Technical Report for Cambridgeshire County Council -

in response to a planning application submitted by the developer, Novus Environmental, Royston, Ref: S/008/15/CW

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Contents

1. Introduction

This report assesses the potential safety implications for aircraft operations at Duxford Aerodrome as the result of a proposed development, including siting of a chimney stack, immediately to the south-west of the runways. The assessment has been carried out in response to the request made by Cambridgeshire County Council Planning Committee at their meeting of 12 May 2016 with regard to the planning application submitted by the developer, Novus Environmental, Royston, Ref: S/008/15/CW.

The report provides technical evidence as to why the chimney would pose *a significant hazard* (to quote the terminology of Mineral and Waste Core Strategy Policy CS40) and in particular provides evidence (with appropriate distances, speeds, angles, types of aircraft and the implications of engine power loss or other incidents, including those weather-related) showing how safety would be affected from a factual perspective.

It is acknowledged that the height of the proposed chimney obstacle is below the statutory clearance surface currently required by the UK's Civil Aviation Authority for visual flight operations. However, one of our contentions is that regulatory requirements prescribe minimum clearances, and that these clearances would have been based on a sample of operating manuals/data for aircraft – and as such may not be entirely relevant to the realities of operating historic and vintage aircraft (many of which were manufactured without the production of operating manuals as we or the CAA would recognise them) within the context and environs of Duxford Aerodrome.

As requested (per Emma Fitch's email of 13 May 2016) this report also refers to the significance of the grass runway for historic aircraft operation, as distinct from the asphalt runway (Section 3). The report also addresses the assessment and importantly the conclusions made by Alan Stratford and Associates Ltd (detailed within the Planning Committee report) and how these conclusions differ from the experience-based opinion of long-time Duxford aircraft operators (Appendix A).

This report has been reviewed and endorsed by the Chairman of the General Aviation Safety Council; and Chairman of Duxford Aerodrome's Independent Flight Safety Committee.

2. Background and Definitions

This report focuses on why the construction of a 25m (82.9 ft.) chimney would introduce a significant hazard to flying into and out of Duxford Aerodrome.

Notwithstanding this obvious headline item, we request that this report should also be considered in the context of many previous successive (and entirely lawful) Vetspeed/Novus planning applications. Collectively, the perhaps unforeseen effect has been the incremental creation of what is even today something of a hazard to air and road traffic, not to mention a site substantially and negatively impacting the rural vista a non-industrial landscape (with its' historic vistas, both aerial and from the aerodrome).

Figure 1 - Royal Air Force (RAF) Duxford - 1918

The Duxford Aerodrome has been in use since 1918 and has seen and played a significant part in our country's history. Basing of the first operational Spitfire squadron and then key involvement in the Battle of Britain will, we hope, be remembered for all time. Legendary figures such as Douglas Bader and Frank Whittle flew and trained at Duxford. Duxford's Aerodrome, its buildings and place in history is formally recognised by Historic England; the venue attracts over 300,000 national and international visitors a year, which along with the work of our onsite partners supports over 250 jobs within the local economy. Our research shows clearly that our unique selling point is that not only does IWM Duxford have world class collections and accompanying history, but importantly that it is still an operational airfield with living history being made on a daily basis. Duxford has been in operation for 98 years… so far. IWM and its partners have together built a global

reputation as a, if not the, centre of excellence for restoring and flying historic vintage aircraft.

The last point is a key issue and is the driver for our concerns with regard to the safety implications of the Vetspeed site, and in particular the construction of a 25m (82.9 ft.) chimney. Additionally there are issues of uncertain extent with regard to the heat and pollutant content of the chimney emissions.

Duxford has achieved its status as a centre of excellence for vintage aviation and display flying in no small part because it offers a well-managed and safe operating environment within currently manageable restrictions. Flying can be variously for the purposes of; controlled testing to approve newly-restored aircraft, training to develop the necessary old aircraft handling skills in new generations of pilots, retention of existing pilot proficiency, public pleasure whether as participant or onlooker, or for film work.

This combination of structured operation in a dedicated environment has fostered immense developments in practical flying experience and engineering capability at Duxford, and widespread recognition of this by the historic and vintage aviation sector. For such reasons our partner ARC Ltd has recently secured the prestigious contract to refurbish the Royal Air Force Battle of Britain Memorial Flight (BBMF) WWII Lancaster bomber. ARC Ltd are world leaders in restoration and maintenance of Spitfires and Hurricanes, and are operators of their own Bristol Blenheim.

de Havilland Support Ltd is the custodian of original de Havilland Aircraft Company design data and the source of advice worldwide for all topics pertinent to aircraft such as the Tiger Moth, Dragon Rapide, Chipmunk and Scottish Aviation Bulldog.

The Fighter Collection own and operate one of the world's premier private collections of 'Warbirds' (former military fighter and bomber aircraft) and deliver the renowned 'Flying Legends' air show every July at Duxford. Visiting vintage aircraft and public visitors alike are attracted from all over the world.

These operations are subject to CAA oversight and to external validation, not least by Insurers. The test flying of any aircraft is tightly managed, and involves planning for the eventuality of a partial or complete engine failure, or indeed other shortcomings which may exist until diagnosed and corrected. During the testing phase the ability of an aircraft/pilot combination to manoeuvre effectively, or to deal with unexpected external factors such as air turbulence or sudden changes in temperature, may well be less than when more operating experience has been gained. Despite all precautions the reality of Human Factors experience is that it is at such times of stress that an 'obvious' issue, such as an obstruction, may be overlooked and lead to an avoidable accident.

Definitions

Duxford Aerodrome constantly reviews its risk management approach, both for general day to day operations and airshows. Given reference to the term 'significant hazard' we look here to quantify that term. In terms of 'significant' we define this (in line with standard English) as 'sufficiently great or important to be worthy of attention; noteworthy'.

In terms of the word 'hazard' we define this (both in terms of the standard English of the noun; and in line with the Health & Safety Executive's definition) as 'a potential source of danger: a safety hazard' and; 'a hazard is something (e.g. an object, a property of a substance, a phenomenon or an activity) that can cause or lead to adverse effects'.

