[redacted]

From: [redacted]
Sent: Thursday, 8 April 2021 3:10 PM
To: Enabling Drone Integration
Subject: Fishing drones

My plea is to leave fishing drones, like I use, out of any of this beauracratic governance.

I use it at beaches.
It never gets more than 30 metres in the air and if there's any aircraft near that where I use it then they are already in serious trouble and my fishing drone will be the least of their worries..!

This is a popular method of fishing and we don't want the beaucracy involved as what we do is perfectly safe by anybody's standards . Just leave us out of it.

Regards

[redacted]

[redacted]
LINK Bay of Plenty
[redacted]
W. linkbusiness.co.nz
26 Fourth Ave Tauranga Bay of Plenty 3110 New Zealand

[redacted]

From: Louise Woolf [redacted]
Sent: Monday, 19 April 2021 2:50 PM
To: Enabling Drone Integration
Subject: feedback for ENABLING DRONE INTEGRATION

TO WHOM IT MAY CONCERN

I wish to provide a submission to the above CAA survey closing 21 May 2021.

My name is Louise Woolf
I currently work as an [redacted] with 10yrs Doc Control Officer, previously approx 10yrs Radar & Tower simulation and 8yrs on Area Radar - 35yrs ATC experience.
PPL 40yrs + Owner/Operator private aircraft
Postal code 7571
I am vested in, actively involved in lab + field testing + drafting of op procs and an advisor for an innovative fog dispersal initiative by Pyper Vision.

Pyper Vision was selected in the top 10 Innovator for NZ of Year 2021. Together with business partner HoverUAV, their fog dispersal has been approved for onfield testing at 2 airfields in Australia under CASA's risk processing methodology of JARUS-SORA for 5x Part 102 Certifications (heavy lift, dispersal, inside NO OPS at airport, BVLOS & non-VMC). It is a stunning breakthrough and an absolute game changer in aviation. **CASA have approved this complex Part 102 with these 5 certifications on 2 airfields inside 12months.** CAA 12-18mths for the first certification alone, then bottom of the heap to wait for the next. From reading the CAA proposal for enabling Drone integration, it appears that it will be in excess of 5yrs before a definitive regulatory process within CAA is up and running?

FOG DISPERSAL OP PROC BACKGROUND:
During LVO (Low Vis Ops) in fog at an airport (without Autoland like NZAA) the crux of the frustration and main cause of restricting traffic is due to the Tower & Ground Controllers' inability to "sight and visually separate" aircraft. If you can not visually separate your traffic - then you can only move one (unless specific airport MOU authorises additional procedures). At CH with RVRs between 400-500m (so below arrivals but above dep met min) an A320 will take 15mins from push/start onto a taxiway, taxi to stub, line up and roll, then be confirmed as a positive rate of climb on radar before the next A320 can receive a push back....only 4 deps an hour. Over recent years NZCH experiences RVRs closer to the 150-250m for an hour. Nothing moves.
When all flights are either grounded/diverted due met minima below all operations due fog and nothing is moving on the MAN - only then does the Airport NOTAM a 45min duration closure for the purpose of fog dispersal. A temporary closure would be welcomed by airport/airline/ANSP to restart a seamless IFR schedule or proactively clear radiation fog before the morning IFR schedule is due to start. Within 4mins after an average 7min fog dispersal flightpath, the dispersed hygroscopic "dumps" the dewpoint and an area of created cleared visibility that is 5x that of the area dispersed. Longevity of cleared visibility is advertised at >2hrs in under 5kts of wind - but in practice has proven to be in excess of 4hrs for warm radiation fog. Visibility created meets requirements of taxiing aircraft, ground controller and arriving aircraft from Decision Height on final approach - they would see a large oval of cleared visibility centred on the landing threshold ahead. Ground and Tower controllers would communicate via "Airfield 1" (who is in charge of FRTO and working alongside HoverUAV PIC), see the UAV's ADSB readout on their radar screens as the fog dispersal process transitions through the 5 stages (setup/orientation/lift+run/land/packup+FOD check). By the end of Stage 5 the Tower will have a clear view over the majority of MAN to beyond the landing threshold and will be able to sight and visually separate traffic. The airport's ability to efficiently and economically and SAFELY move traffic using visual separations will be returned.

Emergency diverts or Medivacs as well as Runway Works can be accommodated thanks to fog dispersal. Forecast fog on the 6pm TAF have cost airport companies hundreds of thousands over the course of a project (eg; replacing runway shoulders at night) with overruns and all equipment brought onsite but workers sent home on full pay because of the forecast 40% prob of fog.

SUGGESTIONS to expedite ENABLING DRONE INTEGRATION:

- The TTMRA (Trans Tasman Mutual Recognition Act) needs to be widened to encompass Part 102 licenced UAV operators, their UAVs and the general operation - requiring a local validation approval check in NZ only.
- The same JARUS-SORA risk processing methodology now utilised in most ICAO abiding nations, needs to be embedded in the Aviation Regulatory Authority on both sides of the Tasman.
- CAA could upskill/train from **Jackie Dujmovic** (HoverUAV CEO/Founder and CASA Director and JARUS-SORA contributing writer and led Google's Wing division with BVLOS pizza delivery in an Australian suburb.)
- CAA could split their UAV licensing division similarly to CASA - with basic "cookie cutter" Part 102 approvals with a 6 day turnaround, separated from the more complex which are led by Aviation professionals but still with an agreed economically viable turnaround.

AIRSHARE SUGGESTION:
As a tower controller the rules laid out for us to control UAVs are somewhat limited - by sight and visually separate (or possibly composite visual using radar) and with 2-way coms on frequency. The ability to keep a UAV insight is near impossible and I have yet to experience one able to operate on my frequency. Inside the CTR, beyond NO OPS/restricted areas and below 400ft - a tower controller is not really effective in adding to aviation safety. Some days we can have 7-10 UAV strips active on the Tower Controller's board, layering in distraction. Personally I would be satisfied with only approving and holding strips on those Airshare operations that are in the vicinity of CH NO OPS/restricted areas, either Hagley park/hospital helipads or operating above 400ft in CTR. All others I can look up on Airshare if need be, without cluttering up my board.
Did you know Canada and India have denied UAV ADSB? Two years ago UAV in Canada outnumbered aircraft 30:1 and sheer overwhelming numbers of ADSB clutter painting on a radar screen, slowing down the data processing and potentially introducing risk with a malicious trojan UAV FPL into the system convinced the authority to stop that from starting. Maybe only the Part 102s operating inside Airport NO OPS or restricted areas or above 400ft inside CTR should have ADSB?

Thank you for the opportunity to submit. I look forward to the ongoing discussion on enabling drone integration and happy to clarify any points raised in this submission. If you think I can help in any way - **please ask**. (I would be very interested to read through Air Services Australia's instruction from CASA on separation of UAVs from other aircraft/vehicles both within the CTR and beyond in CA - should you have access to those.)

Pyper Vision is an original NZ brainchild and wants to put NZ ahead of Australia on the roll out of fog dispersal at airports. But unless CAA can move more quickly (inside 6months), align with CASA and grab hold of the JARUS-SORA training on offer from HoverUAV, ask Min of Transport, MBIE and NZTE to advocate the government to extend TTMRA on Aviation to include UAV Part 102 licensing?? - I believe the operation will have no choice but to formally launch in Australia instead.

Yours sincerely
Louise Woolf

[redacted]

From: robin hose [redacted]
Sent: Friday, 30 April 2021 9:48 AM
To: Enabling Drone Integration
Subject: drone integration

To whom it may concern'
Dear sir / Madam

I am a 62 year old drone operator to which I only use for fishing. I fly a swellpro fishing drone 3+ with a total combined weight of around 3kg (loaded), and the unit is geofenced (120 x 500 mtr) set by the manufacturer and only fly in GPS mode. I also have my name and contact number attached to the drone and only use it for fishing, as per the kontiki rules

Normal fishing height for a cast is 20-30mtrs altitude max with a max distance of 250-500mtrs (system GPS geofenced), and only use in VOLS, normal flight times 4-5mins max (out and back)

I understand and follow Part 101 rules and stay within these boundaries. I too have also started to use Air-share for my flights and check mapping for no fly zones regularly when out of the area, (still getting the hang of this)

When I first started drone fishing a few years ago I contacted CCA and DOC departments in Wellington to find out where i stood in the areas I normally fly in (Coromandel). I also contacted the Tauranga control tower to ensure they knew we were to fly on the coast, they too had no problem with this as long as we stayed under the 120mtrs (eg; 400 ft) altitude as this area is a general fight zone. Yes we do have a large number of small aircraft flying the coast and have respected the airspace and ensuring it is clear before take off,

I also know there are fishing drones capable of greater distances (up to 1200 plus meters) and is of a bit of a concern for VLOS but you must also remember these are flown by mostly responsible people fishing only and are normally in a group so do have a spotter on hand

So;

Yes I agree with the 30mtrs rule from people, privacy rules should remain, people and property is private, so should be respected and require permission.

Yes I agree that all drones should be registered and should be done so at the time of purchase.

If a licence is required then an online license may be the best way to go, you must realise you'll be dealing with a large number of older, close to, or retired people that have taken up this sport for fish for two reasons. When you compare the size of the drone case to the size of a kontiki, winch, trolley etc, it is much easier to store and transport in a camper or car and not a lot to carry on to the beach.

Concern;

Is this going to be another reform bill like the firearms bill where only the honest persons were affected by doing the responsible thing and handing in firearms because firearm crimes remain and seem to be on the rise by irresponsible owners.

Concerned drone fisherman
Robin Hose

[redacted]

From: Bryce Gibson [redacted]
Sent: Thursday, 6 May 2021 3:27 PM
To: Enabling Drone Integration
Subject: Submission - Enabling Drone Integration

Regarding Chapter III
Drone registrations
Q1. Yes, being able to trace ownership and hence use of drones has benefits but registering the operator/owner to the drone by an ID number or QR code carried on the item is a cheaper and simpler option than registering each drone individually.
Q2. I currently own and fly between 150-200 model aeroplanes.
I'm a member of MFNZ and all except scale models carry my MFNZ number or my FAI licence number. Requiring each to be individually registered is likely to be such an onerous operation that I simply wouldn't bother both for cost and practicality reasons. Given that I follow MFNZ operation rules including operating only from registered flying sites I'm unlikely to cause a problem so why should I incur an additional cost to fly a model perhaps twice a year or which may be destroyed after one flight ?
If individual drone/ model registering and deregistering is required what would the process be when a model is destroyed, taken out of service or changes ownership? Would there be further cost ?
The system needs to be as simple and low cost as possible, registering operators rather than drones will minimise cost and complexity.

Q3. The system needs to be automated, I can see why there needs to be some identity verification but it feels very intrusive.
A real me ID would be gold standard but MFNZ membership number might be another option
Q4 A cricket ball weighs 163 Gms so a 250-300gm lower weight threshold seems reasonable. A 300Gm drone would have high drag and low kinetic energy and be potentially no more damaging than a large bird in flight.
Q5 Drones / models flown indoors or from MFNZ designated sites I feel should be exempt from registration.
Requiring an owner ID to be attached to the model (other than for scale models) should be good practice.
That those models only flown indoors shouldn't need registration is obvious. I also think that drones under say 300gm without FPV, cameras or downlink capability should not need registration.
The only reason I can see for registering drones or operators is for protection of the right to privacy and air safety.
Enforcing registration of "dumb" or indoor use only drones I feel would be so draconian as to be counterproductive.

Bryce Gibson

[redacted]

From: Geoff Jensen [redacted]
Sent: Wednesday, 12 May 2021 1:24 PM
To: Enabling Drone Integration
Subject: Proposed MoT drone regulations

Dear sir, I have just read a paper re the proposed MoT drone regulations. It became immediately obvious that there is a confusion between "model aircraft" and "drones".

Model aircraft are winged aircraft, maybe multi engine and multi wing, but are traditional shape and fly in a forward direction. Model helicopters come into this category but of course are not winged and can fly in other directions besides forward.

Drones on the other hand are quite different. They do not have wings, are multi rotor and can fly in every direction.

It is quite wrong to try and make "model aircraft" subject to the rules that will need to apply to "drones" and vice versa. Therefore the proposed rules should be altered to consider each type of aircraft separately and individually.

Regards
Captain GN Jensen

[redacted]

From: Barbara Clarke [redacted]
Sent: Wednesday, 12 May 2021 4:51 PM
To: Enabling Drone Integration
Cc: members@modelflyingnz.org
Subject: Drones/Remotely Piloted Vehicles.

All Drones should be banned from private citizens.

The only organizations that should be operating drones are - - -
Police, Army, Navy ,Airforce, Civil Defence, Medical supplies to Hospitals, Search and Rescue and Fire Services.
Certain companies dealing with power pylons and lines. water pipes and dams, high country farming, forestry surveillance, Maritime authorities and University research.

Model aircraft flying is a creative and enduring art which encompasses, creative design, aerodynamics, even trigonometry, materials, trade drawing, experimenting plus commercial plans and kits. Modeling was part of my ambition to become a pilot. I am now 88yrs. of age and have made models all my life and have flown them.

Drones are not part of model CREATIVE flying and should be totally divorced, separated and regulated under another regime entirely and severe penalties for misuseage.

Model aircraft have more than sufficient safeguards already for example - - CAA regulations and NZMAA Rules, approved flying sites, height restrictions, pilot licences, safety aspects, and insurance to name a few.

There are thousands of people in NZ who feel and act like me and get exilerating pleasure from our creations in a realistic manner.

NO HUMAN EXPRESSION OF INNOCENT CREATIVITY SHOULD BE SUPPRESSED OR BANNED BY CAA.

H.O. Clarke (ex R.A.F. pilot)
New Zealander.

[redacted]

From: [redacted]
Sent: Friday, 14 May 2021 4:32 PM
To: Enabling Drone Integration
Cc: Paul Clegg
Subject: Feed back from Whakatane Model Aircraft Club #59
Attachments: Drone Regulations 4.docx

Good Evening,

Please find attached our clubs feed back regarding the recent Drone regulations proposal.

Kind regards

[redacted]
Whakatane Model Aircraft Club
#59

Enabling Drone Integration ***08 May 2021***
A response to Ministry of Transport Discussion Document

- Pilots operating under Model Flying New Zealand rules
    - We are pleased that the proposed regulations recognise that pilots operating under the auspices of MFNZ will be exempt from some of the proposed measures, such as:
        - an additional basic pilot qualification,
        - registration of individual aircraft.
    - We note however that registration would still be required if an MFNZ member wished to fly outside of a designated area. We therefore seek assurances that any proposed compliance costs will be such that those enjoying their hobby on restricted incomes can continue to fly legally.
- General classification
    - MFNZ club flyers of fixed- and rotary-wing models object to the term "drone" being applied to their aircraft.
    - The general public understand a "drone" to be a quadcopter or similar. Actively fuelled by sensational media reports, drones have acquired a reputation for airspace and privacy incursions.
    - Serious RC model flyers do not wish to be tarnished by these perceptions. Calling all their aircraft "drones" is seen as a significant slight. Is there a more specific term?
- Numbers of drone-related complaints
    - The document includes a table (Table 2: Annual drone reports by type (CAA)) which shows the numbers of complaints by category from a total of 680.
    - We note that 70% of incidents in 2020 concerned "consent of people under flight path not obtained" and "other".
    - Safety-related issues accounted for only 24% of reports.
    - All category numbers are either static or well down from previous years.
    - This suggests that the numbers of quadcopter-type drones actually operating in New Zealand may have peaked and that "random" drone operators may have moved on to other pursuits. Many drones are known to be inoperable, scrapped or gathering dust on shelves, often as a result of their owners becoming bored.
    - We seek assurances that the activities of a small minority will not impact upon the freedoms of those who operate under and abide by the MFNZ rules.
- Remote ID and geo-awareness
    - The document explains that many modern (quadcopter) drones have inbuilt remote ID and geo-awareness capabilities. It also states that drones without these capabilities should be retrofitted with such devices. The authors assume that few drones in operation are more than two years old, so not many would require retrofitting anyway.
    - However, this assumption does not apply to typical fixed-wing models such as those operated by MFNZ members. Many are far more than two years old, some more than two decades.
    - The technology has not been widely applied to fixed-wing model aircraft. Applying it could be expensive and suitable devices currently may not even exist.
    - This is a concern because of what might happen if too many unregistered drones were operated illegally by pilots who had not acquired the proposed online qualification. If identification proved to be difficult, how long would it be before those operating under the auspices of MFNZ were also required to register their aircraft? If that came into effect the cost could be significant, particularly as most own and fly several or many aircraft.
    - We would appreciate some sort of assurance that this could not happen.

[redacted]

From: John Isitt [redacted]
Sent: Friday, 14 May 2021 5:58 PM
To: Enabling Drone Integration
Cc: Members MFNZ
Subject: Submission
Attachments: Enabling Drone Integration.docx

Hi
Attached is my submission

Regards

John Isitt
[redacted]

Enabling Drone Integration

Sir / Madam

Thank you for allowing me to put in some thoughts about the proposed legislation change.

First some background about myself. I am a model aircraft builder and flyer. I have been continuously involved in this hobby for the last 34 years. I have in the past flown hang gliders, (approximately 200 hours). Full sized aircraft, giving up my PPL flying with less than 100 hours. I have also flown microlights, but never obtained a licence for them.

I currently have nine flying aircraft with their own receivers in place. I have a further eight aircraft that only need a receiver added to them for them to become flyable. (Receivers are transferable). They each have their own engine/motor and all servos needed to fly. Plus a further five frames that need fixing, repairing or fitting with further equipment to become flyable. Twenty are fixed wing while two are drones. Two of the twenty-two are powered gliders. Most of my aircraft are electric powered. Four are 30cc sized petrol powered aircraft. Three are methanol powered, 7-10 cc.

