volume v_{los} standard deviation, revealing increased turbulence at the edge of the wind turbine wake.

As a final illustration of relevance to Craigwood, the following are from a 2019 paper[19] that demonstrates the variation of the wake in neutral (NBL) or convective (CBL) boundary layer flows. The study was a Large Eddy Simulation (LES) of a 126m diameter turbine with a hub height of 90m:

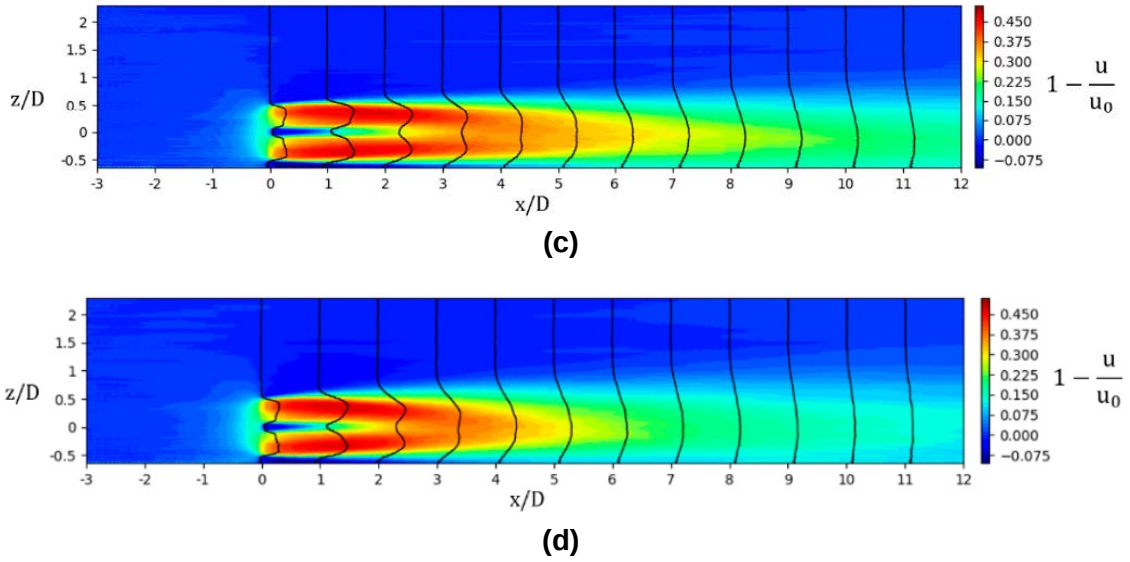


(a)



(b)

19 Ning X and Wan D, 2019, "LES Study of Wake Meandering in Different Atmospheric Stabilities and Its Effects on Wind Turbine Aerodynamics", *Sustainability* **2019**, 11, 6939, MDPI



(c)

(d)

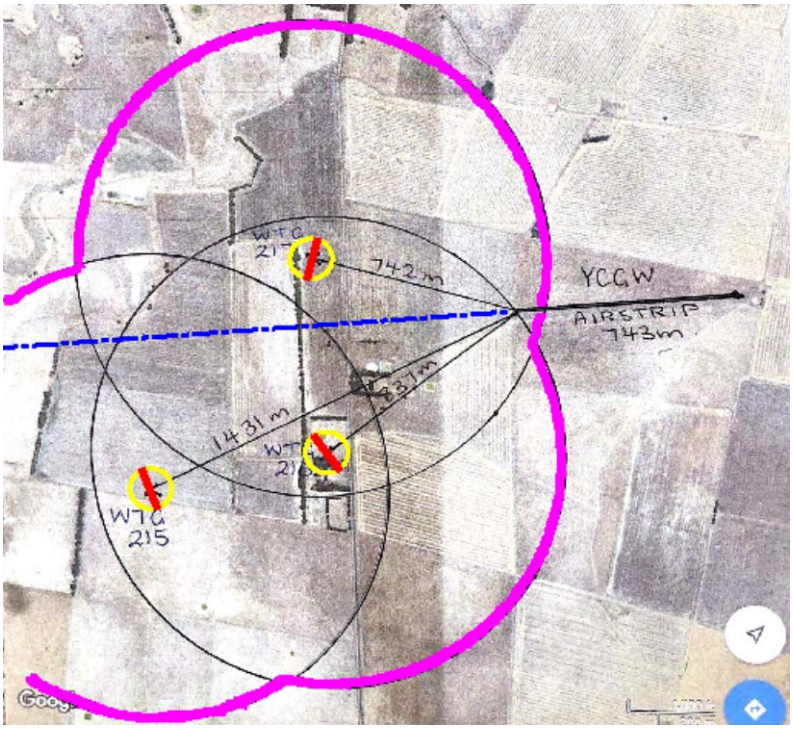
Figure 5. Wake velocity deficit contours and profiles. (a) Hub height x-y plane in NBL; (b) Hub height x-y plane in CBL; (c) Middle x-z plane in NBL; (d) Middle vertical x-z plane in CBL.