This report looks **therefore as to whether the proposed introduction of a new 25m (82.9ft) chimney represents a new 'significant hazard'** using the definition set out: 'a potential source of danger'.

In addition Appendix C shows the Civil Aviation Authority's definitions with relation to 'hazards', included in CAA Safety Management Systems (SMS) Guidance for Organisations CAP795 – CAA February 2015. Making an informed assessment, any incident of an aircraft clipping or flying into a 82.9ft (25m) metal chimney stack is likely to lead to either a "Catastrophic consequence (i.e. Results in an accident, death or equipment destroyed); and/or a Hazardous consequence (i.e. Serious injury or major equipment damage).

Apart from the risk of an aircraft simply flying directly into the proposed chimney stack because of its location, weather conditions and pilot factors - given that on average there is approximately one 'forced landing' in the surrounding area per annum (see section 4 'Safety Scenarios' for some causes/contributory factors) we would assert that the likelihood of occurrence would be either "Occasional (i.e. Likely to occur sometimes (has occurred infrequently); and/or Remote (i.e. Unlikely to occur but possible (has occurred rarely), with reference to CAA definitions.

Applying any combination of these, would result in the risk being deemed 'unacceptable' using the Civil Aviation Authority's hazard/risk matrix as at Appendix C.

3. Airfield Operations in Context

Duxford Aerodrome sees in excess of 25,000 aircraft movements per year; with an approximate 50/50 split between use of the grass runway (06L/24R) and the asphalt runway (06R/24L). It is worth noting that many historic/vintage aircraft need to utilise the grass runway for controllability reasons, or because at the rear they feature a

skid rather than a wheel. The larger historic/vintage aircraft, and modern aircraft, tend to use the asphalt runway.

Because of the prevailing wind direction in East Anglia, the great majority of take-offs and landings at Duxford are made in a south-westerly direction. This is fortuitous as the phase of flight in which a pilot has least time to react to any emergency, and if necessary position for a low circuit to land or an off-aerodrome landing, is during the initial climb directly after take-off. To the south-west the terrain remains relatively open and unspoilt other than for hedgerows and foliage (see Figure 4, page 18), which are at least relatively frangible if impacted by an aircraft. Conversely, to the north-east the Duxford surroundings have become significantly congested by the development not only of housing but also commercial properties for Volvo, Welch's Transport, Holiday Inn Express and BP.

The Aerodrome operates as a Category Level 2 airfield on a day to day basis, but increases to Category 3 on airshows and as and when specific larger aircraft are due, for example the BBMF Lancaster. Please see Appendix B which explains the different categorisations and the work of Duxford Aerodrome's Rescue and Fire Fighting Service.

Duxford Aerodrome boasts a multiplicity of home-based piston-engined historic/vintage aircraft dating from WW1 to the 1960s; modern light aircraft are also resident at Duxford. Daily visitors can encompass piston, turboprop and occasionally jet types, and also civil and military helicopters including those of the emergency services.

Historic/Vintage

- Spitfire (all marks) and Hurricane - mainly Grass Runway (06L/24R)
- B17 (Flying Fortress) - Hard Runway (06R/24L) only
- Bristol Blenheim - mainly Grass Runway (06L/24R)
- P51 Mustangs - Hard (06R/24L) and Grass Runway (06L/24R)
- Tiger Moths - Grass Runway (06L/24R) only due to skid undercarriage
- DH Rapides - Hard (06R/24L) and Grass Runway (06L/24R)
- DHC-1 Chipmunks - Hard (06R/24L) or (mainly) Grass Runway (06L/24R)
- Catalina Amphibian - Hard (06R/24L) and Grass Runway (06L/24R)
- P40 Kittyhawks - mainly Grass Runway (06L/24R)
- Hawker Biplanes – Grass Runway (06L/24R) only

Light/Modern General Aviation (representative types only)

- Cessnas* - Hard (06R/24L) and Grass Runway (06L/24R)
- Cherokees* - Hard (06R/24L) and Grass Runway (06L/24R)
- Robins* - Hard (06R/24L) and Grass Runway (06L/24R)
- PA34 Seneca - Hard (06R/24L) and Grass Runway (06L/24R)

*These types of aircraft are non-historic but regularly visit Duxford carrying the sizeable number of Museum visitors who are able to arrive by air. Further, such aircraft attend from other airfields for training purposes, as Duxford is recognised as a safer site for this purpose than the many airfields which have become encircled by habitation to the extent of having restrictions.

> ***"Accidents such as failure to get airborne, collision with obstacles after take-off and over-run on landing occur frequently to light aeroplanes…."***
>
> Section 1 Introduction (a) CAA SafetySense Leaflet 7c Aeroplane Performance – CAA January 2013

However, it has to be accepted that visiting pilots, even when diligently briefed, will be less familiar than Duxford pilots with local obstructions.

Defining the precise operational and performance capability of many historic and vintage aircraft is problematic as such data was not required to be codified for civil aircraft prior to 1949, and may never have been measured with precision for ex-military types. For the latter, adequate but not exhaustive information will be embedded in the bespoke Permit to Fly limitations which the CAA raise before allowing such aircraft to fly in the civil environment. Non-aviators might reasonably regard historic and vintage aircraft operation as analogous to classic car motoring, for which not every modern requirement may be practicable to meet. Adequately safe operation (with risks rendered ALARP, 'as low as reasonably practicable') is nonetheless obtained by applying a sensibly cautious approach to operation, and by allowing some margin of error as insurance against a worst case event.