Firstly there needs to be some separation within the classes of 'drones'. You have lumped all remote controlled aircraft into one heading where most flyers class a drone as an aircraft that has multiple lifting propellers. I accept that a drone is also a predator/ surveillance style aircraft used in war situations. However my racing drone and my 1/5th scale Piper Cub are totally different aircraft.

I can see what the proposed legislation is wanting to cover and I see that members of MFNZ are exempt provided they are flying at a registered flying site. I can also foresee several problems for these flying sites. There needs to be a simple ability to move sites to another area as most sites are at the agreement with some friendly farmer. To the best of my knowledge, flying sites are not fixed. Are not owned by the clubs and are not provided by local or national government. Each site is for a short tenure. The club that I belong to has been forced to move in the past because of noise and visual pollution. It is not an airport such as Rangiora. Even getting a resource consent doesn't guaranty stability.

We have had problems even moving a 'radio control' symbol on an aeronautical map from one part of a farm to another. (Have a look at the latest map around Burnham, you will see two symbols side by side).

I also fly at a piece of land that my family own. There are twenty hectares at this location, but under the proposed changes I will need to add some type of transponder to my aircraft. This transponder will have to be able to broadcast my Latitude, Longitude, Altitude, Speed, Position of take-off and my registration number. For each of my flyable aircraft.

I see that there is mention that the life span of each drone is between 1 – 2 years. I don't know where this information has come from. It seems a bit subjective to me and not realistic at all. I have several aircraft that are over twenty years old. I have also owned aircraft that have been written off on their first test flight. It appears that I will need to register an aircraft before I fly it. It may be that I will also need to deregister it the same day.

So let's have a chat about the transponder that needs to be fitted to each of my seventeen flyable aircraft. I see that in America someone has suggested that the cost will be approximately US $50 each. That's US $850 so far on someone's guess. The reality is that a transponder similar to a telemetry link giving similar information from the aircraft back to the transmitter costs US $110. (Futaba SBS-01), now suddenly the cost has increased to US$1,870.

I don't even want to think of the cost of a full sized aircraft transponder here in New Zealand with a cost between $1,000 and $4,000 each. And they only need to be fitted to aircraft that fly in controlled airspace. When I was flying full sized aircraft all I was transmitting was the planes location to the tower and the type of plane I was flying such as a light aircraft/glider. So a model aircraft is required to transmit a signal giving more information than full sized aircraft are required to transmit. But if you are a hang glider, parachute or microlight, or fly outside a controlled area in a full sized aircraft, there is no need to carry a transponder.

The simple fact is that I, and others like me will become compliant, we will fork out money for these transponders. So I see that in the future there will be two types of drone pilots, those that comply and those that don't.

The advantage here for you, is that if I am flying my two meter wingspan foam glider and I exceed 120 metres because suddenly I find a decent area of lift, then it will be easy for someone to report and prosecute me, but if I don't have a transponder then someone will need to find me, estimate the height of my glider and prosecute me. In a court of law. 'And sir, how did you estimate the height of my clients glider?'.

So for me I don't see much of a carrot, just extra cost. How big is the stick? Is the CAA going to employ extra staff to go around the country on a Sunday morning looking for errant flyers? Or is it going to be Police being dragged away from a domestic dispute to chase after a sighting of a drone flying over Punakaiki? Not much chance of that happening either.

I see that overseas there is an on-line test, in most countries the test is free at the moment, or $150 in the USA. The test needs to be passed every five years. Plus a list of your aircraft updated every year. I have to presume that this list will be simple to get to and simple to access and update. It will need some type of password protection on it and I expect someone overseeing the list, fixing problems, answering inquires etc. Naturally this will be supplied free to all users, or will this be another cost to the user? In the club I belong to there are two members who do not own a computer, and their phone is for phone calls. Yes they are old and one day will pass away.

Have a look at UK's CAA internet site and try to find what class a 5 kg petrol powered airplane fits in, I couldn't find that information either. Flash looking site though. Lots of information via links to other areas, but I couldn't find the information I was looking for. Hopefully when the CAA design their site here, it will be easier to navigate than the UK's site.

I am sure others will talk about 'park flyers' who fly electric planes that weigh less than 1.5 kg who also fly inside controlled airspace. This is because the local city park they fly in is under 4 km to the side of the airport. There needs to be some acceptance that an A320 is not going to be flying under 120 metres over a city park 3.8 km to the side of the airport. There could be a situation where the local rescue helicopter will need to land in that park to save someone. I think in that situation all model aircraft pilots would land and put their planes in the boot of their cars long before the helicopter lands and blows the foam planes away.

Yours sincerely

John Isitt

19/05/2021

[redacted]

From: Kerry Eggers [redacted]
Sent: Sunday, 16 May 2021 3:26 PM
To: Enabling Drone Integration
Subject: Submission

The thing I do not like about these proposals is it will remove the possibility for people to fly a small (250gr is not practical to fly outdoors) radio controlled airplanes in line of sight around their local field due to over complicated compliance issues and costs. This is not where the problems are coming from. So once again the kiwi kid just getting out there and having fun will lose out yet again.

Regards

Kerry Eggers

[redacted]

From: [redacted]
Sent: Monday, 17 May 2021 1:10 PM
To: Enabling Drone Integration
Subject: Submission on Discussion Document
Attachments: Drone Integration Submission RevA.pdf

Please find attached my submission on the Discussion document "Enabling Drone Integration"

Yours faithfully,

[redacted]

Plant & Platform Consultants Ltd

PO Box 660
141 Devon Street West
New Plymouth 4340
NEW ZEALAND

[redacted]
W: www.pandp.co.nz

[redacted]

ENABLING DRONE INTEGRATION

M.O.T. DISCUSSION DOCUMENT COMMENTS

[redacted]

This documents contains the views of a long term (55 years) recreational user of model aircraft on a visual line of site (VLOS) basis and as a member of Model Flying New Zealand, the Large Model Association of New Zealand, the Jet Modellers Association of New Zealand and the New Plymouth Model Aero Club

May 2021

SUMMARY

The goal of proposed changes is appreciated. Regrettably, the discussion document fails to appreciate the different risks posed by various airspace users because it does not adequately recognise, and differentiate between, the nature of these users and their operations. While recognising the successful integration of visual line of sight (VLOS) operations under the current system by MFNZ, for example, proposed measures would result in existing safe and compliant airspace users being adversely affected for no appreciable benefit.

Issues of compliance of existing VLOS operators and their impact on full size aircraft are also conflated with the integration of beyond visual line of site (BVLOS) and Autonomous operation (e.g. 250g weight limit, operation in proximity to airports vs transponders on drones). In view of this, the approach proposed is, in my opinion, flawed and potentially unnecessarily restrictive for current recreational VLOS airspace users. With a few changes, compliance improvements can be made within the existing regime that is working for VLOS operations. What is clearly required is the development of rules to integrate BVLOS and Autonomous operations, not a total revamp of a system existing users are, for the most part, familiar with and that is successfully managing the risks.

An analogy can be drawn from autonomous vehicles on our roads. I, and I suspect most New Zealanders, expect the commercial developers and promoters of this technology to put the time money and effort into providing and proving the safety of that technology when using the existing infrastructure, including allowing for current users. Further, this should be done with absolutely minimal impact to existing users. It appears to me that if the approach proposed for drone integration (BVLOS and Autonomous) were applied to autonomous road vehicles, it would involve totally revamping the rules (with attendant costs) for existing vehicles and drivers (particularly private/non-commercial) to accommodate them.

To take the analogy further, we should not try to stop tailgating by a few drivers by making rules around autonomous braking systems in driverless vehicles and trying to apply them to the current driven vehicle fleet (notwithstanding normal vehicle safety system development).

DEFINE THE PROBLEM

The keys issues are:

1. Compliance (primarily private and recreational) to ensure safety of full size aircraft.

2. Integration (primarily commercial) of BVLOS and Autonomous operations into the existing system.

The discussion document conflates and confuses them.

GLOSSARY

The document contains a number of definitions for the same thing, some that are irrelevant, and yet they are not exhaustive.

The RPA, UA, UAV, are all pilotless vehicles and yet no mention is made in the definition as to whether they are remotely piloted, autonomous, carrying passengers or not. (Unmanned is limited to pilots as far as the definitions are concerned) I assume these proposals are limited to non-people carrying aircraft?

The term UAS implies remote piloting, but doesn't stipulate it, and RPAS appears to cover the same thing.

The inclusion of control line models and free flight models does not make sense. Control line models operate in an extremely limited airspace, up to approx. 30m radius hemisphere on the ground and do not need to be considered by the proposed legislation. Free flight models on the other hand are not remotely piloted and therefore, by definition, are uncontrolled other than potentially by time limit if fitted with a dethermaliser, for example.

Rather than trying to lump all these under the label "Drones", it would be helpful to apply definitions that recognise the significant differences between types of aircraft and/or their operation and associated risks.

Suggested (assuming person carrying aircraft aren't contemplated)

Types

Free flight

Remotely piloted (vehicle and systems)

Autonomous (vehicle and systems)

Operating regimes

VLOS would include FPV (observered)

BVLOS/Autonomous would include FPV (unobserved)

DEFINITIONS

The current definitions are confusing and indistinct and the use of the word "drone" is emotive as it has specific associations, (multi rotor, camera, adverse media reports, etc.). UAV/RPAS etc. are less evocative and more appropriate.

Notwithstanding, MFNZ members operate multi rotors, rotary wing and fixed wing UAV's safely under the current regime. Given this the use of "model aircraft" is also problematic as MFNZ members are operating more than scaled down replica's of full size aircraft.

INTRODUCTION

While it may be true that the drone applications are rapidly increasing, total numbers of drones are not necessarily though. Most issues have been associated with over the counter multi-rotors purchased by members of the public for recreational use. Indications are that sales of these peaked in 2018. Longstanding users of the airspace for recreational activities continue to operate safely under the current Parts 101 and 102, primarily as a result of belonging to clubs and associations that educate their membership on the rules, regulations and obligations associated with the operation of their UAV's. That the commercial and recreational use have been covered by the same risk based rules is appropriate.

As stated in paragraph 45 the ability to purchase and operate a multi-rotor with little or no knowledge of the rules associated with its legal operation and no training to operate it has been the key issue with lack of compliance with the CAA rules. It is not the traditional recreational users of the Airspace operating in a disciplined manner under the rules and supervision of relevant clubs and associations.

While the desire to rein this in is understood and appreciated, the rules should not restrict those who are compliant because of those who are not. While commercial use of UAV's should be catered for, it should not be at the expense of the recreational use of the airspace by responsible New Zealanders. A risk based approach should be adopted.

Note: the issues raised under the current Part 101 and 102 framework are all associated with VLOS operations and the threats posed to full sized aircraft. These are different issues to those contemplated by the introduction and integration of BVLOS and Autonomous operations. Failure to recognise this in the current discussion document is likely to lead to further confusion and suboptimal outcomes.

WHAT'S WORKING

The Part 101 and 102 rules are risk based and are working for VLOS operations.

Changes and better awareness can improve compliance.

Membership of a recreational user group is a big help, e.g. MFNZ.

Education not more regulation is the key to current issues with Part 101 and 102.

DRONES IN THE CIVIL AVIATION SYSTEM TODAY

Paragraph 18. Is there an issue with the number of Part 102 operators? I would have thought that this was an appropriate way to track the operations of UAV's.

Paragraph 20. This survey data is of no value as it makes no distinction between numbers and types of drones e.g. less than 250g, less that 25kg. Fixed wing, Multi rotor, etc.

Paragraph 27. It is noted that there appears to be no representation from recreational or commercial users in the Unmanned Aircraft Leadership Group. Why not?

AN EFFECTIVE COMMITMENT TO DRONE INTEGRATION IS NECESSARY

Paragraph 32. Identifies the **key issue**, that being the impact of BVLOS and Autonomous operations. The proposed integration of these operations should place the onus on these operators to integrate with the existing airspace users with minimal impact on the existing users.

HOW DO WE PROPOSE TO ACHIEVE THIS?

Paragraph 38, 39 Figure 3. The proposal to update the rules is good. There are a number of aspects that need attention, the minimum weight threshold, and removal of reference to model aircraft for example. It is important not to throw the baby out with the bath water as the rules are working for VLOS operations.

The basic pilot qualification for Part 101 pilots is fine and I would suggest that membership to a registered club or association such as MFNZ be accepted as meeting this basic requirement.

LIES, DAMNED LIES AND STATISTICS

The survey data is of no use whatsoever in informing any meaningful input into policy analysis.

Why no airspace users on the Unmanned Aircraft Integration Leadership Group?

A text without a context is a pretext!

Drone registration should not be required for VLOS operated UAV's particularly under Part 101. I expect the administration of this and its accuracy would be a nightmare for little, if any, benefit, particularly for VLOS operations which are by their nature, localised and tend to be in designated area's or shielded operations.

Remote identification should only be required for BVLOS and Autonomous UAV's

Geo-awareness. Standardised map is a good idea. Technology limited to as appropriate (onboard for BVLOS and Autonomous).

Paragraph 44. The current lack of compliance is an issue for the general public buying and operating over the counter multi-rotors without being informed of the legal obligations regarding their operation.

Paragraph 47. The conclusion about the failure of education is unwarranted based on the data given as there is no indication of the total number of drones in operation in the given years. For example, if the numbers are increasing as stated paragraph 17 and, for arguments sake, there are 4 times as many in 2020 compared to 2015. Then the total incidence of non-privacy related reports is 25% down in 2020 compared to 2015 on a drone population basis. Also, how many of these were under the proposed 250g limit?

Paragraph 48. Again without further context and analysis (Were they actually "drones"? Were they real incursions? Size of "drone"? What does the incidence mean in terms of total drone numbers?) the data is of little value and any conclusions drawn are suspect.

Paragraph 56. The problems is a lack of compliance due to a lack of awareness apart from those who deliberately flout the law such as those idiots who shine lasers at aircraft. We should not be making rules for the lowest common denominator. It could equally be argued that education is working and more could be done relatively cheaply. (Social media)

Paragraph 57. The existing rules are, for the most part, fine for other than BVLOS and Autonomous operations. The rules for these should be developed with minimal impact on the current VLOS operators.

Paragraph 58. Part of the solution for BVLOS and Autonomous operations is alluded to with designated air corridors that VLOS operators can keep clear of. Similar to the current 400ft AGL height restriction.

MORE LIES, DAMNED LIES AND STATISTICS

The report data is of no use whatsoever in forming any meaningful conclusions about the success or not of education initiatives.

A text without a context is a pretext!

BENEFITS, COSTS AND RISKS ASSOCIATED WITH THE PROPOSED APPROACH

Reduced airspace incursions. Answer, **educate the public**! Also, there is technology available to neutralise "drones" that would be a lot more cost effective to implement at airports

Paragraph 64. This is irrelevant as changing the rules won't affect lacerations and punctures!

Paragraph 65. Unwarranted speculation!

Paragraph 66. So will improved education for the general public who are by and large also the problem!

Paragraph 69. True, but deal with them on that basis. The benefits are primarily associated with BVLOS and Autonomous applications. Deal with that without throwing out what is working for VLOS operations.

Paragraph 70. Here's the issue, **seamless BVLOS or automated drone operations at low altitudes.**

Paragraph 71. What it's all about. **Enabling BVLOS operations** "..key element of the Goverment's drone integration vision."any proposed changes should recognise and be relevant to this.

Paragraph 73. While BVLOS are not considered safe, VLOS are under part 101 and 102. What's needed is rules that manage BVLOS and Autonomous operations not throwing out what works for VLOS.

WHAT IS NEEDED?

Educate the general public buying and operating recreational drones for VLOS use.

Regulation of BVLOS and Autonomous operations (commercial operators).

Education is the key for (recreational) VLOS operations.

User pays for (commercial) BVLOS and Autonomous operations.

RISKS

Paragraph 86. The status quo with a few minor tweaks to part 101 and more intense education are appropriate for VLOS operations. Work is needed on how to integrate BVLOS and Autonomous operations, not on the "integration of Drones". VLOS operated Drones are already successfully integrated using the current rules!

Paragraph 87. This statement is not true. Privacy should not be an airspace use issue. Problems are associated with BVLOS and Autonomous operations not increased VLOS operations.

Paragraph 88. This is misleading. There has been no credible evidence provided indicating that the Rules effectiveness is eroding. The characteristics of aviation are only shifting away from the scope of the existing framework in a very limited area, i.e. BVLOS and Autonomous operations. That is what needs to be dealt with! The rest is functioning to an acceptable level to manage risks associated with VLOS operations. (Ref Paragraph 73)

CONCLUSION

The current discussion document fails to clearly state the problems and to provide credible evidence for the scope and nature of the proposals it seeks comments on.

This failure to recognise the nuanced nature of the airspace users and their operations along with the absence of relevant data on which to reach justified conclusions is a recipe for bad decision-making and wasted effort and money for adverse outcomes, including unnecessary costs or restrictions for current compliant airspace users.

Consultation with existing users under Parts 101 and 102 with a view to updating these rules based on the last 5-6 years of experience would be worthwhile, as would further education initiatives on them.

It is still early days for BVLOS, other than perhaps some specific industrial applications, (e.g. power line inspection), and currently these should not require a major revamp of the rules to be safely accommodated. A detailed response to the proposals in Chapters 1 through V has not been included in this response, as the overall basis and approach needs revisiting in my opinion.

SOLVE THE REAL PROBLEMS

The keys issues are:

- Current compliance (primarily private and recreational) to ensure safety of full size aircraft.
- Future integration (primarily commercial) of BVLOS and Autonomous operations into the existing system.

Separate rather than conflate and confuse them.