The colours in Figure 5 are essentially the traffic light colours typically used in risk assessments. To that extent, the outcomes are self-evident.

AusALPA strongly believes that the various illustrations highlight the foolhardiness of treating wind turbines as simply obstacles to be avoided as well as the pitfalls of considering turbine wakes as fixed well-defined objects with firm deterministic boundaries.

"…CONTINUE SAFELY WITHOUT SIGNIFICANT IMPACT…"

As a final exercise, let us consider the nominal 5 RD rings for WTG 215, 216 and 217:



When the wind is below cut-in speed for the turbines, they are three obstacles that penetrate the normal airspace pilots use to conduct circuits and to take-off and approach the runway. If built to the maximum permitted height of 230m, they will penetrate up to 75% of the normal obstacle-free circuit height. For aerial application, they will force major restrictions on flight paths and increase the time taken to complete the task. Turning before them when departing to the west requires excessive manoeuvring at low level – high angles of bank substantially increase stall speeds and the risk of loss of control.

When the wind is such that the turbines are producing nominal power, they will produce turbulent wakes. Those wakes will overlay normal flight paths and altitudes and, based on comparative studies, will be sufficiently close to the turbines that dangerous velocity deficits and turbulence intensities are most likely to be encountered. For aerial application, there may be reduced risk at very low altitudes close to the towers provided that there are no overlapping or meandering wakes, but that small window is not very predictable given that the wake expands more at lower wind speeds.

AusALPA considers that the construction of the three wind turbines would severely impact the utility of Craigwood ALA by increasing risks to unacceptable levels. We do not believe that Condition 78 can be satisfied.

THE NATIONAL AIRPORTS SAFEGUARDING FRAMEWORK

In 2019, we wrote as part of our submission to the NASF Implementation Review:

> **AusALPA's Commitment to NASF**
>
> AusALPA applauds the achievements of NASAG in creating the NASF. We consider the NASF to be well in the forefront of the essential protection of aviation infrastructure worldwide and we are committed to contributing our operational knowledge to furthering the positive achievements of airport safeguarding in Australia. Critically, we maintain a focus on aviation safety and offer perspectives that we believe that regulators, service providers and aircraft operators have consistently failed to provide in past consultations.
>
> AusALPA recognises the inherent difficulties faced by NASAG participants, particularly those brought about by Constitutional issues and the politics of Federation. While we acknowledge the complexities, we nonetheless believe that the NASF is the best current vehicle to eventually achieve our goal of a standardised national approach to airport safeguarding that applies to all airports in all jurisdictions.

We remain concerned at the commitment of the States and Territories to adopt the NASF Guidelines into local law.

With the exception of Guideline A *Measures for Managing Impacts of Aircraft Noise*, AusALPA considers the remaining Guidelines to be all safety-related and amenable to the application and enforcement at each level of government in Australia. As we said at the outset, our primary concern in relation to the Craigwood ALA and the Golden Plains Wind Farm is with aviation safety as the underpinning philosophy of Australia's airport safeguarding framework.

While we understand the pursuit of a financial settlement as the path of least resistance, at least for DEWLP, that emphasis militates against observers concluding that DEWLP and the Victorian planning processes embrace the underpinning philosophy of the NASF. As we noted, our abiding concern is that planning decisions affecting current and future aviation infrastructure are, for all practical purposes,

irreversible. We are highly conscious of the intersection of private, community, State and national interests in these types of decisions and we accept that the best of balanced outcomes will not always preserve utility for all stakeholders. However, we want those decisions to be based on the best, highest quality advice and with a firm eye on the future.

As we put to NASAG during our presentation in November last year, there are many things that need to be done to update the NASF Guidelines. However, the principles are robust and should drive the culture of all government agencies tasked with safeguarding Australia's aviation infrastructure.

We therefore ask that you encourage a more open approach, both within government and business in Victoria, to the adoption of all of the NASF Principles and the Guidelines. We accept that developing the right legislative approach is time-consuming but for the most part it just needs a champion – as the Minister for Planning, we believe that you are the right person to drive the necessary cultural and legislative change.

If we can be of further assistance, please don't hesitate to contact us.

Yours sincerely,

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