Grass Runway

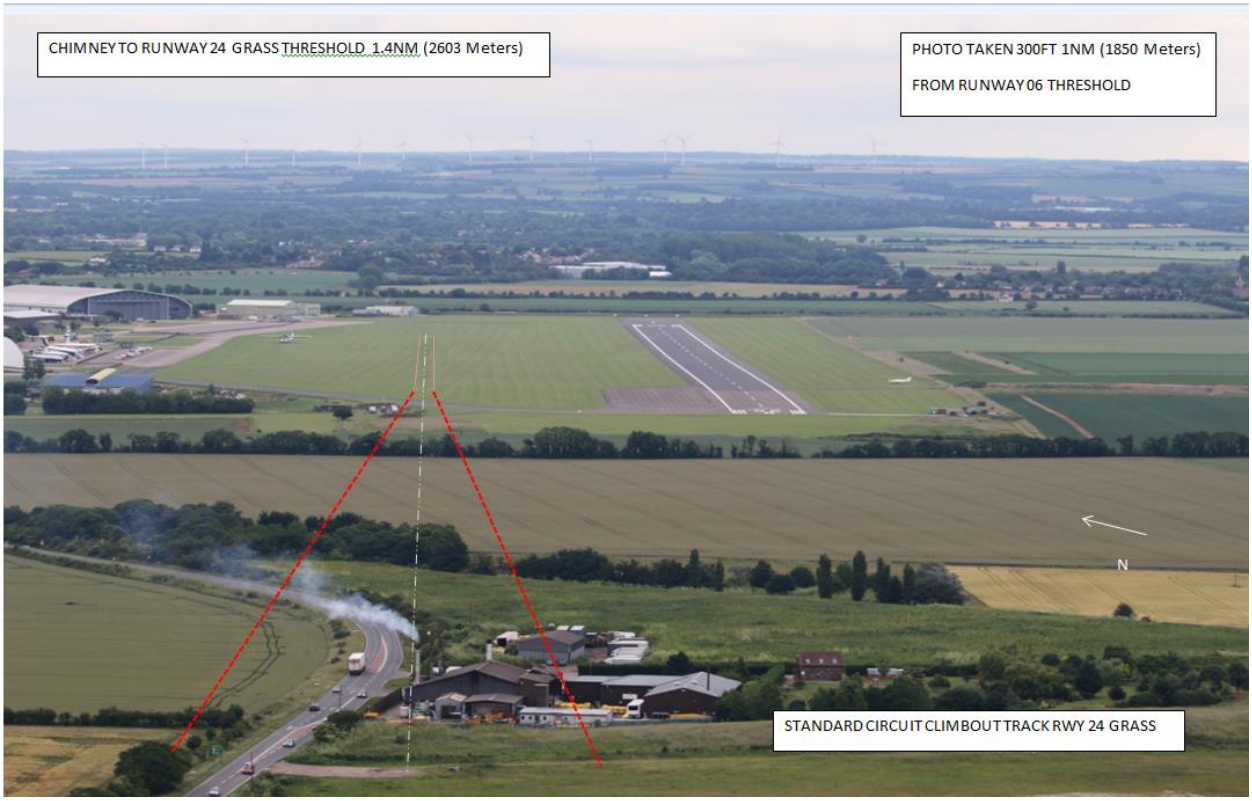
The current proposal / planning application submitted by the developer, Novus Environmental, Royston, Ref: S/008/15/CW is to construct and introduce a new 25m (82.9ft) chimney in line with our grass runway, and just over 1 kilometre away (please see Figure 2(a) below). Figure 2(a) shows and highlights the grass runway in respect to the current Vetspeed/Novus International processing plant.

Figure 2(a) - Grass Runway (06L/24R) at Duxford Aerodrome

Plainly the higher chimney, and the breadth of the Vetspeed site in general is of greatest significance for departures from the grass runway. However, especially with slower aircraft types, it is not always the case that the runway heading will be tracked accurately during the initial climb. In crosswind conditions an aircraft must compensate for drift, like a ferry boat seeking to cross a flowing river, and the correction required will normally increase as height is gained and windspeed increases. The slower flying the aircraft, the greater the correction required. Given that the pilot's view directly forward from a climbing aircraft can be limited by the nose ahead, it is not unusual for the achieved flight path to deviate slightly left or right of the extended runway centreline. Thus, in conditions of a strong southerly wind, an aircraft having taken off from the paved Runway 24 could well find itself tracking over the Vetspeed site.

With smaller lighter aircraft they are more subject to and affected by 'wind drift' i.e. the effect of wind buffeting the aircraft, pushing the aircraft across and diverting the aircraft from the planned path. The degree to which an aircraft will move of course will depend on both the aircraft, the experience of the individual pilot, aircraft performance and of course the wind speed and direction. The image overleaf (Figure 2(b)) shows some possible impact this can have, with the red-dotted lines indicating possible drift/divergence.

Figure 2(b) - Grass Runway (06L/24R) at Duxford Aerodrome (Drift)



It will be noted that we concentrate here on the case of aircraft taking off in a south-westerly direction, rather than landing to the north-east. This is because in visual flight conditions we assess the take-off and initial climb to entail much greater risk of emergency or error than a stable approach to land. In the take-off case the aircraft and engine performance is not yet proven on that particular flight, the nose is high and forward view obstructed, the pilot may be regaining familiarity having not flown recently, and a sudden failure will require decisive and correct action to change the aircraft pitch attitude, maintain flying speed and obtain a safe outcome.

In contrast, the landing approach by definition occurs when both pilot and aircraft are in steady state operation, and is characteristically a more measured operation. In turn, this frees mental capacity for other tasks, and improved spatial awareness in respect of avoiding known obstructions will certainly be one benefit. Nonetheless, chains of events can conspire to cause 'undershoot' accidents such as that which occurred in 1989 at Kegworth near East Midlands Airport.

With specific reference to Engine Failure After Take-Off (EFATO) training/testing, at Duxford Aerodrome for safety reasons this has to be undertaken for both asphalt and grass runway take-offs away from the M11 i.e. in the direction of the Vetspeed/Novus International processing plant. This is primarily due to the M11 itself and the considerable concentration of buildings in the surrounding area.

4. Safety Scenarios

IWM Duxford acknowledges that the height of the proposed chimney is lower than the statutory clearance height currently required by the UK's Civil Aviation Authority. However our assertion is that those statutory clearance heights are not entirely relevant to the operational realities of operating historic and vintage aircraft within the context and environs of Duxford Aerodrome.

As requested by the Planning Committee we have endeavoured for various types of aircraft to provide factual evidence to show the safety implications of a loss of engine power or other arising.

In order to ensure that our assessment of risk is relevant we have used scenarios based on some of the aircraft that currently regularly fly from Duxford (see Section 3).