[redacted]

From: Phil Corfield [redacted]
Sent: Tuesday, 18 May 2021 10:36 AM
To: Enabling Drone Integration
Subject: Control Line Model aircraft submission

A submission on Control Line model aircraft in regard to present and pending drone legislation.
To who it may concern.
I am an affiliated member of the N.Z.M.A.A. (New Zealand Model Aviation Association which is affiliated to the F.A.I. in France) [redacted] and also The Dunedin Model Aero Club.
I see that you have new legislation pending regarding the law on drones, that also include model aircraft.
Model aircraft are divided into three catagories, Radio Control, Free Flight and Control Line.
Control Line models, which I have been flying since 1965, are models flown using the U-Control system, invented by Jim Walker from Portland Oregon and patented in 1942 (now out of patent).
A Control Line model aircraft is flown by a pilot who has direct control of the model using the U-Control system. This system uses a control line handle (which the pilot holds in one hand and moves to control the model), two control lines, usually made of multi strand steel and no longer than around 20 metres, a bellcrank, a pushrod to the elevator/flaps. The U-Control system allows the pilot to control the elevator/flaps to fly the model within a hemisphere of around a maximum 25 metre radius (line lenght + height of pilot with outstretched arm + the outbord wing lenght of the model).
This means that a control line model is in direct physical control of the pilot and the model is never more than 25 metres above the ground.
I consider that a Control Line model is not a drone because it is under the direct physical control of the pilot and has a height ceiling of 25 metres.
Therefore Control Line models should fall outside any drone regulations.
The N.Z.M.A.A. has it's own long standing, comprehensive and detailed regulatory rules that apply to Control Line model aircraft flown in New Zealand.
Phil Corfield

[redacted]

From: [redacted]
Sent: Wednesday, 19 May 2021 9:02 AM
To: [redacted]
Subject: FW: Enabling Drone Integration
Attachments: BARNZ Drone Consultation Letter May 2021.pdf

From: [redacted]
Sent: Tuesday, 18 May 2021 2:32 PM
To: [redacted]
Subject: Enabling Drone Integration

[redacted]

Please find attached, the results of a survey we recently conducted with our member airlines regarding the discussion paper on Enabling Drone Integration.

Kind regards

[redacted]

[redacted]
www.barnz.org.nz

BARNZ
VOICE OF THE AIRLINE INDUSTRY

To: Sarah Dickson-Johansen

By email:

18 May 2021

Enabling Drone Integration

About BARNZ:

The Board of Airlines Representatives of New Zealand Inc., is the respected and trusted voice of the airline industry in New Zealand with over 31 members. We work closely with the Government, regulators, businesses and local communities to provide cost savings and service improvements for our member airlines; and to create an environment that fosters continued, sustainable growth for them in NZ. For more information, please visit www.barnz.org.nz

Dear Sarah

After consulting with our member airlines, please find below, further submission material on the discussion document – Enabling Drone Integration

Overview

BARNZ has reviewed and is very supportive of the initiatives to develop a regulatory approach to drones which will accommodate their safe progressive integration into New Zealand's air transport system.

The global and rapid development of the uses and capabilities of drones poses an ongoing risk to international airline operators. The dangers are well understood by the airline industry, but less well understood by many drone operators or worse, the risks are ignored. It is timely for the Ministry of Transport and CAA to undertake this welcome initiative. The Discussion Document sets out a well-considered set of proposals.

Fit for purpose regulation of drones is critical to the safe operation of commercial aircraft in New Zealand. Fit for purpose regulation in this context includes an effective ruleset and a strong capability to enforce by identifying, apprehending and prosecuting those who place aircraft and personal safety at risk. On this basis the proposed enhancements to the rules look like a strong step forward.

Specific Responses

Introduction (Questions from page 25)

Q.1 *What is your view on the proposed series of measures? Are there any other alternatives you suggest we consider?*

The proposed series of measures appropriately address the main issues required to be considered in designing a regulatory scheme for safe drone operation by both commercial and recreational operators.

Q.2 *Would the proposed approach help achieve the desired objectives?*

The problems identified in outlining the objectives of regulation are correctly stated and if implemented as outlined in the discussion document, the measures will achieve the desired objectives.

Q.3 *Would the proposed approach help address the problems and opportunities identified?*

Yes. The problems associated with operation of drones are now reasonably well known and understood. The proposed regulatory scheme will address the problems and allow for those opportunities to be accessed, particularly to the extent is is consistent with other key regulators including FAA, EASA, CASA and CAA(UK).

Q.4 *Are there any other problems and opportunities you can think of?*

BARNZ is particularly pleased to note recognition of the importance of international alignment in developing this body of Rules. International aviation regulation has always maintained a high level of consistency and this is crucial to safety. Airlines from may jurisdictions operate in New Zealand airspace and it is important that pilots can rely on a consistent level of safety being applied in respect of all common aviation risks. This is particularly so in the specific context of maintaining a safe distance from aerodromes, discussed further at Q.2 below.

The discussion paper does not explore costs in any detail which is understandable at this early stage. BARNZ would like to see some assurance that the costs of designing, implementing and operating the proposed regulatory regime for drones will be borne by the real beneficiaries of the regulation, primarily the owners and operators of drones. Airlines should not be required to contribute financially to mitigation of a risk which they suffer from but did not create. There should be no subsidy by airlines of the costs of maintaining the regulatory system or any related costs such as additional Airways charges.

Q.5 *Do you agree with the proposed order of implementation of the measures?*

Yes, a staged approach and in the proposed sequence makes good sense.

Rules Updates

Major Changes to the Rules

Q.1 *Should drones have their own standalone Rule Part?*

Yes. There is a considerable difference between operating conventional aircraft (particularly international jets) and drones. The current regulatory structure, training and licensing requirements are substantial and appropriate to commercial and other conventional aviation. Attempting to fit regulation of drones into that structure is likely to confuse operators of both conventional aircraft and drones.

Q.2 *Should we review the four-kilometre minimum flight distance from aerodromes?*

The current 4 km limit for Tier 1 aerodromes has provided adequate protection so far. Clearly there have been instances of non-compliance, but a key purpose of the proposed Rules is to minimise the problem of non-compliance.

With the increasing number and scale of drones the risk increases. Conversely as technology advances some risks, such as unintended incursion into controlled airspace, are mitigated. This strongly suggests a risk-based approach to the protected zones around both controlled and uncontrolled aerodromes and flight paths. The regulations should provide for the limits to be subject to review as risk levels increase or decrease. Such review should include the proposed graduated levels permitting greater altitude at greater distance.

However, a baseline needs to be set regardless of review powers, maintaining 4 km as the default distance; at 100km/hr a drone would travel 4km in just over 2½ minutes. Advanced commercial drones can reach considerable altitudes, driving a need also to develop more prescriptive rules related to commercial aircraft flight paths.

The development of strong regulation, including pilot qualification, should reduce instances of unintended incursion. Even if unintended and particularly if intended, potential penalties for incursion should be severe, reflecting the risk to life that such events create. The costs of such events to airlines are substantial when they result in airspace closure as happened famously at Heathrow and Gatwick, and also in New Zealand with the required diversion of a B787 in 2019.

Q.3 *Should we change the requirement to gain consent to fly above property by:*

a.	Using 'safe distances' as an alternative?	Yes
b.	Relaxing the requirement in another way?	Yes
c.	Removing the requirement completely?	Yes

Q.4 *Should we change the requirement to gain consent to fly above people by:*

a.	Using 'safe distances' as an alternative?	Yes
b.	Relaxing the requirement in another way?	Yes
c.	Removing the requirement completely?	Yes

Q.5 *If we use 'safe distances' as an appropriate alternative to the consent provision, what distance(s) would you consider is appropriate?*
Drones travel at substantial speeds. A 'safe distance' from people should be considered both horizontally and vertically with at least 20m horizontal and 15m (above head height) vertically.

Q.6 *Are there any major Rules changes we should consider?*
The Rules changes are generally focussed on drones operated by a pilot with VLOS control or First Person View (FPV) control and potentially BVLOS. With advances in technology, automated drone operations are expected to become a major factor in the growth of the industry. This raises the issue of what an "automated" drone is? Just as with driverless land transport, the issue of automation compared to pilot interaction also becomes a factor relevant to assessing liability for a breach of the Rules or for a drone causing harm or damage.

Minor Changes to the Rules

Q.7 *Are there any minor changes to the Rules that would make them easier to understand?*
A standalone Rules part for drones will assist understanding of the relevant Rules

Q.8 *What do you think of the proposed minor Rules changes?*
All make good sense. FPV technology is already capable of 360 degree visibility and will become more commonplace, although detect and avoid technology will likely negate the need for FPV for risk mitigation.

Q.9 *Are there any other changes we should consider?*
Not currently aware of any.

Basic Pilot Qualification

Q.1 *Should we introduce basic pilot qualification for Part 101 drone pilots?*
Yes. Mandatory training and qualification is the best means of educating drone pilots about not just the risks but also the fact that *there are legal requirements* which make those rules enforceable. Accidents caused by drones are certain to attract media attention. The industry should be taking all reasonable steps to ensure a sound risk based regulatory system for drone operators.

Q.2 *What impact would a basic pilot qualification likely have on you?*
Reduction of risk to airlines.

Q.3 *What format should this test take?*
An appropriate on-line training programme with self test questions and then a final scored on-line test would be the most appropriate and are a widely used format. A successful score (and consequent licence) then becomes part of the CAA database, searchable by appropriate authorities. The operator can upload a portrait photo and request a credit card sized ID of the licence to satisfy any inquiry while in the field. The test and ID should be subject to a nominal fee set at a cost recovery level.

Q.4 *Should there be a minimum age for basic pilot qualification?*

Yes. The suggested age of 14 is logical to support the legal enforceability of the rules with the related requirement of 16 years for a supervisor. The rules should be very clear on the legal responsibilities of a supervisor, particularly for any operator aged under 14 years – drones will inevitably become a sought-after toy for younger age-groups, particularly those familiar with computer games.

Q.5 *Do you agree with the proposed special authorisations given to Part 141 and Part 101.202 approved training organisations?*

Provided the content in the Basic Qualification training is all covered within Part 141 and Part 101.202 training, holders of such qualifications should not be required to hold the Basic Qualification. However, a licensing system should be integrated to ensure a consistent approach to record keeping of qualifications and issue of ID style licenses.

Q.6 *Is there any other special authorisation you would like to see?*

No.

Drone Registration

Q.1 *Should we introduce the proposed drone registration system?*

Yes. If we are to have drones integrated into the air transport system, they need to be regulated as a matter of fundamental public safety. There is no point having rules that cannot be enforced. The only way enforcement can work in this industry is through identification of an operator and identification of an owner. Consequently each drone must be identifiable and traceable to an operator or failing that (eg an unlicensed operator) the rules must attribute liability to the owner. That liability should ensure that the owner knows at all times who the operator is.

Many and possibly most drones of a commercial scale will be owned by companies. In such cases it may be prudent to adopt, above a specified weight level, an Approved Person structure as well as the owner so that in the case of a company which can easily "disappear" or become insolvent, there is an individual with a strong interest in managing the drone assets.

This accountability is important both in active risk management (eg. live tracking of a drone straying into unauthorised space) and in post event enforcement proceedings and accident investigation. This level of accountability and enforcement will also assist with developing social acceptance of the industry.

Q.2 *What impact would drone registration have on you?*

Reduced risk to airlines.

Q.3 *What do you think of the proposed system design and requirements?*

Very practical and sensible.

Q.4 *Should there be a minimum weight threshold for registering a drone?*
The suggested 250 grams is well reasoned and there is value in a consistent international standard.

Q.5 *Should certain drones not need to be registered?*
No. Save for the 250 gram threshold, exemptions such as for indoor drones or Model Flying Club drones. Consistency is important in rules making and such drones should be registered. There is no practical constraint on such drones being operated outdoors or beyond the supervision of a flying club.

Remote Identification

Q.1 *Should we consider introducing Remote ID?*
Yes. For all the reasons relevant to Registration, introduction of Remote ID is also important to enforcement and public confidence. Remote ID is also important as part of detect and avoid technologies which will become increasingly important as numbers of drones increase and they become more frequent users of airspace, including over urban environments.

Q.2 *What impact would Remote ID likely have on you?*
Minimal – limited to the cost of installing remote ID technology (which is likely to quickly become standard on-board equipment in any event) and any necessary costs of third party or regulatory monitoring.

Geo-awareness

Q.3 *Should we consider introducing geo-awareness?*
Most of the risk management benefits of geo-awareness can be achieved with the simpler geo-fencing / geo-caging. Geo-awareness is more complex and therefore a more difficult and possibly confusing area for regulation. As the technology develops, geo-awareness should be incorporated as needed for specific environments and operations but trying to create a catch-all regulation or even a matrix-structure of regulation for geo-awareness is unlikely to provide sufficient benefit to justify regulation in the short term. However having regard to the longer time frame proposed for introduction of geo-awareness, it makes sense to be at least considering it at this stage.

Q.4 *What impact would geo-awareness likely have on you?*
Given the range of possibilities around geo awareness, the impact could be anything from nil to substantial, depending on the operations involved. This underlines the difficulty inherent in designing a suitable regulation.

Yours sincerely

[redacted]

[redacted]
Board of Airline Representatives New Zealand

[redacted]

From: [redacted]
Sent: Wednesday, 19 May 2021 9:30 AM
To: Enabling Drone Integration; David Thornley; K&K Barnes
Cc: Bryce Gibson; A Hamilton; Andrew Robinson; Phil Eldridge
Subject: Submission by Control Line Special Interest Group of MFNZ
Attachments: CL SIG MoT Submission on Drones 17052021.pdf

To Enabling Drone Integration consultation,
Ministry of Transport,
PO Box 3175,
Wellington, 6140.

Hello
Please find attached the Control Line Special Interest Group's Submission

Regards
[redacted]

Enabling Drone Integration - Consultation
Ministry of Transport
PO Box 3175
WELLINGTON 6140

[redacted]

19 May 2021

Dear Sir/Madam,

Thank you for the opportunity to comment on your consultation document.

The Control Line Special Interest Group (Control Line SIG) is a subsidiary group of Model Flying New Zealand. The Control Line SIG comprises approximately 70 members across New Zealand who fly a range of FAI (Federation Aeronautique Internationale) regulated event classes.

Control-line flying involves flying a tethered model plane with a motor in a half hemisphere. The pilot holds a control-line handle and gives up or down control, enabling the model to fly different maneuvers. Control-line aircraft neither go beyond visual line of sight nor have any built-in cameras. The length of lines is never more than 22m also limited by FAI rules depending on the competition class. A video link showing typical control line model flying is here: [Introduction to Control Line Flying - YouTube]

The Control Line SIG is generally supportive of efforts to bring New Zealand's regulatory regime for drones into line with international standards to avoid any possible infringements of privacy, health and safety issues, or conflict with full-size aircraft. However, our group is of the view that the level of regulation proposed by government with pilot registration, remote ID and geo-awareness testing is disproportionate to the level of risk posed.

Our submission is that the consultation document incorrectly identifies control line flying as either remotely piloted aircraft (RPA) or as unmanned aircraft (UA).

The relevant part of the document (Glossary on page 5) is quoted below:

Remotely Piloted Aircraft (RPA)	An aircraft and its associated elements which are operated with no pilot on board.
Remotely Piloted Aircraft System (RPAS)	A remotely piloted aircraft, its associated remote pilot station(s), the required command and control links and any other components as specified in the type design.
Unmanned Aircraft (UA)	An aircraft designed to operate with no pilot on board, and that includes unmanned balloons, control line model aircraft, free flight model aircraft and remotely piloted aircraft.
Unmanned Aircraft Systems (UAS)	An aircraft and its associated elements which are operated with no pilot on board.

The consultation document goes on to categorise RPA/UA as drones. The document defines drones as:

"Drones are aircraft that can be remotely piloted or flown autonomously."

Our submission is that control line model aircraft are in no way comparable to the legislators' current definition of a drone and should be exempted as being of no risk. This is the case in the UK, as shown in the UK CAA table. (refer consultation document excerpt attached to this letter).

The health and safety risks of control-line flying to either the pilot, full-size aircraft or members of the public is similar to indoor flying.

Our submission seeks that any new regulatory regime should treat control line flying in the same way as our counterparts in the United Kingdom.

The United Kingdom has similar laws and legal conventions to New Zealand and has a nuanced approach to this regulatory issue. In our view, this approach achieves a good balance between monitoring drones and exempting control line models from regulation.

Yours faithfully,

[redacted]

Attachment 1- Table Showing U.K Exemption for Control Line from Consultation Document

		Registration			Competency Testing			Identification			
	Where are they up to?	Who/what?	Cost	Validity	Who?	Cost	Validity	Physical and electronic ID	Remote ID	Minimum age	Special authorisations
United Kingdom Civil Aviation Authority (CAA)	New rules effective from 30 November 2019 *UK CAA will review and implement any changes from April 2021*	• All owners of drones between 250g and 20kg • Operators of drones above 20kg must obtain an exemption before any flight can take place	GBP9 per operator	1 year	Operator gets a **Flyer ID** on passing Online theory test/online education package based on a new Drone and Model Aircraft Code mandatory for all drone operators • 20 multiple choice questions • Pass mark of 16 • Unlimited number of attempts	Free	3 years	Operators must label each drone with unique digital Operator ID issued by UK CAA (one code for all drones)	Mandatory Remote ID will be introduced at a later stage (details not yet decided)	For registration: • 18yrs For competency testing: • None, but children under 13 can only register with a parent or guardian present	Exemptions from the competency test apply to: • holders of current CAA permissions or exemptions for drone operations • operators holding an achievement certificate issued by a UK model aircraft association Exemption from registration and education apply to control line model aircraft flying

[redacted]

From: [redacted]
Sent: Wednesday, 19 May 2021 12:55 PM
To: Enabling Drone Integration
Subject: Response to discussion document proposal
Attachments: Enabling Drone Integration Submission - Colin Roycroft.pdf

Regards

[redacted]
Aeronavics Limited New Zealand
[redacted] **Website:** www.aeronavics.com | **Find us on:** **FACEBOOK**

19 May 2021

[redacted] AERONAVICS Ltd. New Zealand since January 2021 and prior to that 12 years service in GA at Pacific Aerospace Ltd as Production Manager for 9 years and 3 years as General Manager for Production holding the Senior Person approval for Rule Part 148

Submission to Ministry of Transport discussion document regarding the integration of unmanned aerial vehicles with manned titled Enabling Drone Integration.

I found the content of this document constructive and reasonable in the approach proposed to improve the control of unmanned aerial vehicle operations to maintain a high level of safety in New Zealand airspace.

As a holder of a Part 102 certificate and with plans to become a fleet operator in the future, operating BVLOS missions, it is, in my opinion, critical to ensure that drone activity is controlled and as such Aeronavics supports the proposed approach set out in the discussion document.

This response will be structured around my opinion regarding the questions put forward within the discussion document.

General

The proposed series of measures seems fair and reasonable, The proposed approach will help to achieve the desired objectives to improve control of drone operations, ensure pilots and owners are aware of the rules, bring more accountability and will help address the problems and opportunities identified. The proposed order of implementation is also fair and reasonable.

Major Rule Changes

I believe that drone operations should have a standalone Rule Part. If there is a possibility to harmonises where practical with current Rule Parts that are applicable to manned aerial vehicle operations, I think this should be considered but ultimately a standalone rule part is the way to go.

The four-kilometer minimum flight distance from aerodromes can be restrictive and could be reviewed by looking at the possibility of identified operating zones inside the 4 km distance. Graduated altitude limits could also be introduced within these zones from 50m to 4km distance from the aerodrome, the lowest level limit being at 50m. That said, it may be wise to implement registration and Remote ID, possibly even Geo-awareness before drones are permitted to share aerodrome airspace with manned aircraft traffic. Such measures introduced prior to changing this rule would encourage compliance and facilitate enforcement of any changes to the current rule.

As drone numbers in the skies increase the requirement to gain consent to fly above properties and people will become, not only restrictive but very difficult to manage and enforce. With the proposed measures regarding registration and remote ID implemented, it would seem reasonable to relax this rule to adopt a safe distance alternative approach of 50 metres.

No other rule changes have been considered

Minor Rule Changes

I have no objections to the proposed minor rule changes and no others I wish to request.

Basic Pilot Qualifications

I believe that there should be a qualification process in place for all Part 101 drone pilots, this would ensure pilots are aware of the rules, facilitating compliance and enforcement when rules are not complied with. The preferred format for such a process would be electronic/online theory. The proposal not to introduce a minimum age for basic pilot qualifications is a sound one and allowing a pilot to be tested/trained through a Part 141 or 101.202 approved training organisation is also acceptable.

There are no other special authorisations I would like to see proposed

Drone Registration

The proposed registration system is necessary to offer visibility on drone operating numbers in NZ and improve identification of drones that are being operated in a non compliant fashion. This will encourage compliance due to the fact that owners/pilots are known to the CAA and this will also offer the CAA a communication network throughout the drone community. A digital platform would seem to be the most cost effective and efficient method for registration.

Regarding the scope of registration I support the proposal that drones weighing 250 grams or more should be included.

I do not however agree that there should be exemptions for indoor operations or specific designated areas such as within MFNZ sites, this would result in un-registered owners/users and vehicles over 250 grams operating under the registration system radar, what is to stop such an operator taking his drone outside or operating outside the MFNZ controlled site. In addition one key benefit of registration is that the operating fleet (drones above 250 grams) are known to the CAA and as such are in the known drone community with no exceptions. I do not believe it is in the interest of airspace safety to have this exemption.

Remote ID

In order to ensure that safe drone operations are maintained there is a need for pilots to be more situationally aware of the air traffic around them and for each drone to be identified uniquely while in operation, therefore I support Remote ID implementation. ADS-B devices are readily available and inexpensive. I would suggest that conditions on Remote ID capability should start with importation controls.

Geo-awareness

Such a capability that alerts the pilot of the potential of entering a controlled zone would remove the burden on pilots to continually update themselves with the status of restricted and controlled airspace and improve compliance and therefore I support the introduction of geo-awareness

[redacted]

From: [redacted]
Sent: Wednesday, 19 May 2021 1:44 PM
To: Enabling Drone Integration
Subject: MOT submission - Aeronavics Ltd.
Attachments: MOT rule changes-Aeronavics.docx

Please find attached my submission for the proposed changes to Drone operational regulations in New Zealand.

Please contact me if you require any further information from us and also, I am happy to help in any other capacity you may require.

Kind Regards - Rob Brouwer

--

[redacted] Aeronavics Limited New Zealand

[redacted] | **Website:** www.aeronavics.com | **Find us on:** **FACEBOOK**

19 May 2021

[redacted] AERONAVICS Ltd. New Zealand

Submission to Ministry of Transport

Discussion Document: Enabling Drone Integration

Overview

The Discussion Document sets out very clearly a logical, sensible and well considered set of proposals for the development of the Drone industry in New Zealand and the integration of drones into the air transportation system.

Recognising the very rapid development of the numerous technologies and infinite variety of applications as technology progresses, the proposed process and eventual structure of the regulatory system makes excellent sense.

Aerospace Inspections has familiarity with the testing and use of drones and other remote controlled and autonomous devices within the airline industry in USA and EU for inspection of large aircraft airframes. The ongoing step changes in drone technology will enhance such inspections and more importantly, a vast array of commercial, safety and social applications.

Specific Responses

Introduction (Questions from page 25)

Q.1 *What is your view on the proposed series of measures? Are there any other alternatives you suggest we consider?*

In our opinion the proposed series of measures address the main issues required in designing a regulatory scheme for safe drone operation by both commercial and recreational operators and present a good foundation to progress towards full drone integration into NZ airspace.

Q.2 *Would the proposed approach help achieve the desired objectives?*

If implemented as outlined in the discussion document and following the timelines presented, then we believe the measures will accomplish the objectives.

Q.3 *Would the proposed approach help address the problems and opportunities identified?*

Yes. The problems encountered with drone operations are now obvious and understood; the opportunities drones present are continually expanding and so the proposed regulatory scheme will address those problems and allow for further opportunities to be realised with this technology.

Q.4 *Are there any other problems and opportunities you can think of?*

BVLOS and automated installations present an expansive range of potentials in NZ and should be included in new regulations soon in our opinion - however, not in this round of proposed regulatory changes as significant development work is still required to establish and prove suitable safe operational frameworks for BVLOS.

Q.5 *Do you agree with the proposed order of implementation of the measures?*

Yes, the approach and the proposed sequence makes good sense as do the timeframes.

Rules Updates

Major Changes to the Rules

Q.1 *Should drones have their own standalone Rule Part?*

Yes. There is a considerable difference between operating conventional aircraft and drones. The current regulatory structure, training and licensing requirements are substantial and appropriate to commercial and general aviation. Drone operators in particular may be daunted by the complexity and extent of current aviation sector rules that in most part, do not apply to them, leading to potentially increased non-compliance, or restricting development of the benefits drones can bring to NZ.

Q.2 *Should we review the four-kilometre minimum flight distance from aerodromes?*

Perhaps later when the proposed measures have progressed along the timeline and drone systems become smarter and more reliable to self manage safety - but for now in my opinion - NO.

Q.3 *Should we change the requirement to gain consent to fly above property by:*

a. Using 'safe distances' as an alternative? Yes

b. Relaxing the requirement in another way? Yes

c. Removing the requirement completely? Maybe

To advance social acceptance of drones, I believe it 'may' be necessary to keep the requirement to gain consent, however, should licencing and registration rules be introduced as planned this measure should support more socially acceptable drone operations by consumer drone pilots. Installing safe distance rulings for drone operations over people and property according to size and weight class should be considered in my opinion to maintain safe operations.

Other smart technologies integrated into drones over time will support the relaxing of this ruling and so will the eventual progression with general social acceptance of drones. An example of safe distance per drone class and weight could be:

under 250 grams - 5m x 5m Horizontal and Vertical - (self regulated)
over 250 grams to 7kg - 30m x 30m - (self regulated)
over 7kg and under 25kg - 50m x 50m - (monitored)
over 25kg not over people unless equipped with suitable emergency parachute to significantly reduce kinetic impact energy - then 50m x 50m - (monitored)

Q.4 *Should we change the requirement to gain consent to fly above people by:*

a. Using 'safe distances' as an alternative? Yes

b. Relaxing the requirement in another way? Yes

c. Removing the requirement completely? Maybe

Please also refer to the response to Q.3 above.

Q.5 *If we use 'safe distances' as an appropriate alternative to the consent provision, what distance(s) would you*

consider is appropriate?

under 250 grams - 5m x 5m Horizontal and Vertical - (self regulated)
over 250 grams to 7kg - 30m x 30m - (self regulated)
over 7kg and under 25kg - 50m x 50m - (monitored)
over 25kg not over people unless equipped with suitable emergency parachute to significantly reduce kinetic impact energy - then 50m x 50m - (monitored)

Q.6 *Are there any major Rules changes we should consider?*

The Rule changes are generally focused on drones operated by a pilot within LOS control or First Person View (FPV). With advances in technology, automated drone operations are expected to become a major factor in the growth of the industry. This raises the issue of what an "automated" drone is? How much automation compared to pilot interaction also becomes a factor. The Rules should consider a definition of "automation" and ideally identify various levels. One such matrix has been developed by Exyn Technologies, a USA based drone manufacturer.

Minor Changes to the Rules

Q.7 *Are there any minor changes to the Rules that would make them easier to understand?*

No - if a drone pilot cannot understand the rules as they are being presented here then they probably should not be piloting a drone at all.

Q.8 *What do you think of the proposed minor Rules changes?*

They are well thought through and present a sound and safe progression of drone rules in NZ.

Q.9 *Are there any other changes we should consider?*

Not currently. We are happy to work with MOT/CAA during our MBIE AITP program (and beyond) to help address emerging issues and operational requirements for future technologies and broader operating environments such as BVLOS and fleet management of automated drone installations.

Basic Pilot Qualification

Q.1 *Should we introduce basic pilot qualification for Part 101 drone pilots?*

Yes. Mandatory training and qualification is the best means of educating new drone pilots about the risks but also the fact that *there are legal requirements* which make those rules enforceable. Accidents caused by drones are certain to attract media attention and could potentially hinder the progression of drone development and their benefits in NZ. The industry should be taking all reasonable steps to ensure a sound risk based regulatory system for all drone operations, commercial and recreational.

Q.2 *What impact would a basic pilot qualification likely have on you?*

It would help ensure that our industry can progress by ensuring that potential incidents, which could hinder that progress, are significantly reduced.

Q.3 *What format should this test take?*

An on-line test and scoring system - 0% failure. Can apply as many times until they get it right. Current drivers licence should be part of the ID process - if they can't drive a car they should not be operating a drone (unless at a model airfield). A successful score (and consequent licence) then becomes part of the CAA database, searchable by appropriate authorities. The operator can upload a portrait photo and request a credit card sized ID of the licence to satisfy any inquiry while in the field. The test and ID should be subject to a nominal fee set at a cost recovery level.

Q.4 *Should there be a minimum age for basic pilot qualification?*

Yes. The same as for driving a car in my opinion, unless under the supervision of an adult at a model airfield,

Q.5 *Do you agree with the proposed special authorisations given to Part 141 and Part 101.202 approved training*

Organisations?

Provided the content in the Basic Qualification training is all covered within Part 141 and Part 101.202 training, holders of such qualifications should not be required to hold the Basic Qualification. However, a licensing system should be integrated to ensure a consistent approach to record keeping of qualifications and issue of ID style licenses.

Q.6 *Is there any other special authorisation you would like to see?*

As the drone industry evolves, particularly for commercial applications, simultaneous monitoring of multiple drones on a "fleet management" basis will become a reality. This will require more comprehensive training and licensing arrangements, so consideration should be given soon to such operations and working with current drone operators that are progressing towards such operational frameworks should be high on MOT/CAA priorities.

Drone Registration

Q.1 *Should we introduce the proposed drone registration system?*

Absolutely - there is no way to advance to the full spectrum of drone potential in NZ without such measures. Drones need to be regulated as a matter of fundamental public safety. Additionally, each drone must be identifiable and traceable to a licensed operator (or an unlicensed operator) with the rules attributing liability to an owner. That liability should ensure that the owner knows who the operator is at all times.

Most drones of a commercial scale will be owned by companies. In such cases it may be prudent to adopt, above a specified weight level, an Approved Person structure as well as the owner so that in the case of a company which would "disappear" or become insolvent, there is an individual with a strong interest in managing the drone assets.

This accountability is important both in active risk management (eg. live tracking of a drone straying into unauthorised space) and in post event enforcement proceedings and accident investigation. A level of accountability and enforcement will also assist with developing social acceptance of the industry.

An additional benefit to owners from registration is that recovery of lost or stolen drones is made possible.

Q.2 *What impact would drone registration have on you?*

It will support the safe and timely advancement of drone adoption and benefit across a range of industries and applications in NZ - we welcome the measures wholeheartedly.

Q.3 *What do you think of the proposed system design and requirements?*

They are sensible.

Q.4 *Should there be a minimum weight threshold for registering a drone?*

Yes - *t*he suggested 250 gram limit is consistent with emerging international standards.

Q.5 *Should certain drones not need to be registered?*

No, absolutely not. Except for the under 250 gram threshold. There can be no exceptions to this rule if we are to maintain airspace safety.

Remote Identification

Q.1 *Should we consider introducing Remote ID?*

Yes - for all the reasons relevant to Registration, introduction of Remote ID is also important to enforcement and public confidence. Remote ID may also become important as part of detect and avoid technologies. As drones become progressively more integrated in the air transport system Remote ID will help support future manned and unmanned traffic management systems.

Q.2 *What impact would Remote ID likely have on you?*

Simple to include - all of our systems already have provisions for micro ADS-B.

Geo-awareness

Q.3 *Should we consider introducing geo-awareness?*

Yes - it will help form the basis of a smarter drone industry in the future and provide more safety in the skies over time. It is important to consider this now and move toward a framework that enables devices to respond to their environment, especially when it comes to restricted airspace and no fly zones such as CTA.

Q.4 *What impact would geo-awareness likely have on you?*

It will further support our industry and our companies objectives in the future and de-risk greater uptake of drone technology in New Zealand.

[redacted]

From: [redacted]
Sent: Wednesday, 19 May 2021 8:08 PM
To: Enabling Drone Integration
Subject: Kapiti Aeromodellers Club - submission on drone integration
Attachments: KAMCI submission - enabling drone inegration.pdf

Please find attached our submission from the Kapiti Aeromodellers Club.

Regards,
[redacted]

KAPITI AEROMODELLERS' CLUB

Kapiti Model Aero Club Inc.
[redacted]

18/5/2021

Submission on 'Enabling Drone Integration'.

Dear Sir/Madam,
Please find attached a submission from the Kapiti Aeromodellers Club Inc on the current discussions on drone integration.

This submission is made on behalf of, and with input from, the 90 members of this club.

Yours Sincerely,

[redacted]

The Club and its members have read the proposals being put forward and wish to make the following points.

Definition.

We believe there is an inherent problem in the definition of drones, which is an all-encompassing term for unmanned or remote-controlled aircraft. We believe it makes it harder to separate the type of 'hobby' activity enjoyed by thousands of MFNZ members and others throughout New Zealand.

We see many of the regulations being proposed as an effort to regulate and control those type of craft being used in a commercial environment. Also needing to be controlled are those 'drone' type aircraft being used by members of the public to photograph themselves and events, where no authority exists to fly.

The Glossary in the Discussion Document indicates that the MoT does not distinguish between fixed wing model aircraft at clubs and other generic categories (RPA, RPAS, UA, UAS, UAV). A one-size-fits-all approach to unmanned aircraft made by the document is nonsensical in as much and does not best serve the CAA or unmanned aircraft operators. We submit the argument that it is critical that distinctions are defined between different types of drones and model aircraft, and between casual operators, commercial users, and MFNZ members. Definitions of such must be established early in the document to enable the crafting of specific legislation with safe and sensible exemptions.

Pilot Qualification and Drone registration.

This covers.

- Mandatory online theory testing for Part 101 pilots.
- Mandatory notification of all drones weighing more than 250 grams by their owners.
- The proposed regulation "ring fences" MFNZ outside of these requirements, although it does so with rather a large caveat.

> *180 We propose that if a model aircraft is solely being flown within a designated area and under supervision of MFNZ, then registration of the drone would not be required. However, if a model aircraft is flown outside of a designated area, then it would have to be registered.*

MFNZ members would be ruled outside of the requirements of additional qualifications and aircraft registration, but would need to fly in "designated areas".

What is a designated area?

Whilst we can easily define a model club's flying strip as registered to MFNZ as a designated area, there are many other areas enjoyed by club members.

These include but are not limited to:-

- model aircraft displays at public events.
- Club members that operate out of members lifestyle blocks
- temporary flying sites that are only used at specific times of the year and day.
- flight demonstrations, especially focused around schools and the STEMs program
- testing of aircraft on MFNZ members property

Most councils allow for their parks to be used for 'park flyers', which are small 'fixed' wing, electric model aircraft.

Most councils have regulation around the flying of 'drones' in their parks, but limit how and where they may be flown. Here we see a differentiation between 'fixed wing' and 'drone'.

We are also of the opinion that registering the 'drone' is the wrong approach. It is the operator that needs to be registered. It is the operator of the drone that will command it in such a way that a breach of the rules occurs. Operator registration means that it would be possible to have a single 'gadget' to swap between 'drones' as necessary, though having more than one would be more practical. An individual can only fly one 'drone' at a time. If something goes wrong, you cannot prosecute a drone. It is the Operator that is of paramount importance.