Each type of aircraft has different capabilities and practical limitations. Historic and vintage aircraft are generally:

- Affected by changes to atmospheric conditions, especially high ambient temperatures, wind, and air turbulence;

- Extremely subject to 'blind spots' directly in the pilot's forward field of view. This issue is greatly exacerbated when climbing with the aircraft nose pointed well above the horizon. *Spitfires are notoriously blind for approximately 300ft in front of the aircrafts nose*;

- In need of more generous margins for prudent operation, given that actual performance capabilities may be uncertain – especially during the initial test flying of rare or unique aircraft types for which no recent experience exists;

There are numerous factors which can impact on a pilots or aircrafts performance. However in line with the Planning Committee's specific concerns this report focuses on:

- *Temperature*
- *Weather Conditions*
- *Emissions*
- *Engine Failure*

Temperature

Hot summer days – or local areas of elevated temperature downwind of an industrial exhaust – imply a reduction in air density which can be very significant for the efficiency of aircraft wings, propellers, and engines. The combined effect is to

lengthen the take-off run of any aircraft, and to reduce both the rate and gradient of initial climb.

> ***"Temperature: performance decreases on a hot day. On really hot days many pilots have been surprised by the loss of power in ambient temperatures of 30°C and above. Remember, temperature may be low on a summer morning but very high in the afternoon."***
> Section 5 General (e) CAA SafetySense Leaflet 7c Aeroplane Performance – CAA January 2013

For all Duxford aircraft, high temperature operations will require use of a markedly greater length of the runway in order to achieve the requisite air speed. The subsequent climb will also be shallower in these conditions, reducing clearance over any ground obstacles in the flight path.

Therefore a prudent assumption is that an aircraft may only leave the ground at the very end of the grass runway nearest to the Vetspeed/Novus Environmental site which is 0.84nm/1,572m from the end of the grass runway.

In addition if an aircraft were to fly through emissions which will assume are at 35 degrees centigrade as per ASA Ltd's report, this could adversely impact on the aircrafts engine performance.

Weather Conditions

In addition to the effects of temperature, weather conditions can also adversely affect aircraft in two key ways. Firstly, wind or temperature-induced turbulence may require considerable pilot attention to maintain a desired air speed and/or to track a desired path. Corollaries of this fact are a potential reduction in climb performance, due to drag caused by the deflected control surfaces, and diversion of pilot attention. Likely outcomes are a failure to make good the ideal departure track and a diversion of mental capacity and spatial awareness. Inadvertent drift into the emissions from the chimney stack, or into the chimney stack itself, are conceivable in these circumstances. The strength of the wind can 'buffer' aircraft, particularly small lighter aircraft, making manoeuvring the aircraft more difficult. This can take new or trainee pilots in particular by surprise, and if they do not or cannot take avoiding manoeuvres this could lead to aircraft drift directly into the emissions from the chimney stack, or the chimney stack itself.

"Manoeuvre performance: '…..outside air temperature/ altitude will similarly affect engine power available."
Section 5 General (m) CAA SafetySense Leaflet 7c Aeroplane Performance – CAA January 2013

Secondly weather or into-sun conditions can sometimes make obstacles hard to see, just as when driving. This combined with the blind spots on some vintage and historic aircraft would mean that a 25m (82.9ft) chimney stack provides a correspondingly greater risk to such aircraft than at present. A chimney seen from the air against a background of terrain may become to all intents invisible.

Impact of emissions

It is worth noting that we understand that the full implications of the emissions have not yet fully been assessed. However with reference to ASA Ltd's report it states that the emissions temperature would be 35 degrees centigrade, presumably continuously.

Having consulted with pilots of vintage/historic aircraft the consensus is that:

(1) In a marginal case the potentially elevated air temperature could have an adverse impact on engine, aircraft and propellers performance, albeit temporarily, reducing the rate of climb after take-off (slowing of their engines and dropping of altitude).

(2) Air turbulence generated by an upwind heat source could cause upset to lighter aeroplanes, requiring coarse control inputs for correction and which in turn create drag and reduce rate of climb. [Note: an established Gas Venting Station between Duxford and Ickleton is regarded as sufficiently hazardous to be marked on aeronautical charts]

(3) There was concern from some Duxford pilots as to possible health implications – noting that some aircraft do not have enclosed cockpits. [Odours from the existing chimneys are sometimes very noticeable even at ground level on Duxford Aerodrome]

Engine Failure

There are numerous reasons for an aircraft of any age to suffer a partial or complete engine failure after take-off. A most basic cause is when ground refuelling has accidentally occurred with an unsuitable grade. It is the landing options available (along with the experience of the pilot) which can make all the difference to the final outcome.

As a generality it is most often the case that unsuspected problems will surface in the early moments of a flight, just after take-off and while climbing away from an

aerodrome. At this time the physical demands placed upon the engine and its cooling are greatest and steady state operation has yet to establish. Other equipment, such as that for undercarriage retraction or electrical generation, may be first used at this time – with attendant specific forms of other emergency therefore becoming possibilities.

"In the event of engine failure after take-off, achieve and maintain the appropriate approach speed for your height. If the runway remaining is long enough, re-land; and if not, make a glide landing on the least unsuitable area ahead of you. It is a question of knowing your aircraft, your level of experience and practice…….. Attempting to turn back without sufficient available energy has killed many pilots and passengers. (One day, at a safe height, and well away from the circuit, try a 180° turn at idle rpm and see how much height you lose! – then remember you will probably have more drag, and have to turn more than 180º, in a real situation.)"

Section 20 Take-Off (d) and;

"Do not apply extreme control movements at any time."

Section 26 Speed Control (g) CAA SafetySense Leaflet Good 1e Airmanship – CAA January 2013

Importantly an aircraft may face difficulties not because of a singular factor, but as recognised by the Civil Aviation Authority an aircraft may face difficulties due to a combination of factors, for example external temperature exacerbating the consequence of engine failure (i.e. reduced manoeuvrability).

The following scenario(s) endeavour to set out scenarios under 'good conditions' and scenarios under conditions pilots and crews could face.

Example Scenario

Duxford Aerodrome is home to dozens of historic and vintage aircraft as well as smaller modern aircraft. In order to provide actual and factual examples referenced below are scenarios which cover two popular and iconic Duxford resident aircraft: the de Havilland Rapide; and the Bristol Blenheim; it is also worth noting the concerns with regard to the Royal Air Force Aerobatic Team display team, *the Red Arrows*.

Scenario: de Havilland Rapide

The de Havilland Rapide is an early twin engine biplane airliner which dates from 1934. It was still used on the Scilly Islands route by British European Airways (BEA) as late as 1964. At IWM Duxford these aircraft have been used for 33 years to carry up to 8 passengers at a time on aerial tours of Duxford and the locality.

Thanks to its BEA history, the Rapide aircraft benefits from unusually comprehensive performance charts for a vintage aircraft. From them can be deduced the angle of climb after take-off from Duxford's grass Runway 24.

- Realistic assumptions are made as follows:
- Propeller type X9 [representative of the propellers used on the Duxford Rapide aircraft]
- Aircraft at 5,750 lbs take-off weight [250 lb less than maximum permitted]
- Air temperature 30°C
- Nil wind

In which circumstances:

Case A:

With both engines running normally, the gradient of climb can be 7.74% upward. [4.4° above horizontal]

Case B:

With one engine stopped (e.g. after a failure) the aircraft will descend on a gradient 2.31% downward. [1.32° below horizontal]

From which two illustrative scenarios are:

> ***Case A:***
> With both engines running normally, and if lift-off from grass Rwy 24 occurred only at the extreme end of the licenced run, with approx. 1569m horizontal distance to the Vetspeed site, the Rapide aircraft would clear a 25m chimney by 95m vertically.
>
> ***Case B:***
> If on take-off from grass Rwy 24 the aircraft had achieved 36m height above the extreme end of the licenced run - which would be typical - and one engine then failed, and the aircraft continued straight ahead, the aircraft would descend on a gradient 2.31% downward to impact the Vetspeed site at ground level.

Case A is marginal in terms of obstacle clearance and peace of mind, but is permissible in regulatory terms for a take-off event. Please note, however, that even

a CAA Air Display Permission would not allow a Rapide aircraft to fly this close to occupied buildings or to persons.

Case B indicates that an engine failure shortly after take-off is an extreme emergency situation for this aircraft type, especially at high take-off weights and in elevated ambient temperatures. The likely best outcome is a controlled descent to an off-airfield landing. Scope for turning either to left or right is limited as any such manoeuvre would increase the rate of descent. The continued availability of un-developed areas ahead of the take-off path is thus very much a matter of flight safety. Irrespective of the proposed taller chimney, the growing proportions of the Vetspeed operation have already impinged markedly on a pilot's emergency options to the south west of Duxford Airfield (See Figure 4).

"Twin engines: if there is an engine failure after lift-off on a twin, you will not reach the scheduled single engine rate of climb until:
• the landing gear and flaps have retracted (there may be a temporary degradation as the gear doors open); and
Under limiting conditions an engine failure shortly after lift-off may preclude continued flight and a forced landing will be necessary. ……• Performance and stall speed margins will be reduced in turns. All turns must be gentle."
Section 6 Take-Off Points to Note (c)- CAA SafetySense Leaflet 7c Aeroplane Performance – CAA January 2013

Figure 3 - View of the Grass Runway with the Vetspeed/Novus International processing plant directly ahead

Scenario: Bristol Blenheim

The Aircraft Restoration Company Ltd which operates out of Duxford Aerdrome and renovates, maintains and operates Spitfires, and has recently secured the contract to service and carry-out maintenance of the BBMF's Lancaster Bomber (including installing and testing new engines), also restored and operates the only surviving Bristol Blenheim.

The Aircraft Restoration Company Limited have provided their analysis of scenarios pertaining to the Bristol Blenheim with regard to the safety implications at **Appendix D**.

Scenario: The 'Red Arrows'

The Royal Air Force Aerobatic Team (Red Arrows) as per Military Aviation Authority requires any aerodrome where they are to perform to highlight any obstruction in excess of 50ft above Aerodrome Level (Note the current chimney is slightly under this at 49ft 2.5inches (15m).

The Red Arrows re-assess their risks of displaying at aerodromes and airshows. 2016 has already seen them perform at Duxford, at the same time as ceasing to perform at a number of other aerodromes/airshows. It has been indicated that the

construction of a 82.9ft (25m) chimney would mean the Red Arrows would need to reassess whether they could continue to support airshows and displays at Duxford,

The image at (Figure 4) below helps show the line of the runway in line with the Vetspeed/Novus Environmental processing plant. This currently also shows the fields in which forced landings often take place.

Figure 4 - View of Duxford Aerodrome Runways with the Vetspeed/Novus Environmental processing plant directly ahead, and the likely area for 'forced landings'

Duxford Aerodrome Rescue and Fire Fighting Service has not only provided support to local incidents not related to the aerodrome; but they attend and provide emergency support/service to incidents both inside the aerodrome and in the surrounding fields involving aircraft (related to forced landings) including the fields adjacent to the Vetspeed/Nous Environmental site.

In addition the operational size of the site will further expand with the introduction of internal service roads, push the operations further south, further in line with Duxford Aerodrome's runways.

5. Conclusion

So in summary would the erection of a 25m (82.9ft) chimney be:

(1) New?
Answer: Yes self-evidently. Although attached to an existing site and expanding operation, It would be new. It is not a like for like replacement. It is as we understand a brand new chimney and at 25m (82.9ft) it is 60% (10m/33.2ft) higher than the existing chimneys.

(2) Significant?
Answer: Yes. It would be new; and it would be significantly higher than any other obstacle in the immediate vicinity, and 60% higher than the existing chimneys. Therefore it is and would be 'noteworthy'. Indeed with reference to ASA Ltd's report it would need to be flagged as an obstacle to aircraft coming into or out of Duxford Aerodrome; it would also need to be notified to the Royal Air Force Aerobatic Team (Red Arrows) as per Military Aviation Authority requirements highlight any obstruction in excess of 50ft above Aerodrome Level (Note the current chimney is slightly under this at 49ft 2.5inches (15m).