Remote ID.

Remote ID is the mandatory use of remote identification capability on certain drones during flight to enable the transmission of a range of data (e.g. drone unique registration number, real time geolocation) to third parties.
No provision has been given to MFNZ members to exempt them from the future Remote ID project.

> *215 For operators of drones without such capability, there would be the cost to equip with Remote ID and meet the standard. However, we anticipate it to be minimal as the majority of drones operating in New Zealand should already be equipped with some forms of Remote ID capability.*
> *Moreover, most drones currently operating either for commercial or recreational purposes have a life span averaging one to two years. By the time a Remote ID technical standard is adopted, and new rules are enacted, most drones would have had to be replaced, and so the costs of retro fitting a drone might not arise.*

Again, this is where definition comes unstuck. No doubt this statement refers to commercial type drones that are being used for aerial mapping, farm management, pylon surveys, aerial spraying etc.
It does not come close to what happens in the world of Model Aircraft.
Many members have multiple models, and a survey of our club a few years ago, showed a total number of models across our membership in the region of 500.
MOST members' models are several years old, and when we get into scale or large models, it is not unusual for a life span well in excess of 10 years. Some members are quite happily flying models more than 20 years of age.
The assumption here too, is that such identification will come with the newer model. This is the assumption that the 'newer model' comes with its own electronics. Again, there is the assumption that all 'drones' are the same. 'Model Aircraft' are built or purchased for assembly and rarely come with any electronics, such electronics being installed when the model is completed.
There is no seen need to be able to identify such aircraft. They fly a circuit type pattern and are always flown line of sight.

Designated areas for model aircraft flying.

The discussion document has invented the concept of designated areas for model aircraft flying. It then confuses them with Danger areas. Rule 101.207 refers to airspace in use before 2015. This is quite a different concept. We are not aware of any other airspace user that is confined to operating in specific areas. Gliders, Hang-gliders, Balloons and General Aviation are able to operate anywhere that it is safe to do so. This includes taking off, overflying and landing. This principle should also continue to apply to model aircraft.

Changing the 4km rule.

We believe there is no need to reinvent the management of airspace around controlled or uncontrolled aerodromes. The "4km rule" is a close match to the lowest height of an aircraft in a normal descent profile to a runway. Aerodromes should have awareness of anyone operating in proximity. Asking for consent and receiving it is a good control mechanism which is easy for everyone to understand.
Introducing more complex airspace shapes around aerodromes will simply add to the complexity and relies on an unjustifiable expense in promulgating the various differing areas around aerodromes.

The removal of the CAR101.202 rule.

We do not believe the removal of this rule is in any way constructive.
The rule puts a responsibility framework around the building of such size models to ensure the integrity of the model and the safety of its operation.

In summary:

- There is a major problem with definition and therefore segregation of various models.
- 'Designated areas' are undefined, and it is not clear what they would encompass.
- The use of Remote ID should only apply to specific, commercial aircraft. The assumptions on replacement of craft time-cycle is invalid.
- The 4KM rule does not need to be changed.
- The removal of CAR101.202 rule is not constructive.

[redacted]

From: Wayne Elley [redacted]
Sent: Wednesday, 19 May 2021 8:10 PM
To: Enabling Drone Integration
Subject: Submission from Wayne Elley
Attachments: Enabling_Drone_Integration_W.Elley.docx

Dear Ministry of Transport

Please find attached my submission, in Word format, along with full contact details.

I am submitting as an individual but am also [redacted]

Kind regards,
Wayne Elley

[redacted]

19 May 2021

Ministry of Transport

Dear MoT

I belong to [redacted] have been involved with model aircraft since 2003. I have taken the time to read the entire 63-page discussion document titled: *Enabling Drone Integration*. I submit as an individual as my club is also making a collective submission. The concerns I have with the document are that the categories of UAV user are unclear, registering every UAV in the country is the wrong focus, 'designated areas' are restrictive for MFNZ (Model Flying NZ) fliers and others, and there are opportunities for co-operation that could be explored between MFNZ, MoT, and the CAA.

Confusing Categories

From what I have read, the intent of the document is really towards commercial drone operators. However, this is not made clear until Paragraph 178 where it says:

> *"We propose that the following drones would **not** need to be registered:*
> *• drones used solely indoors*
> *• drones weighing less than 250 grams*
> *• drones operating within Model Flying New Zealand (MFNZ) designated areas and under supervision of MFNZ. "*

This paragraph contains the first mention of MFNZ fliers, rather late in the document. The Glossary in the Discussion Document indicates that the MoT does not distinguish between fixed-wing model aircraft at clubs, and other generic categories (RPA, RPAS, UA, UAS, UAV). Perhaps the following could be added: UAMFNZM (Unmanned Aircraft Model Flying NZ Member) or UACF (Unmanned Aircraft Club Flier).

These demarcations would help craft specific legislation along with sensible exemptions.

Over-registration

Considering Chapter Three of the Document, it seems silly to register every single Part 101 model aircraft and drone in the country and legislate a GPS device on it. We do not even have a gun registry in NZ (but we used to) It is ridiculous to suggest that we have a UAV register in a country that does not even have a firearm register! It seems that the cart is before the horse here. Registering the *operator* would make more sense, as currently happens for firearms - rightly or wrongly in that case. MFNZ fliers are already registered through MFNZ. Therefore, the legislation should *only* be targeting the lone-ranger fliers (non-MFNZ) and Part 102 commercial drone community. All the incidents that make the news regarding hazards to full-size aircraft occur with rogue drones, as far as I am aware. There were 680 events in the "Annual Drone Reports" Table 2 at Paragraph 47. From what is presented, none were MFNZ model aircraft.

Designated Areas

I have some concerns about model aircraft having to fly only at a MFNZ "designated area". How about the spontaneous trip to the local park with a small foam aeroplane? This is legal under many local council bylaws. Another example is taking a slope soaring glider to places such as Whitireia Park in Porirua. There could also be a father and son trying out a new RTF (Ready-to-fly) plane at the local park following Christmas or a birthday. The proposed procedures sure would kill that harmless fun. It seems to me there should be exemptions which are seriously considered for non-drone flying (safely) in open public spaces, provided it occurs outside 4km of an aerodrome as is currently the law.

Opportunities

Finally, it is useful to consider opportunities. It is outside the square, but why not support MFNZ (with staffing and money) to co-lead, along with another government-created entity, to take on the training and registration of both drone and MFNZ fliers via the one digital system - all under one umbrella. This would leverage MFNZ's existing and proven 'Wings' training process[1]. This would enable new fliers to sign up via online form, pay whatever fees to the government as well as MFNZ subs. There could also be the option of joining a local flying club via the online process (subject to member approval). I think this could be a win-win for both MFNZ and the Government, and it could be tied in with CAA's systems.

Thanks for your consideration.

Sincerely,

Wayne Elley

[1] The MFNZ Wings process is more advanced than what the Discussion Document proposes when it says: Para 151 *"We do not think it is appropriate to require drone pilots to undertake practical lessons to learn how to fly a drone as part of this basic training."* MFNZ's Wings training has a practical element to verify that a flier can take off, do circuits, and land safely. Here is the link to Wings on the MFNZ website.

[redacted]

From: Alec Fuller [redacted]
Sent: Wednesday, 19 May 2021 9:15 PM
To: Enabling Drone Integration
Subject: Submission from Alec Fuller
Attachments: Submission on Enabling Drone Integration Ver 1.0.pdf

Hi,

Please find attached my submission arguing for a minor change to exempt Control Line Model Aircraft from Drone legislation.

My personal details are:
New Zealand Citizen
[redacted]

With thanks
Alec Fuller

Sent from BlueMail

Submission on Enabling Drone Integration
6 April 2021
Ministry of Transport

I propose that Control Line Model Aircraft be exempt from the definition of a Drone and also exempt from the definition of a remotely piloted aircraft.

A Control Line Model Aircraft can only fly because two wires run from the pilot out to the aircraft. There is no Radio Control involved, only physical control via the two wires that pull on a controlling elevator.
The wires are never longer than 20 metres and so the aircraft can only ever fly in a circle or up to 20 metres in the air.
Control Line operated aircraft will never form any part of an integrated transport sysytem as they are only capable of flying in very small circles. They just go round and round and round.
They are not capable of sustained flight without the wires to the pilot.

To the best of my knowledge Control Line model aircraft have no commercial application and no application in transport in any way, shape or form.
I mean, who would be interested in transporting anything from one side of a 20 metre circle to the otherside of the same circle.

Control Line fliers only ever fly on sites registered with our national governing body, New Zealand Model Aircraft Association.

There is absoluely no reason or justificaion for Control Line Model Aircraft to be part of an integrated drone policy.
Please consider exempting Control Line Model Aircraft from any future drone legislation.

With thanks
Alec Fuller
Member of the New Plymouth Model Aero Club.

[redacted]

From: Don Robinson [redacted]
Sent: Wednesday, 19 May 2021 10:32 PM
To: Enabling Drone Integration
Subject: Submission on Enabling Drone Intergration

I propose that Control Line Model Aircraft be exempt from the definition of a Drone and also exempt from the definition of a remotely piloted aircraft.

Reasons:- Control Line Model Aircraft are flown on 1, 2 or three lines from the aircraft and held by the pilot. There is no Radio Control involved, only physical control via the lines that control the Elevator/Flaps and sometimes a throttle. The lines are a maximum of 25 metres and so the aircraft can only fly in a circle around the pilot and up to 25 metres in height.

Control line model aircraft are not capable of sustained flight without the lines to the pilot.

So how can this be a danger to Aviation.

Control line model aircraft will never form any part of an integrated transport system as they are only capable of flying in small circles and have no commercial application.

Also note that the United Kingdom in their drone rules have exempted Control Line Model Aircraft.

Please consider exempting Control Line Model Aircraft from any future Drone Legislation.

With Thanks,
Don Robinson, [redacted]
Member of the New Plymouth Model Aero Club and affiliated member of Model Flying New Zealand, member number [redacted]

[redacted]

From: [redacted]
Sent: Thursday, 20 May 2021 9:39 AM
To: Enabling Drone Integration
Cc: 'Paul Clegg'; 'Robert Wallace'; 'Paul Squires'; Bill Long; David Ackery
Subject: Submission
Attachments: FF SIG MoT Submission on Drones .pdf

<<...>>

Greetings

Please find attached a submission on behalf of the Free Flight Special Interest Group of Model Flying New Zealand

Regards

[redacted]

[redacted]

Enabling Drone Integration - Consultation
Ministry of Transport
PO Box 3175
WELLINGTON 6140

[redacted]

Dear Sir/Madam,

Thank you for the opportunity to comment on your consultation document.

The Free Flight Special Interest Group (Free Flight SIG) is a subsidiary group of Model Flying New Zealand (MFNZ). The Free Flight SIG represents members across New Zealand who fly a range of New Zealand and FAI (Federation Aeronautique Internationale) regulated event classes.

Free Flight aeromodelling:

- Involves models where all control settings are built into the model before launch. After launch the modeller does not exert any further control – the model flys free of any further controls. This is different to other model aircraft where control is able to be constantly input.
- Is the oldest aeromodelling discipline (70+ years in New Zealand)
- Free Flight models are fundamentally all forms of gliders, with different classes of model having different launching techniques (towline, rubber power, motor power)
    - as gliders these are slow flying models
    - some classes are powered for launch – typically with the motor run limited to 10 seconds
    - the rules for current classes limit the scoring time to 2 or 3 minutes – in general flights are around this time
- Low flying time
    - typically Free Flight modellers would fly less than 35 days a year (some more but the majority less)
    - on a typical day one class of model may fly 3 – 7 flights of 2 – 3 minutes – say an average of 13 minutes actual flying time, plus 5 minutes of testing time
    - most modellers would fly an average of 2 classes per day
- Low weight
    - as far as the submitters know there is only one free flight model in New Zealand over 1000grams. Free flight models range in weight with many models under 200grams and very few models over 800grams
- Safety is a priority in flying these models and this is achieved by:
    - Careful selection of flying fields – generally away from active full sized aircraft areas

- Free Flight models will always drift downwind from where the launch position – so while the models are not controlled the general flying area can be determined
  - The launch area is predetermined – consequently limiting the flying area
  - Models are operated within line of sight – which can include the use of binoculars on windy days.
  - Operators of Free Flight aircraft are generally members of MFNZ and are subject to MFNZ rules and disciplines.
- We note that Free Flight models have been operated in New Zealand for over 70 years with no safety issues. The field selection and operator responsibility criteria have remained largely the same over that time
- Free Flight models are not equipped with cameras
- Involves models that are only used for recreation, sport and/or competition.

The Free Flight SIG is generally supportive of efforts to bring New Zealand's regulatory regime for drones into line with international standards to avoid any possible infringements of privacy, health and safety issues, or conflict with full-size aircraft.

However, our group is of the view that the level of regulation proposed by government with pilot registration, remote ID and geo-awareness testing is disproportionate to the level of risk posed.

While we do not seek exemption we do seek recognition of the low level of risk that Free Flight models pose and request that any regulation development allows for this.

We are available and happy to be involved as necessary.

Yours faithfully, for Free Flight SIG

[redacted]

model FLYING NEW ZEALAND

[redacted]

From: [redacted]
Sent: Thursday, 20 May 2021 3:40 PM
To: Enabling Drone Integration
Cc: [redacted]
Subject: Christchurch City Council submission on Enabling Drone Integration
Attachments: Christchurch City Council Subm~ion Enabling Drone Integration.pdf

Kia ora,

Please find attached the Christchurch City Council's submission on your *Enabling Drone Integration* discussion document.

Thank you for the opportunity to make this submission. Should you wish to further discuss any points raised, [redacted]

Ngā mihi,
[redacted]

[redacted]

[redacted]
[redacted]
Te Hononga Civic Offices, 53 Hereford Street, Christchurch
PO Box 73012, Christchurch 8154
ccc.govt.nz

Christchurch City Council

Christchurch City Council

03 941 8999

53 Hereford Street
Christchurch 8013

PO Box 73016
Christchurch 8154

ccc.govt.nz

18 May 2021

Ministry of Transport,
PO Box 3175,
Wellington, 6140
enablingdroneintegration@transport.govt.nz

Christchurch City Council submission on the discussion document: Enabling Drone Integration consultation

Christchurch City Council thanks the Ministry for the opportunity to provide comment on its discussion document: Enabling Drone Integration. We are encouraged to see the Ministry and CAA reviewing the rules for drones to ensure they are fit for purpose to keep up with the changing technology and increased opportunities for drone use.

Enabling the integration of drones into the aviation and wider transport system should seek to align with the Government's and Christchurch City Council's greenhouse gas emission reduction goals. We recommend a target date of 2025 is set for all registered drones to have zero exhaust emissions.

Full integration of drones into the transport system, and advanced technological development could ease land transport congestion and associated emissions if some goods and/or passenger service trips are replaced by drone operations. At that level, however, there will need to be consideration of infrastructure requirements and associated legislative changes/provisions (e.g. Land Transport Management Act, Land Transport Act, Land Transport (Road User) Rules and Land Transport Rule: Traffic Control Devices).

We do, however, have some concerns about how the changes to the rules to better integrate drones into the wider transport system will align with Council policy to protect Council-owned property, including sites where birds live (nest, feed or rest), and the requirements for permission to undertake certain activities on Council-owned property, including commercial activities and causing obstructions.

The Council supports a wellbeing approach to considering regulatory change, which takes a broad approach to evaluating the potential costs and benefits of this developing sector. A balance needs to be found between the benefits to business/individuals (e.g. cheaper transportation/delivery costs) with potential increased public nuisance such as increased noise over properties and privacy concerns. We need to consider the four aspects of community well-being – social, economic, environmental and cultural – as set out in the Local Government Act 2002.

We look forward to working with both the Ministry and the Civil Aviation Authority on the implications of drone use in public space, including for the wider integration of drones into the transport system.

[redacted]

Kind regards

Lianne Dalziel
Mayor of Christchurch

Christchurch City Council submission on the discussion document: Enabling Drone Integration consultation

Question	Council comment
1. What is your view on the proposed series of measures? Are there any other alternatives you suggest we consider?	In general, the intent of the proposed series of measures is supported. However, we have concerns related to some aspects of the proposed measures – specifically the proposed rule update to relax the need to obtain consent to fly over people and property. The discussion document also seems to focus this aspect of the proposed rule change on flights over property, and doesn't address associated take-off / landing and ground-based operations of flights that are conducted on Council owned land and public spaces. The proposed measures must ensure that provisions remain to allow Council to manage and control use of drones on and around its property and horizontal infrastructure. Consideration of ground operations will also be important in the longer term, as drones are integrated in to the wider transport system and development of specialist infrastructure (or modification of existing infrastructure) is required. More of a 'rules based approach' is likely to be required when drones move into transporting people and goods. This will require knowledge of both the safety of the drone operation and regulatory requirements of local authorities.
2. Would the proposed approach help achieve the desired objectives?	Generally yes, but this will depend greatly on detail of the final rule changes and the level of compliance with proposed drone registration and basic pilot qualification measures. It is perhaps questionable how successful the proposed approach will be in achieving objective four (i.e. New Zealanders feel confident that drones are being used responsibly and accept them in their day-to-day lives) – particularly in regard to nuisance and privacy concerns. The discussion document largely seems to seek to serve small scale domestic use and not address drones for e.g. delivery or the next evolution we'd expect to see (other than appendix 2), which means industry still suffer from long lead times. At the same time, the government may also suffer from long lead in times in regulating an activity that will already be occurring (like what happened with e-scooters – a new piece of technology which was essentially put on the streets as a commercial activity and then local authorities had to decide how to deal with them after they were already being used, with gaps in traffic legislation to manage it). As drone technology advances, it will be important to keep up with changes to the regulatory measures and not have to 'play catch up'.