(3) A Hazard?
Answer: Yes. Any upstanding protrusion or obstacle whether temporary or permanent, in a potential flight/take-off/landing path and so close to an aerodrome is self-evidently a hazard, a 'potential source of danger'. If an aircraft were to fly into or clip the proposed chimney it could, and would in all probability, lead to a serious and possibly fatal incident. This could include fatal or life-changing injuries not only to the pilot/crew/passengers but of the aircraft but also those working or visiting the Vetspeed/Novus Environmental complex, and possibly traffic/users of the A505 immediately next to the site.

Therefore we believe that because of the case set out above in this report that the proposed new chimney stack would represent **a *significant hazard*** (to quote the terminology of Mineral and Waste Core Strategy Policy CS40).

This would therefore put flight safety at risk, and therefore in all probability the long-term continuation of Duxford Aerodrome as an operational airfield after nearly 100 years of historic service; the success of IWM Duxford as Cambridgeshire's premiere visitor attractions, which is of national and international historical importance; our educational programmes including our practical STEM focus; on-site partner businesses focused on the restoration and maintenance of historic and vintage aircraft, pilot training and pleasure flights and the continuation of air-shows – all of which directly support over 300,000 visitors, and 250 jobs.

Report End

References:

1. Royal Air Force Red Arrows Support Manual 2016 Season – Royal Air Force Aerobatic Team (RAFAT)

2. Flight safety implications of a proposed chimney stack to be sited near Duxford airfield: Consultant's Report February 2016 – ASA Ltd on behalf of Cambridgeshire County Council

3. Email: Clarification of requirements in relation to the Pyrolysis Plant Application (S/0008/15/CW) following Planning Committee
   From: Fitch Emma Sent: 13 May 2016 11:58hrs

4. CAA SafetySense Leaflet 7c Aeroplane Performance – CAA January 2013/CAA Website 2016

5. CAA SafetySense Leaflet Good 1e Airmanship – CAA January 2013/CAA Website 2016

6. CAA Safety Management Systems (SMS) Guidance for Organisations CAP795 – CAA February 2015

7. CAA Air Navigation: The Order and Regulations CAP 393 – CAA, Fourth Edition April 2015

Appendix A

Response to ASA Limited Report Conclusions

With regards to the *conclusions* of Alan Stratford Associates Ltd can be as follows:

a) *As a CAA licensed airfield, Duxford must ensure that no obstacles breach the (minimum) take-off and climb and approach surfaces. At Duxford, both the take-off and climb and the approach surfaces would be approximately 25m above the top of the propose chimney, so no breach would occur.*

   As per our report, IWM Duxford agrees that acknowledges that the height of the proposed chimney is lower than the statutory clearance height currently required by the UK's Civil Aviation Authority. However our assertion based on the analysis we have carried out (and summarised in this report) is that those statutory clearance heights are not relevant to the operational realities of operating historic and vintage aircraft within the context and environ of Duxford Aerodrome.

b) *Based on a typical 3 degree glide slope surface, landing aircraft would clear the chimney by some 43.29m (or 142.0ft). This represents an adequate clearance height for both vintage and more modern aircraft.*

   The majority of Historic and Vintage aircraft do not have technical operating manuals as with modern aircraft (post 1970). Many of the historic and vintage aircraft all of whom operate safely out of Duxford Aerodrome operate under a 'Permit to Fly' issued by the CAA, rather than the 'Certification of Air Worthiness'.

   This calculation does not take into account the potential consequences of an aircraft developing technical difficulties – remembering Duxford Aerodrome is a centre of excellence for the refurbishment, renovation and maintenance of historic and vintage aircraft.

   Therefore having consulted with over 40 pilots and engineers of historic and vintage aircraft - we would submit that the historic and vintage aircraft are not 'typical' and therefore reliance on ASA Ltd's application of 'a typical 3 degree glide slope surface' would represent a risk.

   In addition many student pilots train in and around Duxford Aerodrome.

   The Royal Air Force Aerobatic Team 'the Red Arrows' fly practiced routines including their signature synchronised pair rountines which they fly at 100ft above the ground, at 600 miles per hour. The Royal Air Force Aerobatic Team

require aerodromes to inform them of any obstacles above 50ft, within 6 nautical miles. The proposed chimney stack is 82.9ft. We believe that if this chimney stack was to be built it would potentially put such displays at risk.

c) *All aircraft using Duxford could turn after take-off to avoid the chimney stack and smoke plume.*

This presumes that no performance issues arise with the aircraft on take-off or approach – remembering that Duxford Aerodrome is home to vintage and historic aircraft, their flying, maintenance, testing and pilot training. It is worth noting that performance issues with aircraft are more probable during and just after take-off and when coming into land with changes to engine stress as well as with landing gear, and flaps.

In addition there are already a number of avoid/restricted areas, the erection of this 25m (82.9ft) stack would introduce a new additional hazard and therefore restriction, which in turn would make flying into and out of Duxford Aerodrome more complex; and reduces the options for manoeuvring and/or recovery action in the case aircraft develop technical difficulties. Aircraft have previously had to carry out emergency landings in the fields directly in line with the runways.

d) *Smaller vintage and more modern aircraft would make a curved approach into the airfield to avoid overflying the chimney and would avoid the smoke plume.*

There are already a number of avoid/restricted areas, the erection of this 25m (82.9ft) stack would introduce a new additional hazard and therefore restriction, which in turn would make flying into and out of Duxford Aerodrome more complex; and reduces the options for manoeuvring and/or recovery action in the case aircraft develop technical difficulties. Aircraft have previously had to carry out emergency landings in the fields directly in line with the runways.

e) *Larger vintage and more modern aircraft use the asphalt rather than the grass runway and therefore do not directly overfly the chimney on approach. Even if the grass runway were to be used, the clearance height would be sufficient.*

This presumes that no performance issues arise with the aircraft on take-off or approach – remembering that Duxford Aerodrome is home to vintage and historic aircraft, their flying, maintenance, testing and pilot training. It is worth noting that performance issues with aircraft are more probable during and just after take-off and when coming into land with changes to engine stress as well as with landing gear, and flaps.