	The discussion document could have gone further to address the more commercial elements people are coming up against, like process and infrastructure, including the regulatory requirements at ground level (both national and local). The use of drones for recreation and commercial activities needs to be balanced with other uses in public spaces. Examples of this include drones being flown in close proximity to paragliders on the Port Hills; drones being used a part of an event (for recording or as a lightshow) and attendees trying to film with their own drones. It is important that climate change implications are a focus. While drones may be a lower-emission means of transport than other types of transport, there are still a number of (mostly larger) drones using greenhouses gases or are hybrids. Setting a target, e.g. 2025, for all drones to be emission-free would align with the government's zero carbon goals.
3. Would the proposed approach help address the problems and opportunities identified?	Generally yes, but will again depend on final outcome and detail of proposed rule changes and level of compliance with (and enforcement of) proposed regulatory measures. Realisation of longer term transport opportunities will require CAA/MoT to involve local authorities and other key transport sector stakeholders in the process.
4. Are there any other problems and opportunities you can think of?	We note these in our responses to the following questions, but to summarise: • Greenhouse gas emission reduction – We recommend a target date of 2025 is set for all registered drones to have zero exhaust emissions. This would align with both the Government's and Christchurch City Council's greenhouse gas emission reduction goals. • Council bylaws and policies – we can protect against noise and nuisance (take-off/landing, not flying over certain areas) or require permission for commercial activities or obstructions, however, penalties do not include infringements when made under the Local Government Act 2002 (i.e. fine on conviction). Councils also have a duty to protect and manage council property. How can councils work better with the Ministry and CAA to integrate/align drone regulations into local authority regulations? • Commercial use – distinguishing recreational flights from commercial flights would benefit the drone operator in helping them understand different requirements (permissions) for flying over council-owned property. • Privacy concerns – while mostly a matter for the Privacy Commissioner, councils and CAA both receive privacy-related complaints about drone use. Further work needs to be done to address

	these concerns, particularly as camera technology develops and pictures become clearer. There is a potential high risk that users may inadvertently breach privacy of individuals. Clear and effective guidance would need to be developed to protect personal rights and mitigate risk to users. • Compliance – as drone use increases, there will be further difficulties in the ability to enforce the rules. Will CAA be able to issue infringements after the fact? How will CAA be able to resource this, e.g. will other authorities be authorised to issue fines? • Transport – the use of drones could provide opportunities for transport asset owners and operators for tasks such as traffic management, incident response, road/road layout inspections, and traffic and pedestrian surveys.
5. Do you agree with the proposed order of implementation of the measures?	Yes, although the longer-term measures to integrate drones into the aviation system and then the wider transport system will have a number of cross-overs, particularly when drones are landing/taking-off from public spaces. Aspects of the measures to enable drones to work successfully in the wider transport system should be brought forward to manage the risks of drones above the transport corridor, including when drones are being flown in urban areas where taller building can impact the wind, etc.

Rules Update

Question	Council comment
Major changes to the Rules	
1. Should drones have their own standalone Rule Part?	Yes.
2. Should we review the four-kilometre minimum flight distance from aerodromes?	Yes, we agree with reducing the distance from aerodromes, but consideration should be given to the type/use of aerodrome(s). For example, major airports need a greater clearance distance than say the roof-top helicopter pad at Christchurch Hospital. We recommend distinguishing between fixed wing aerodromes and heliports. Heliports could come down to a 1km radius, while fixed wing airports could be modified to reflect the approach and take-off gates.

	We note that most of Christchurch airspace is controlled airspace and often drone operators think the Council's landowner approval for a flight is all that they need (even though the Council policy requires full compliance with the Rules), and they do not seek air traffic control permission. There needs to be more education about the different approvals from different organisations.
3. Should we change the requirement to gain consent to fly above property by: a. Using 'safe distances' as an alternative? b. Relaxing the requirement in another way? c. Removing the requirement completely?	We do not agree that the landowner permission should be removed completely. We do recognise that this rule can be impractical and often unachievable for drone operators. However, if the rule is removed then it will fall to councils to manage permissions solely through its bylaws and policies. Many drone operators are already unaware of the different permissions required from landowner and also air traffic control in the airspace above Christchurch. This question appears to be focussed on flights transiting above private property, in which case relaxing the requirement or using safe distances might be appropriate. However, many drone operators use Council land for take-off and landing as well as flights above Council land. These changes must also consider associated ground operations within/from Council-owned land and infrastructure/property, not just flights over. Any rule change must still allow the Council to manage/control use of its property for ground operations. If the 'safe distances' alternative is adopted, we would suggest a tiered-approach that considers different types of property/land (e.g. arterial roads, pedestrian malls and public spaces with large concentrations of people, bird nesting areas)? It is recognised, however, that such an approach would be more difficult to implement, manage and enforce. Another consideration is that of occupied and/or developed land versus unoccupied/undeveloped land. It may be more appropriate to fly without permission over undeveloped land. However councils have many of the same issues on its reserve land as the Department of Conservation does on conservation land. We also recommend that any changes to the consent rule should exclude filming and photography. If mapping or taking imagery of a property then consent should be required. This may be more achievable if commercial vs recreational flights are separated.

4. Should we change the requirement to gain consent to fly above people by: a. Using 'safe distances' as an alternative? b. Relaxing the requirement in another way? c. Removing the requirement completely?	We support the use of 'safe distances' as an alternative to the requirement to gain consent to fly over people. Again, however, consideration needs to be given to places and/or events with large concentrations of people, and perhaps also nature of events/gatherings. From a safety perspective, consideration should also be given to the different level of risk for people outside (and exposed) underneath a flight path and those people inside buildings/vehicles. We recommend drone operators flying above crowds/at events should be Part 102 qualified.
5. If we use 'safe distances' as an appropriate alternative to the consent provision, what distance(s) would you consider is appropriate? a. 10 metres b. 30 metres c. 50 metres d. Other.	If safe distances are to be considered, we think 50m would be an appropriate height for flying over property and people. It is unclear how the safe distance would work in built up urban environments, for example drones flying above a transport corridor that has high-rise buildings on each side (i.e. reducing the open airspace around the drone) and the implications of this. Additionally, should safe distances for different sized drones be imposed? For example question 4 discusses the requirement for drones over 250 grams to be registered, a drone of that size could be ok flying 50 metres above property, but flying 50m above with a larger drone of 25kg, for example, could seem extremely low.
6. Are there any other major Rules changes we should consider?	**Rules for take-off and landing**, and setting down of things, not just the operation of the flight. The Council would like to work with the Ministry and CAA to fully understand the implications of take-off and landing on Council-owned property and how to mitigate the risks and other hazards, especially if the landowner permission rule is relaxed or removed. Councils can introduce bylaws to manage nuisance, for examples our Parks and Reserves Bylaw clause related to aircraft landing, taking off and setting down of anything. However, bylaws made under the Local Government Act 2002 do not have provision for issuing infringements. We recommend that the Director of Civil Aviation consider authorising the ability to issue infringements to authorised Council staff. This would have an impact on resourcing of Council staff, but we are open to discussion with the Ministry and CAA.

	Wildlife: The existing Department of Conservation guidelines should apply to other wildlife areas also – including "fly no closer than 50 m in any direction to shorebirds or seabirds" and "abandon contact at the first sign of any bird being disturbed". Geo-fencing and other innovative solutions would be useful for this purpose and CCC encourages their development and installation. The Wildlife Act makes it unlawful to disturb the nesting of protected native birdlife, but it doesn't specifically make it unlawful to disturb birdlife at other seasons of the year – except in the specific instance of birdlife occurring within reserves, refuges and sanctuaries where disturbance and displacement is unlawful. A gap therefore exists around protection of non-breeding protected bird species from disturbance by drones outside of the breeding season. This is problematic as it doesn't protect birds at key parts of their annual cycle – such as, during the moulting season for waterfowl; the shorebird pre migration/migration period; when birds are concentrated at roosts or high density feeding grounds, etc. Drones have the potential to cause disturbance to birds, most particularly wetland birds, shorebirds and coastal birds. Often, drone operators and observers are unaware of negative impacts on birdlife. The physical intrusion of a drone (and to a lesser extent, the impacts of noise) can cause anxiety amongst flocks of feeding, roosting and breeding birds. Sometimes they are simply confused and cautious or unsettled, while at other times they may perceive the drone as an approaching avian predator (i.e.; they mistake the drone for a hawk or gull, etc.). Disturbance involves a cascading of effects from activity cessation (e.g. birds stop feeding) to vigilance behaviour, to movement away over ground/water; to flying away (flight initiation; to temporary displacement; temporary or permanent abandonment of nests or young; permanent displacement from a site or part of a site, etc. Physiological effects include raised stress levels, loss of condition through reduced feeding or burning up energy by taking flight to escape, disruption to roosting, feeding and breeding behaviours, etc.). We recognise the useful value of utilising drones as a tool (including for wildlife-supporting activities such as bird and habitat surveys) and the wider commercial and recreational potential. The key consideration from a wildlife conservation perspective is to ensure that drone activity does not cause detriment to native bird populations. The discussion document recognises DoC-administered conservation land but it should also recognise and provide for drone controls on conservation land

	administered by other agencies (regional and territorial authorities for example) and for areas where important wildlife populations occur (such as over estuaries and wetlands, on the shores of lakes and lagoons, along rivers and their margins, on beaches and sand spits, on coastal cliffs, rock stacks, reefs and islets). **Part 102** – currently Part 102 process is long and costly and requires a lot of work to generate the exposition. The approvals process is also extremely long taking around 6 months. Consideration should be given to splitting part 102 into two parts, for example: - 102 Practical – this would be for companies who generally abide by Part 101 (particularly if persons and properties are relaxed) but could sit the 102 Practical and take an online airspace course (much the same as now) but not complete the exposition and other requirements. Most agency's see the 102 certificate as a competency, and not a consideration as to what rules you have an exemption to. - 102 Full – this would be the same as it is now, and still cover complex drone operations where rules such as flying at night, BVLOS are going to be breached as part of standard operations. This would increase the number of people/companies operating under 102. Many see the application as to onerous and fly outside of the rules anyway.
Minor changes to the Rules	
7. Are there any minor changes to the Rules that would make them easier to understand?	No.
8. What do you think of the proposed minor Rules changes?	We support the high-level changes to clarify the rules. However, the introduction of 'tethered drones' under the rules raises some concerns with us. Consideration should be given to the risks associated at ground level, for instance other users of the public space not realising a drone is being used/tethered when they walk nearby, additional risks of cables, etc. flying near power lines and trees. How will the rule incorporate these sorts of risks to ensure the drone is flown safely (not only in airspace)? We agree with clarifying the spotter/observer requirements for First-Person View, and that relaxing this rule should only be for closed condition flights.
9. Are there any other changes we should consider?	No.

Basic Pilot Qualification

Question	Council comment
1. Should we introduce basic pilot qualification for Part 101 drone pilots?	Yes. Requiring pilots to have a basic qualification would increase awareness to drone operators that there are rules to follow and the purpose of those rules. The education campaigns and initiatives should also continue as a mechanism to raise awareness about safety, security and privacy issues.
2. What impact would a basic pilot qualification likely have on you?	More confidence of reduced risk / risk management related to drone operation on/over road corridors and other public places. A simple process will also enable many drone operators to do business in Christchurch without the delays currently faced by pilots needing Part 102 for what would be covered under Part 101 if the proposed changes are made. It is not clear, however, how compliance be encouraged/monitored/enforced? How will overseas tourists to New Zealand be made aware of this requirement?
3. What format should this test take? a. Electronic/online theory test b. Paper based written theory test (at a provider) c. A practical examination of skill and a paper based written theory test (at a provider) d. Other	We would support an electronic/online theory test, on the basis that it would achieve the greatest level of uptake and support New Zealand's efforts to reduce its carbon footprint. If the registration requirement can be built into the basic qualification test it would greatly improve compliance To use a drone requires understanding of technology, a paper-based written theory test does not align with this (even at a provider, access to a computer should be available or the theory test to be completed separately online). While a practical skills examination would give greater confidence in terms of risk reduction and management, this requirement would be more of an imposition on drone users such that uptake is likely to be low. The process should be as simple as possible to reduce delays in processing. As the technology develops and different uses for drones (e.g. delivery, transport) increases over time, operators of drones for commercial purposes should be required to undertake a test. This will give councils more confidence of the drone operator's abilities to fly a drone safely, as the purpose of the flight (i.e. commercial activity) requires permissions under their bylaws.

4. Should there be a minimum age for basic pilot qualification?	If it is intended that pilots flying drones without the qualification will be infringed, then the age should be consistent with the drone registration requirement (i.e. 14) and the reasons provided for that rationale. Anyone younger should be supervised by someone over 14, regardless of drone ownership. The basic qualification could be optional for younger users to encourage further understanding of the drone rules.
5. Do you agree with the proposed special authorisations given to Part 141 and Part 101.202 approved training organisations?	Yes.
6. Is there any other special authorisations you would like to see? Why?	We recommend that the Director of Civil Aviation consider authorising the ability to issue infringements to authorised Council staff. This would have an impact on resourcing of Council staff, but we are open to discussion with the Ministry and CAA. If drones are taking off or landing in council-owned public space, council bylaws and policies made under the Local Government Act 2002 do not give councils the ability to issue infringements (fines on conviction only).

Drone Registration

Question	Council comment
1. Should we introduce the proposed drone registration system? Why?	Yes. Requiring drones to be registered will increase the public perception about drones, and once drone transmitting information is required, it will improve safety as well.
2. What impact would drone registration likely have on you?	Requiring drones to be registered will reduce some of the administration for the Council when receiving requests for permission to use its public spaces, as the data will be generated from a centralised register and the operator will simply be able to provide their registration confirmation.

	We also receive complaints from the public about drone use, therefore once the drone transmitting information is integrated as well, the ability to link the drone to a person will help with enforcement and referral of complaints to the CAA. Often complaints are received after the fact, so identifying the drone and its operator is impossible. We recommend a target date of 2025 is set for all registered drones to have zero exhaust emissions. This would align with both the Government's and Christchurch City Council's greenhouse gas emission reduction goals.
3. What do you think of the proposed system design (e.g. digital platform) and requirements (e.g. identity authentication)?	We agree with the proposed digital platform design and inclusion of appropriate identity authentication measures (e.g. Real Me). As mentioned in our response to the Basic Qualification question above, underlying systems such as Real Me need to be kept up to date and made very easy to use to encourage high use. If this is too difficult (or too many steps) compliance may drop. If the registration can be built into the test when needed it would greatly improve compliance We agree that the drone requirements for registration should be distinguished from other aircraft. It would also be beneficial to separate registration of commercial and recreational users e.g. identification number beginning with C for commercial and R for recreation. How will people be made aware of this requirement, and how will compliance be encouraged/monitored/enforced? How will international visitors be made aware of this requirement?
4. Should there be a minimum weight threshold for registering a drone? If so, is 250 grams appropriate? If not, what would be an appropriate weight threshold and why?	The 250g threshold is appropriate for now but, as technology develops and more light weight, fully-equipped drones enter the market, there needs to be provision to review this threshold.
5. Should certain drones not need to be registered (such as drones flown solely indoors or within specific designated areas (e.g. Model Flying New Zealand sites) from registration? What other drones should not need to be registered and why?	All drones should be registered (above the weight threshold discussed in the previous question). The only exclusions should be drones which are prototypes, custom builds, etc. and when it may not be practical to register as they could be changing often. These types of drones would not fit a standard drone selection such as a DJI Phantom 4.

	Unregistered drones should only fly in designated areas such as danger zones. Universities such as Canterbury also test drones on similar sites, and have one at Birdlings Flat, and these would be custom drones and often changing.

Remote ID

Question	Council comment
1. Should we consider introducing Remote ID? Why?	Yes. Remote ID would assist monitoring and enforcement, leading to improved compliance of qualification and registration requirements.
2. What impact would Remote ID likely have on you?	More confidence of reduced risk / risk management related to drone operation on/over road corridors and other public places. We recommend consideration be given to the Remote ID measure incorporating a mechanism to distinguish whether the flight is for recreational or commercial purposes. This would greatly assist councils (and other owners of public land) to have a better understanding of the purpose of drone flights over public space, and assist in the enforcement of breaches of its bylaws (e.g. permission for commercial use on council land, or the setting down of anything from an aircraft on public land, such as deliveries). How will people be made aware of this requirement, and which drones will be required to have mandatory remote ID? How will compliance be encouraged/monitored/enforced?

Geo-awareness

Question	Council comment
1. Should we consider introducing geo-awareness? Why?	Yes. Geo-awareness would improve aviation safety and increase compliance with the rules by drone operators.

2. What impact would geo-awareness likely have on you?	The Council would like to work with the Ministry and CAA to incorporate sites across the city and Banks Peninsula where it is not appropriate for drone flights. Geo-awareness should extend beyond the airspace to also incorporate what is happening at ground level in public spaces. Drone flights are usually at a lower altitude and can create hazards for other activities and infrastructure on the ground, particularly during take-off and landing. Many drone operators are not aware that there are currently locations in council areas where they cannot fly, even if they are following all the other aviation rules. We have a list of sensitive sites already listed in our policy, such as heritage parks, cemeteries, playgrounds, the legal road corridor along the coast, wetlands, Te Waihora (Lake Ellesmere). Geo-awareness technology would also allow the Council to consider exclusion zones of higher-risk transport property and assets (e.g. arterial roads, key transport junctions and hubs, concentrated pedestrian areas) and particularly busy parks (e.g. the Groynes which generates more complaints from the public about drone use). There should also be the possibility to include seasonal times where drone flights are restricted to protect bird nesting seasons.