f) *There are no safety risks imposed by aircraft flying through the smoke plume and pilots would not inhale the smoke fumes.*

Given the fact that most vintage and historic aircraft will depart and land on the grass runway; and that our understanding is that the emissions will reportedly include nitrogen dioxide amongst other noxious gases there is a likelihood some of those gases could enter the cockpits some of which are not enclosed.

g) *If desired by the IWM, or required by the CAA, information about the stack location may be included in the UK AIP EGSU AD2.10, and in Pooley's Flight Guide for Duxford (Reference 9). No type A or obstacle charts are currently published for Duxford.*

Safety of operations is and will remain paramount for IWM Duxford. We acknowledge that we can, and confirm that if planning permission is granted we would, look to ensure that information about the stack location may be included in the UK AIP EGSU AD2.10, and in Pooley's Flight Guide for Duxford. We would also review and adjust all relevant risk assessments and work with our partners to adjust, amend or cease current practices as necessary – this will lead to restrictions to operations.

Appendix B

Explanation of Categorisation of Airfields

The UK's Civil Aviation Authority clearly sets down the categorisation of airfields with specific respect to the level of Rescue and Fire Fighting Service (RFFS) cover that airfields must provide.

CAA CAP 168 chapter 8 RFFS provision 8.9 states.

The level of fire protection normally available at an aerodrome should be expressed in terms of the category of the rescue and fire fighting services as described in table 8.1 and in accordance with the types and amounts of extinguishing agents normally available at the aerodrome.

Table 8.1 Aerodrome category for rescue and fire fighting

Aerodrome Category	Aeroplane overall length	Maximum uselage width
1	Up to but not including 9M	
2	From 9M up to but not including 12M	
3	12M up to but not including 18M	3M
6	28M up to but not including 39M	5M

These are all licenced movements which mean passengers have paid to go on the flight, Duxford Aerodrome can operate licenced movements up to Category 3 (CAA CATs run 1-10).

Duxford Aerodrome can also operate aircraft such as the B-17 and Catalina which are unlicensed category 4 aircraft which we operate under a duty of care to provide the required RFFS provision.

The largest non-licenced aircraft Duxford Aerodrome has seen C-130 Hercules, BAE 146 and the Lockheed Constellation which are category 6 and again are operated under a duty of care with regards RFFS provision.

Duxford Aerodrome Rescue and Fire Fighting Service has not only provided support to local incidents not related to the aerodrome; but they have attended and provided incidents both inside the aerodrome and in the surrounding fields involving aircraft including ones the fields adjacent to the fields (related to forced landings) near the Vetspeed site.

Appendix C

Civil Aviation Authority's Example Hazard Log

Relates to Chapter 4, Safety Risk Management, CAA CAP 795

July 2016

Example Hazard Log:

Identified Hazard	Associated Risk (consequence)	Existing Mitigation Measures in Place	Current Level of Risk	Further Mitigation Measures	Revised Level of Risk	Action By and when
			Severity *Likelihood* *Tolerability*		*Severity* *Likelihood* *Tolerability*	

Example Severity Table:

SEVERITY OF CONSEQUENCES		
Aviation definition	**Meaning**	**Value**
Catastrophic	Results in an accident, death or equipment destroyed	5
Hazardous	Serious injury or major equipment damage	4
Major	Serious incident or injury	3
Minor	Results in a minor incident	2
Negligible	Nuisance of little consequence	1

Example Likelihood Table:

LIKELIHOOD OF OCCURRENCE		
Qualitative definition	**Meaning**	**Value**
Frequent	Likely to occur many times (has occurred frequently)	5
Occasional	Likely to occur sometimes (has occurred infrequently)	4
Remote	Unlikely to occur but possible (has occurred rarely)	3
Improbable	Very unlikely to occur (not known to have occurred)	2
Extremely improbable	Almost inconceivable that the event will occur	1

Note: The definitions used above are an example only. You may find it more useful to define quantitative definitions, such as, number of events in a given time period or events per number of flights depending on your type of operation.

Example Risk Tolerability Table:

Risk Likelihood	Risk Severity				
	Catastrophic 5	Hazardous 4	Major 3	Minor 2	Negligible 1
Frequent 5	Unacceptable	Unacceptable	Unacceptable	Review	Review
Occasional 4	Unacceptable	Unacceptable	Review	Review	Review
Remote 3	Unacceptable	Review	Review	Review	Acceptable
Improbable 2	Review	Review	Review	Acceptable	Acceptable
Extremely improbable 1	Review	Acceptable	Acceptable	Acceptable	Acceptable

UNACCEPTABLE: The risk is unacceptable and major mitigation measures are required to reduce the level of risk to as low as reasonably practicable.

REVIEW: The level of risk is of concern and mitigation measures are required to reduce the level of risk to as low as reasonably practicable. Where further risk reduction/mitigation is not practical or viable, the risk may be accepted, provided that the risk is understood and has the endorsement of the Accountable Manager.

ACCEPTABLE: Risk is considered acceptable but should be reviewed if it reoccurs or changes that affect the risk are made.

Appendix C

Aircraft Restoration Company's Assessment – Bristol Blenheim Scenario

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Propshop Ltd
Building 425
Duxford Airfield
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CB22 4QR

4th July 2016

Graeme Etheridge
Executive Director
IWM Duxford
CB22 4QR

Graeme,

The Bristol Blenheim is a 1938 design, and was used extensively by the Royal Air Force at the outbreak of the Second World War. Our example is the only Blenheim MK I left in the world, either as a flyer or a museum exhibit. It is therefore extremely rare and precious!

Operating the aircraft, in today's environment of concrete runways and obstacles, brings its own challenges. The aircraft was designed to be operated from grass airfields with adequate clearances for approach to land and take-off.

Obviously we do not operate the aircraft at war time "all up weight" (AUW), the lack of armaments and operational equipment dictate that the normal operating weight is between 9700 lbs and 12000lbs. These lower weights increase our safety margins should an engine failure occur, however, the aircraft still requires good clear take-off and approach paths should a failure occur.

An example of a pre take-off brief will show you the likely considerations on take-off.

Airfield and Aircraft data (Typical)

Runway 24 Grass
Temp + 24°c
Nil wind
Aircraft weight 10,500 lbs

Case 1 – Normal Take – off

The aircraft will accelerate well and become airborne within 700 metres. A very shallow climb is then flown to allow the airspeed to build beyond 130 mph. This shallow climb is essential to allow the airspeed to build whilst the undercarriage is retracted and the propellers changed into "course" pitch. The aircraft will get airborne at about 75 mph, any failure between 75 mph and 100 mph would necessitate the aircraft being landed immediately ahead.

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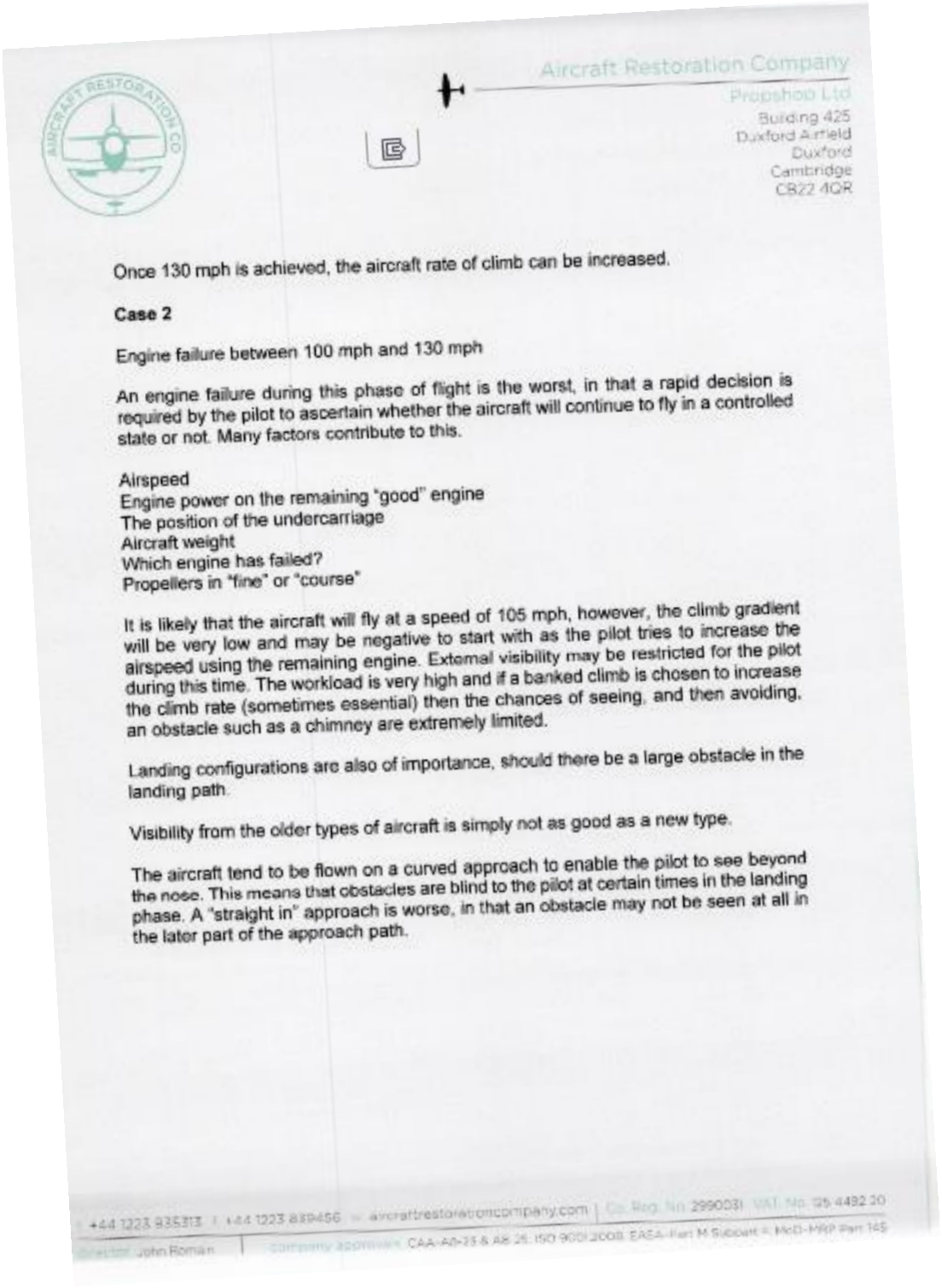

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Once 130 mph is achieved, the aircraft rate of climb can be increased.

Case 2

Engine failure between 100 mph and 130 mph

An engine failure during this phase of flight is the worst, in that a rapid decision is required by the pilot to ascertain whether the aircraft will continue to fly in a controlled state or not. Many factors contribute to this.

Airspeed
Engine power on the remaining "good" engine
The position of the undercarriage
Aircraft weight
Which engine has failed?
Propellers in "fine" or "course"

It is likely that the aircraft will fly at a speed of 105 mph, however, the climb gradient will be very low and may be negative to start with as the pilot tries to increase the airspeed using the remaining engine. External visibility may be restricted for the pilot during this time. The workload is very high and if a banked climb is chosen to increase the climb rate (sometimes essential) then the chances of seeing, and then avoiding, an obstacle such as a chimney are extremely limited.

Landing configurations are also of importance, should there be a large obstacle in the landing path.

Visibility from the older types of aircraft is simply not as good as a new type.

The aircraft tend to be flown on a curved approach to enable the pilot to see beyond the nose. This means that obstacles are blind to the pilot at certain times in the landing phase. A "straight in" approach is worse, in that an obstacle may not be seen at all in the later part of the approach path.

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I could add a host of technical data to the above, i.e. climb/descent gradients and bank angle to stall speeds. However, the facts remain, that in operating any aircraft, especially vintage types, an obstacle placed in the take-off or approach path is an added element of danger that should not be considered. It places an unacceptable level of risk on both the crews and the general public.

Kind regards

John Romain

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