[redacted]

From: A J Hope-Cross [redacted]
Sent: Thursday, 20 May 2021 4:01 PM
To: Enabling Drone Integration
Subject: Submission on Drone Integration

Dear Committee for the integration of drones:

I would like provide submission against the proposed legislation which seeks to classify and integrate Model Aircraft as "Drones". The classification of Model Aircraft as Drones is a deeply concerning misrepresentation of Model Aircraft place in the world of aviation, and will result in miscarriage of justice at best or force illegal operation.

Firstly, I and members of my family have been involved with Model Aircraft at a local, national and international level since the early 1950s'. My late father was inducted into the NZ Hall of Fame (Model Aviation) as a competitor and administrator. Our family have also been behind one of NZs largest manufacturers and exporters of Models and supplies. We also have been involved in fullsize aviation both here in NZ and in UK/Europe in student, pilot and instructor capacities, in civilian and military environs. I am a management consultant to some of NZs leading companies.

Over this period of the last 70 years, there have been few, if any documented incidents where model aircraft have caused an accident involving fullsize aircraft, and equally few, if any documented incidents where model aircraft have been used for surveillance/invasion of privacy. On the other hand, in the decade since the invention of Drones there are numerous documented incidents where Drones HAVE caused a collision risk to fullsize aircraft AND have been used to invade privacy.

<u>It is essential for accurate legal definition between Drones and Model Aircraft.</u>

So what is the difference between a Drone and a Model Aircraft? There are many:

<u>A drone is:</u>

- a remotely piloted vehicle which
- has the capacity to operate in airspace often kilometres out of visual sight of the pilot
- and/or has the capacity to undertake imaging surveillance about the property/terrain it is flying over (ie, spying or invasion of privacy)
- and/or has the capacity to deliver significant payload to a designated target (eg over 5kg, such as warhead, courier package, surveillance or recue device).
- Drones are a technology device and generally have a lifespan of 2-3 years from manufacture

Currently drones look like multi-rotor camera carrying devices, or military pilotless spy/bomber aircraft. It could be envisaged that Drones be used for courier delivery, rescue operation or aerial surveying.

Contrastingly, Model Aircraft are most often hand built from scratch or kitset by their owner (or re-built) and can last many decades (some of my models are 60years old, most are 20years old).

Model Aircraft come in 3 different types/disciplines: 1) Control line; 2) Free Flight; 3) Radio Control:

<u>1. "Control line" (CL)</u>

CL are models which are tethered to their pilot by steel wires. The pilot stands on the ground when controlling them and the wires correspond to direct the model attitude. For practical reasons (and competition rules), these wires ("lines") cannot be longer than 20 meters maximum. Because of this they can only fly in a circle of radius 20m or maximum altitude 20m (ie momentarily overhead). Therefore it is impossible for CL models to stray into flightpath of fullsize aircraft; or to fly over neighbouring property; or, because of their rotational speed, take photographs/surveillance.

It is completely unnecessary that control line model aircraft be classified as drones and should be specifically exempt from this classification.

2) Free Flight (FF):

This is the most traditional, low-technology orientated model aircraft discipline. FF models are almost always constructed entirely by their owner, or from a kitset to plans. FF models are not *interactively controlled*, and are pilotless (they fly free!). In reality these models have largely pre-set flight pattern (in that they are set to fly in large circles), and in many instances, have "de-thermalisers"(DTs) which bring the model down at a set time (usually a few minutes – always less than 10min). These methods are employed because FF models are flown within visual contact of the operator. Unlike the recently invented "drones", an out of sight FF model cannot be brought back during flight – an out of sight means the model is lost! Losing a model is highly undesirable and is avoided at all cost. FF models are either flown in parks (very short flights usually mere seconds so they don't get lost), or on private property/farms. Furthermore, FF models are lightweight and weigh less than a large bird. In the event of birdstrike with a fullsize aircraft, they would have similar or lessor impact due to their mass density. I am unaware of any example anywhere in the world where a Free Flight model has caused an accident with a Fullsize aircraft, yet Free Flight models have been around since before the invention of the fullsize aeroplane! The reality is that there are thousands of large birds flying uncontrolled throughout NZ airspace at similar altitude to a FF model, while the total number of operators of FF models across NZ is less than 200, and national competition brings together fewer than 50 competitors at a time. Statistically speaking, FF models do not represent a threat to other users of airspace.

In summary, FF models differ from the recent technological invention of "Drones" because they are simply not technologically suitable for 'spying'/surveillance/privacy invasion; and are unable to be operated outside visual contact.

In this respect all FF models should be specifically exempt from classification as "drones".

Remote ID and Geo-awareness for FF and CL models – it is *completely impractical* to require these types of model aircraft, which are either gliders or powered by rubber motor or diesel engine to carry Remote ID or Geo-Awareness or Traffic Management transponders: These models have no electrical systems on board, and most are simply too light and do not have the payload capacity to carry an electrical transmitting device. To create legislation for these types of models simply demonstrates that regulators have no understanding about the subject which they are regulating, and is outlawing what has been for many decades a safe and harmless hobby/sport, since they do not have the capacity to carry the required equipment.

3) Radio Control Models (RC).

This is the most common and technologically advanced discipline of Model aviation. Radio Control models are operated by pilot on the ground, but are currently limited by the range of the radio control equipment and visual contact with the model by the pilot.

In this respect RC models are the *most similar* to Drones – both are controlled by radio wave. However there remains significant differences between RC models and "drones" which should be taken into consideration when forming legislation. Unlike drones, RC models cannot be flown out of sight because the radio systems do not have the signal strength to control them outside of visual sight/contact. RC models also do not have image recording devices, so are incapable of 'spying" or privacy invasion.

Therefore there should be a ***general* exemption for RC models from classification as "drones".** This is the most appropriate and practical course of classification.

However, in the future it is foreseeable that drone technology might become available for a new category of *enabled* RC model (ie enabling them to be flown with out-of-sight piloting or spy equipment as drones already are) - then there would be ground to specifically require this category of ***enabled* model** to carry Remote ID/Geo Awareness transponders/Traffic management systems, and require this potential new category of model aviation to undergo pilot certification. However, the reality is that it is not currently technologically/commercially possible for this, **<u>and RC models therefore not equipped with this "drone" technology should be exempt from classification as "drones".</u>**

<u>Part 149</u> <u>– Requirement to issue **certificates of competence** and **airworthiness**</u>:

This is onerous and impractical for flyers of model aircraft for the following reasons:

1) Issue of Certificates of Airworthiness (CofA) for all models: Will a models certificate expire if the model crashes and needs repair? This can happen many times in one evenings flying session, and simply isn't practical. Will the Ministry of Transport provide officials at every flying evening across the country each week to check and re-issue CofAs each time a model crashes and gets repaired (usually taking a few minutes to repair)?

2) Most modellers have collections of multiple models – some of us have 50+models. To require Certificate of Airworthiness for each and every model is onerous and will not improve safety outcomes for fullsize aviation.

3) Unlike Drones, most models pose no threat to fullsize aviation (reasons stated above under CL, FF, RC discussions). Therefore, why impose them with this CofA requirement?

4) Cost: The cost of this proposed new compliance being pushed onto MFNZ (Model Flying NZ, the NZMAA – the bodys which govern model flying in NZ) to enforce on its members will cause members to leave MFNZ because it does nothing to advance model aviation nor does it do anything to improve the safety outcomes of model aircraft on fullsize aviation. Therefore it will simply result in financially crippling MFNZ, render MFNZ useless and model aircraft enthusiasts will simply 'go undergound".

An example of cost sensitivity of Modellers is that to enter MFNZ national events, events are often priced at $10-20. Aeromodellers are very price sensitive and where event prices have been raised above this level, enrolment in those events has quickly ceased. Unlike fullsize flying (which is a hobby for the rich), and unlike Drone operators (which is a hobby for "yuppie" electro-technology types who care little about cost), Aeromodelling is a hobby for the creative self building type, or those who do not have the funds to fly fullsize or technology orientation to fly drones.

Furthermore, enforcement is a practical reality – it is difficult to locate an operator of a small (or even large) model aircraft operating on private property

Certificates of Competence and Mandatory online theory testing, whatever this may involve, it will not help flyers of CL and FF models. CL models never enter the airspace of fullsize aircraft, and if the pilot is incompetent, the result is immediate and the model hits the ground in mere seconds despite being tethered to the pilot. FF models – fly free. They have no pilot and an incompetent operator will quickly lose their model. <u>A certificate of competence is of no use here, nor will it improve safety outcomes for fullsize aircraft.</u>

<u>In conclusion</u>

1) It has been shown that model aircraft are entirely different from drones. Model aircraft therefore need to be correctly and separately defined, and not wrongly categorised as drones. Furthermore they should be exempt from mis-categorisation as "drones".

2) Drones and not model aircraft are the cause of near miss and reported incidents with fullsize aircraft and invasion of privacy.

3) Mis-categorising Model aircraft as "drones" will not improve fullsize air safety.

3) Enforcement of Certificates of Airworthiness on models is not practical, and will not benefit fullsize airspace users nor result in less model crashes.

4) Mandatory testing of model aircraft "pilots" will not improve airspace safety for fullsize aviation.

5) The future might enable some types of Radio Control models to have out-of-sight operation and to be able to carry spy equipment, and therefore provision should be made *for this specific category of RC models only*, to have to meet similar criteria that is proposed for drones but that this should not apply to existing RC models.

6) **The proposed legislation is entirely misinformed and unsuitable to categorise Model Aircraft as "drones" and will only result in adverse outcomes in the management of Model Aircraft aviation.**

Anthony Hope-Cross [redacted]

[redacted]

[redacted]

From: David Ackery [redacted]
Sent: Thursday, 20 May 2021 4:55 PM
To: Enabling Drone Integration
Subject: Eabling Drone Integration
Attachments: Enabling Drone Integration.docx

Dear Sir,
My submission is attached.

best regards
David Ackery

[redacted]

20/5/2021

Re - Enabling Drone Integration

Dear Sir,

Thank you for the opportunity to comment on your consultation document.

I am generally supportive of efforts to bring New Zealand's regulatory regime for drones into line with international standards to avoid any possible infringements of privacy, health and safety issues, or conflict with full-size aircraft. However, I believe that the level of regulation proposed by government with pilot registration, remote ID and geo-awareness testing is disproportionate to the level of risk posed, and would effectively wipe out free flight model flying in New Zealand.

Free flight model flying has existed for approximately 100 years, well before drones were even considered possible. In that time model flying has a very strong record of safety and sensible management, governance and control, which exists at National and International level.

1) National level, by Model Flying New Zealand by MFNZ (Model Fly New Zealand) https://www.modelflyingnz.org/
2) International level, by the FAI (Fédération Aéronautique Internationale) www.fai.org

I ask that consideration be made for free flight models due to their special character that makes them completely unlike drones and with a strong and sustained safety record.

This being

- Lightweight and slow gliding flight
- Always operate within line of sight
- Fly only in circles, ie are not driven around the sky by an operator
- Flight duration is limited by their rules to 2 or 3 minutes
- Do not carry cameras
- Used for recreation, sport, or competition
- Used for 70 years by New Zealand teams to complete at World Championships and World Cup events under the control of the FAI (Fédération Aéronautique Internationale) www.fai.org
- Operate under clear and comprehensive rules and safety guidelines set out by MFNZ (Model Fly New Zealand) https://www.modelflyingnz.org/ , and the FAI.

I ask for an exemption for free flight models up to 1Kg, which would allow the continued use of models specified by the FAI for World Championships and World Cup events so that national teams and individuals from New Zealand may continue to compete in their chosen sport.

Results of some World Championships can be seen here,
http://www.freeflightnews.org.uk/champs/mast.htm

Best regards

David Ackery
[redacted]

[redacted]

From: Anton Nikoloff [redacted]
Sent: Thursday, 20 May 2021 7:19 PM
To: Enabling Drone Integration
Subject: Comments on the proposed legislation attached
Attachments: Comments on Enabling Drone Integration.docx

I can be contacted by phoning [redacted].
or using the Email address.

anton nikoloff, [redacted].

Comments on *Enabling Drone Integration*

Anton Nikoloff

I am aware that the function of the discussion paper is to raise awareness of the issues but, I see a number of generalisations and mistaken ideas that need to be addressed.

Comments on various aspects follow:

There is no clarity of definition on the relationship between "drones" and Model Aircraft. Even the word "drone" is open to various interpretations, so needs to be more rigorously defined. Here I use the term "drone" as being different from Model Aircraft.

Para. 13 basically refers to policing action; this appears to be lacking in the current approach and needs to be at the forefront of the new legislation. Basically, people can see that they are unlikely to get caught, so do whatever they want to, wherever they want to.

Para 21 I hope that Model Flying New Zealand, as one of the longest aviation organisations in existence in NZ, is going to be consulted regularly?

Para 25 the statement that there will be no undue burden on existing users is contradicted by later statements in the document in which the suggestion is made that Model Flying New Zealand be limited to fly in is designated sites and that some costs will likely fall on users. My understanding of one of the proposals, for instance Model Aircraft needing transponders signalling a registration and location would require some cash outlay, and it's not clear whether every model/ drone would require this, if so a significant cash outlay.

Para 37 enabling innovation and development shouldn't come at the expense of imposing restrictions on existing users, unless it can be proven that safety has been compromised.

Figure 3 How does an online theory test measure practical skill? What is the relationship between registration and notification?

Comment in box under *Para 44* is a blanket statement without any evidence. As a model aircraft flyer I see that "compliant Model Aircraft " pilots are being targeted in this proposed legislation, I hope that non-compliant users, (the ones most likely to infringe the current rules), are going to be rigorously brought under the umbrella of the legislation?

Table 2 Annual Drone Reports

Figures presented are at best inconclusive and it could be argued are relatively consistent over the last 5 years, except the category of *not getting consent of people under the flightpath.* Those figures, as well as the significant increase in reports to the police recorded in Para 49, (which appear to relate to privacy breaches and probably are only the tip of the iceburg) indicates to me that the general public are concerned about privacy, more so than safety.

The figures shown in Para 43 Table 3 appear to show a tailing off of incursions, perhaps the education program is having an effect?

The statement in Para 51 is tautology where the premise is justified by the conclusion.

I suggest that the reason the public are reluctant to accept drones is because they are concerned about the possibility of intrusion into their privacy, as well as safety concerns. Ie "delivery" drones overflying their houses/ property, generating noise, visual disturbance, etc, etc. plus the possibility of crashing into themselves, or their property.

Para 58 contrary to the statement, privacy concerns are well justified and some people, myself included see the possibility of delivery drones operating freely as an example of peoples' welfare being placed as second, to money making schemes.

I have significant doubts whether regulations will stop people who want to operate outside the regulatory framework, whether through ignorance or wilfulness. I think that people, not drones need to be registered. Generally only one drone, or model aircraft can be flown at once. So a transponder could be moved and placed in the current model being flown.

Thus retailers need to be mandated to register who they sell "drones" or equipment to, and geo-fencing equipment needs to be mandatory in all "drones" sold over the counter, or through the internet into NZ.

Perhaps a grandfather clause for existing model aircraft could be enacted. Given that many of the existing drones are in fact model aircraft which are very compliant with the current regulations.

Para 99.

I have no problems with introduction of a basic pilot qualification but question how it will be enforced. How are you going to stop people using their drones if they haven't got the licence? I see enforcement as a significant issue that is not really discussed in this document. Ensuring accountability and responsibility should be a major part of the reason for enforcement action. Enforcement should reflect the significant costs inflicted on others, by an unwanted intrusion into airspace.

Para 105

I do not think that drones should be given carte blanche to overfly private property, whatever safety measures are proposed. Is the proposed legislation going to override local bylaws? The Local Council where I reside, has a bylaw that regulates drones cannot fly within 10 meters of a private property, is that likely to be overridden? For money making schemes?

What happens if a "drone air corridor" passes through a Model Flying NZ dedicated site?

Safe distances will not address this concern. If air traffic corridors are established it would mean that concentrated air traffic over established houses etc. We live under an existing air corridor between Christchurch Airport and Rangiora Airport and occasionally get annoyed at the constant buzz of aircraft overhead.

There is no reason to change the operational requirement of 4 kilometre distance from an airport. Graduated zones depending on the safety requirements could work, if well understood.

Para 180. Why two rules for Model Aircraft, why can't model aircraft fly where ever, as long as they are flying safely and under the auspices of Model Flying NZ?

Eg I live about 1 kilometre from a Model Flying designated site. I could fly a model aircraft from my property but it's not a designated site. I see no reason apart from safety that I shouldn't be able to fly from my property?

Drone registration

Model Flying NZ already has a registration system, I would be happy if that was incorporated into the regulations and so do not see there is any need for a duplicate system.

Any registration should be for the individual rather than a particular drone. Maybe the registration could be marked on the drone but what happens when the ownership of a drone changes?

Para 207

What is the point of Remote ID if the person cannot be readily identified surely that defeats the purpose? Privacy concerns should not over ride safety.

Para 215

It would not be a minimal cost to set up Remote ID in my Model aircraft. I own over 20 models, there is no software in them, nor a transponder. And contrary to the statement that many drones only last 2-3 years, a few of my models are over 30 years old, varying from 33 years up to less than a year old. Some of my fellow modellers have significantly more models and a similar variation in age range.

Who is going to bear that cost? Anyway I cannot see the point if I'm only flying at Model Flying NZ designated sites as I can readily be identified there.

Generally I would see that geo-fencing is not required for aircraft flying under the auspices Model Flying NZ as most members are fully aware of the requirements to fly safely and would not intrude on full size airspace.

Conclusions

I understand this discussion document's intension is to raise issues for discussion and consideration. My concern is that there are a significant number of blanket statements and generalisations, which appear to be a result of a limited understanding of the "drone" industry and those that fly "drones". That seems particularly so, when it comes to understanding where Model Aircraft fit into the whole "drone" scene.

The problem facing those drafting this legislation is that drones and model aircraft can be either brought "off the shelf" ready to fly, or constructed from parts. Thus both those aspects need to be covered by the legislation. Something that needs to be taken into consideration, is that Model Aircraft, generally, are harder to fly and a significant amount of coaching/ training is required in order to fly in a sustained way. "Drones" on the other hand are generally equipped with software that enables sustained flying to take place, even when operated by somebody, with limited skills and experience.

Those selling equipment that "enables out of sight" control/ flying of "drones" also need to be brought under the auspices of the legislation as well. Registering a person for drone piloting rather than the "drones" would be of benefit in this area.

I see that policing any proposed legislation would be the main problem area. Policing needs to fall mainly on those not abiding by the current rules and regulations.

I think that privacy is of greater concern to the general public than many people realise. Those concerns need to be understood and be part of the proposed legislation.

[redacted]

From: Hamilton MAC <hamiltonmaclub@gmail.com>
Sent: Thursday, 20 May 2021 8:47 PM
To: Enabling Drone Integration
Cc: [redacted]
Subject: Enabling Drone Integration consultation - Submission from the Hamilton Model Aero Club Inc.
Attachments: HMAC Submission - Enabling Drone Integration.docx

Hi Team

Please find attached a brief submission document from the Hamilton Model Aero Club Inc. in relation to the "Enabling Drone Integration" consultation process.

Furthermore, the Hamilton Model Aero Club would like to express that it is in full support of our national body, Model Flying New Zealand (MFNZ) and endorse the submissions made by MFNZ on our behalf.

Thank you for accepting the attached submission
Kind regards
[redacted]

Hamilton Model Aero Club Inc.
PO Box 1333
Waikato Mail Centre
Hamilton 3240
Email: hamiltonmaclub@gmail.com

Hamilton Model Aero Club Inc.

PO Box 1333

Waikato Mail Centre

Hamilton 3240

Email: hamiltonmaclub@gmail.com

Hamilton Model Aero Club Inc.

Submission regarding the

"Enabling Drone Integration Discussion Document"

Hamilton Model Aero Club (HMAC) is one of the largest and most active clubs affiliated to Model Flying New Zealand (MFNZ). The club has 83 members who own more than 400 airworthy recreational model aircraft. HMAC has been Champion Club at the MFNZ National Championships in five of the last six years.

HMAC recognises the need for new regulations and supports strongly the role that MFNZ has in assisting MOT and CAA with this work. HMAC also endorses and supports the positions taken by MFNZ regarding the key issues.

We wish to make the following specific points:

1. We appreciate the principle that the new regulations will enable MFNZ and it clubs to operate with as little interference as possible. However, we note that this principle will have to be implemented in practical ways.

2. While we applaud the intention to place MFNZ operations outside Stage 1 Pilot Qualification and Drone Registration, the proposed reliance on the concept of 'designated areas' would raise practical difficulties. This is because a very large number of areas would need to be designated by a club such as HMAC. We suggest that the 'designated areas' concept be discarded because 'under supervision of MFNZ' would be sufficient to specify recreational model aircraft flying that complies with the rules and processes of MFNZ.

3. The provisions of Stage II Remote ID and Stage III Geo-awareness would not be practical for our fixed wing recreational model aircraft. This is because none of our models have Remote ID capability and have no need for it. Further, most of our models are home-built and are airworthy for many years (20 years is common) so there is no rapid turnover/replacement of fully-built aircraft that would provide opportunities for introducing ID capabilities. Hence, a

requirement for installation of Remote ID would incur prohibitive costs. In any case, MFNZ rules appear to cover the need for geo-awareness because they require adherence to strict altitude limitations and line-of sight operations that effectively limits the geographic location of any model to a relatively small known area.

4. We are very concerned that consideration is being given to removing aspects of the current Part 101. Within the overall mandate to fly recreational model aircraft, HMAC relies on two crucial provisions of Part 101:
    a. CAA approval of the MFNZ certification procedures that allow recreational model aircraft in the weight range 15 – 25 kg. These procedures were developed in association with CAA and work very well.
    b. Provisions that allow free-flight models to be flown. HMAC members own more than 40 airworthy free flight models.

Thank you for allowing submissions to the regulatory review of Airspace Use for all New Zealanders.

[redacted]

From: [redacted]
Sent: Friday, 21 May 2021 12:31 AM
To: Enabling Drone Integration
Subject: Submission to Enabling Drone Integration
Attachments: Enabling Drone Intergration - Submission 20-05-2021.pdf

Submission attached

--
Paul Ryder

[redacted]

20th May 2021

Submission on **Enabling Drone Integration**.
From both a commercial and private drone user perspective.

The four kilometer restricted flight rule around airports and helipads.

I believe that there needs to be a different ruling around low density flight corridors and there restrictive zones. I also believe changes to this rule needs some urgency.

A: 0-1 kilometer fully restricted unless shielded or a 102 certificated operator.

B: 1-2 kilometers enabled up to 30 meters, There is a lot drone operators can do in 30 meters of air space. Real-estate photography for example.

C: 2-4 kilometers enabled up to 60 meters.

People will only abide by rules they feel are fair and fit for purpose.
In my town there is an uncontrolled airport, a hospital helipad and an industrial helipad each with restrictive flight zones which butt up to each other creating a no fly zone of approximately 14 by 10 kilometers. With very little activity around the two helipads drone operators feel penalised by this heavy handed rule. So they flout the rules. As a commercial operator in many cases I agree with them.

Flying over the public, in public places or during public events.

I believe when filming over a public space or public event in which members of the public may come into the field of view should be permissible. On the proviso that the person or persons are not the primary objective of the filming. Permission not required.

A: Filming people on private property their needs to be verifiable consent given. This should also apply when flying over domestic animals.

B: For the purposes of real-estate aerials informing the neighbors with a formal notice (in the letter box) with your details detailing and what you are doing should cover you even if you over fly some of the neighbors property in doing the job. Some kind of reasonable use of airspace clause.

C: Flying in public spaces must include flying over public roads. Certainly for certificated operators. Including both roads that are in use or closed for parades etc.
There could be a minimum height for flying over a road. At a 25 meter minimum drones should be high enough not to distract motorists or frighten pedestrians.

Identification.

As both a commercial and private drone operator I have no issue with the identification requirements.

A: A seller should have access to an online registration form (via their mobile). On selling a drone they record basic details, nothing too onerous, use the drivers license as proof of identity, plus enter a seller registration number.
At what level this needs to be done I am open to suggestions.

B: The registration should clearly identify the operator and the drone.

C: There also needs to be a simple system where an operator can cancel their registration and that of a drone thats been on sold or is now out of service.
An online system with minimal cost to both the operator and the governing body.
Artificial intelligence has future in drone and operator ID, plus its cheaper.

Compliance and Non Compliance.

As both a commercial and private drone operator I have no issue with the issues of compliance. If the rules are fit for purpose compliance should be reasonably high. If we have lots of rule breakers first check the rules to see if that is the issue.

A: If authorities catch a non conformist, non compliant drone operator who is making no effort to reform, then instant on the spot fines.
If really serious, then confiscate the drone and crush it.
No court case, no wasting public money on someone playing hard ball.

B: Fines could be structured around levels of Health and Safety concerns.
And earnings from non compliant activities.
They need to be clear and straight forward, compliance officers need to be authorised to issue such fines and seizure notices.

END

Paul Ryder - [redacted]

[redacted]

From:	[redacted]
Sent:	Friday, 21 May 2021 10:23 AM
To:	Enabling Drone Integration
Subject:	Submission Enabling Drone Integration 21.05.21 by the Hounourable Company Of Air Pilots
Attachments:	Submission Enabling Drone Integration 21.05.21.docx

21 May 2021

Enabling Drone Integration – Consultation
Ministry of Transport
PO Box 3175
Wellington, 6140

ENABLING DRONE INTEGRATION

Thank you for the opportunity to provide feedback on the Ministry's Discussion Document "Enabling Drone Integration" dated 6 April 2021.

The Honourable Company of Air Pilots, NZ Region (the Air Pilots) appreciates the consultation effort and presentation, which several members attended. The multi- ministry effort involved is to be commended. The pamphlet supplied was informative and succinct.

1 **Objectives of the Proposal.**
In general terms, the Air Pilots support the vision enunciated on the cover of the aforementioned pamphlet: **to create a thriving, innovative and safe drone sector**. The Air Pilots advocate however that the words **integrated into the existing aviation environment** should be added. Many of our members have commented that there is very little integration ideas in the proposals. It seems to be focused on regulating small drones and keeping them separated from the rest of the aviation infrastructure.

2 **The "See and Be Seen Concept.**
During discussions with the Ministry of Transport, it was stated that the paper seeks to keep drones and their operators from having to enter the Aviation System and the attendant costs. Therefore, the current Part 101 and Part 102 will be retained in some form. As the Air Pilots understand it, Rule 102 is operating as intended, and will not be amended. Rule 101 has proved to be ineffective. While this separation into specialist Parts may be cost effective, it does create serious separation problems. In a mixed aviation environment having a separate system for Drones that are very hard to see, falls foul of the basic tenet of our system of "see and be seen".

3 **Line of Sight Operations**
Enabling beyond line of sight operations and drone operations in integrated airspace - technically this is already possible under Part 102. It doesn't seem to be addressed by the current proposals, although the MOT written material refers extensively to it e.g. the "Advanced integration trials" flyer and the discussion document "Enabling drone integration".

4 **Current System of Regulation**
If the current separation is to be retained, then the Air Pilots supports the proposed changes to Part 101, if the current two divisions are retained, and advocates a lowering of the 15 kg limit for the general public group. The Air Pilots are concerned about how effective the changes will

be, given the Government record on other recent registrations, in particular firearms registrations. You can register both firearm owners and individual firearms, but a high- powered firearm is still a dangerous weapon and it's not much comfort after someone has been killed by one to be able to track back who owned it. Better to also control the power of the firearm as well, or in the drone scenario, limit the mass of the aircraft.

The Air Pilots advocates a strong focus **on education of drone operators into the rules and requirements, remote identification, and effective deterrents/penalties for those who don't think the rules apply to them.**

5 Education - Pilot Qualification

The proposals will enhance the educational aspect of providing drone operators and the general public with a basic knowledge of the Rules for operating small drones. The prescriptive nature of the current Part 101 and the simple rules should be preserved if possible. It might be better to issue a certificate rather than a license for the basic pilot qualification.

6 Registration

The Air Pilots support these proposals. Anecdotal evidence indicates that many overseas tourists bring drones in their luggage, mainly for photography purposes. Is it reasonable to expect these people to undergo the basic pilot qualification? A number of acquaintances that use drones are adamantly against compulsory registration, These same people seem to be content with the prescriptive rules in Part101. Given that nobody knows how many drones are already in New Zealand, compulsory registration has a considerable handicap from being effective for the stated purposes. It follows then that remote identification when available is unlikely to be fully effective as well, until the US manufacturers include it as a basic part of their design.

7 Remote Identification:

The FAA says "Safety and security are top priorities for the FAA and remote identification (remote ID) of drones is crucial to our integration efforts." (Quote from a FAA info sheet). The FAA material indicates that remote ID is quite viable, and to enter the US drone market foreign drone producers will have to comply with the FAA remote ID technical standards. Consequently, drones bought into NZ should also have the same remote ID equipage requirements as in the US.

The FAA remote ID requirement is to apply to all drones over 0.55lb (approximately 250gm), the same weight as the proposed MOT requirement for drone registration.

These three measures (qualification, registration and remote identification) would go some way to lessen the Air Pilots concerns, but the proposals would allow a very young person under Part 101 to fly a drone of up to 25kg. The Air Pilots do not believe the measures proposed are likely to be sufficiently effective to protect manned aircraft and the general public from such potentially dangerous drones, should the prescriptive rules contained in Part 101 be transgressed. A simplified ADS-B or a FLARM system (Flight Alarm) would be far more effective for separation purposes, especially in the interim period until remote identification is available.

8 Overlying private property

This is a major concern of the Air Pilots. There was much discussion on relaxing the privacy provisions about flying over private property. This could be fraught with difficult if the balance stuck is found to be unpopular with the public.

The MOT is saying they are only interested in the safety issues of overflight, not privacy. However if the MOT wants to achieve public acceptance of drones the privacy issue must be addressed. The wholesale removal of the existing prohibition on flying drones over private property would be problematic. Some relaxation may be possible but the right to 'quiet enjoyment" by people on their own property must be protected. This extends to public places such as parks, cemeteries and sports facilities over most of which drone operations are currently prohibited by local Council landowners. The "reach" of the Health and Safety at Work Act and it's requirements on Persons Conducting a Business or Undertaking (PCBU) is also a factor. PCBU's have a responsibility to ensure the safety of people on their property or using their facilities. i.e. if drones have the potential to create safety hazards beneath them then the appropriate PCBU must be able to control overflight.

9 Relaxation of the rule on operating within 4km of an aerodrome.

This will be of serious concern to many aerodrome operators. CAA currently places considerable responsibility on aerodrome operators for the safety of their airspace. Drones operated irresponsibly are a great risk to aircraft taking off and landing. The existing 4km rule may be seen as a somewhat "blunt instrument', and its effectiveness is hampered by lack of enforcement ability due to difficulty identifying transgressing drone operators (a bit like the use of lasers near airports). The Air Pilots do not agree that it should be removed. Responsible drone operators can operate within 4km currently by requesting approval from the airports concerned.

10 Geo-awareness

Maintaining paper maps showing "no fly areas" or areas with other restrictions on drone use will be expensive. Amending VNC charts to show hospital no-fly zones etc might be a better interim measure. However, the information could be made available on "airshare" as well. Requiring drone manufacturers to geo-fence drone operations is a more reliable approach for the future. Drone manufacturers need to take responsibility for the ways their products are used. Geo-fencing with regular updates via internet (similar to car SATNAV map updates) is a very beneficial way drone manufacturers can assist the safe operation of drones.

11 Leading the world on drone airspace integration

Rather than seek to be a world leader in drone airspace integration the Air Pilots would prefer NZ to follow well researched overseas integration models such as ICAO standards and recommended practices, the FAA, UK/Europe and Australia proposals. Better to be a fast follower.

[redacted]
Honourable Company of Air Pilots
New Zealand Region

[redacted]

From: [redacted]
Sent: Friday, 21 May 2021 1:58 PM
To: Enabling Drone Integration
Subject: Enabling Drone Integration - Consultation
Attachments: 210521 MoT Enabling Drone Integration.pdf

Kia ora,

Please find attached the submission of Federated Farmers of New Zealand on the *Enabling Drone Integration* discussion document.

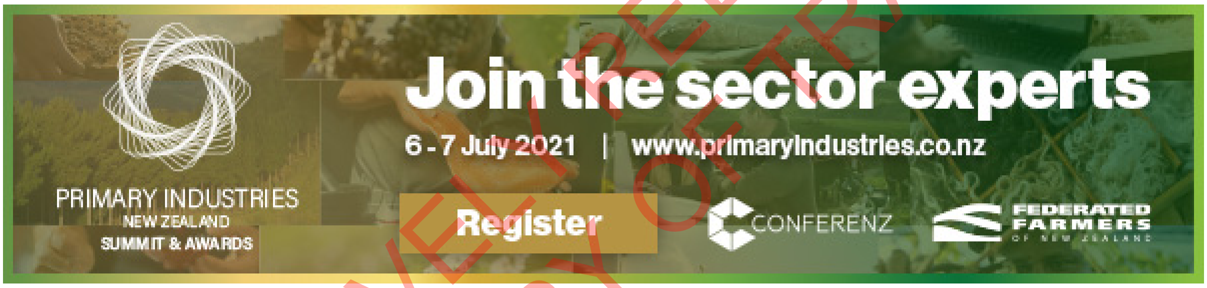
Regards,

[redacted]

[redacted]

Federated Farmers of New Zealand

M [redacted]
E [redacted]



THINK BEFORE YOU PRINT

Enabling Drone Integration

Federated Farmers of New Zealand

21 May 2021




0800 327 646 | FED FARM .ORG.NZ

SUBMISSION ON ENABLING DRONE INTEGRATION DISCUSSION DOCUMENT

TO: Ministry of Transport

DATE: 21st of May 2021

ADDRESS FOR SERVICE

Name	Position	Phone Number	Email Address	Postal Address
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

OTHER CONTACTS

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

ABOUT FEDERATED FARMERS

Federated Farmers of New Zealand is a membership organisation, which is mandated by its members to advocate on their behalf and ensure representation of their views. Federated Farmers does not collect a compulsory levy under the Commodities Levy Act and is funded from voluntary membership.

Federated Farmers represents rural and farming businesses throughout New Zealand. We have a long and proud history of representing the needs and interests of New Zealand's farmers.

Federated Farmers aims to empower farmers. Our key strategic priorities as an organisation are that we:

- Be the respected voice of farming.
- Foster an inspired leadership network.
- Support vibrant rural communities.

SUBMISSION ON THE MINISTRY OF TRANSPORT'S *ENABLING DRONE INTEGRATION* DISCUSSION DOCUMENT

1. SUMMARY OF RECOMMENDATIONS

1.1 Federated Farmers considers the proposed series of measures an improvement on the compliance and enforcement procedures currently in place.

1.2 Federated Farmers considers the proposed approach should help achieve better integration of drones through more effective accountability of drone use.

1.3 Federated Farmers considers the proposed measures will help ensure responsible drone use is compliant with more easily understood requirements.

1.4 Federated Farmers considers the proposed measures will struggle to address problems and concerns around irresponsible drone use where drone users intentionally do not comply with requirements to pass the basic pilot qualification test or register the drones they operate.

1.5 Federated Farmers considers further work is needed to explore the full range of options and opportunities available to identify non-compliance and enforce compliance in a way that both supports responsible drone use and addresses the risks of irresponsible or unwanted drone use.

1.6 Federated Farmers supports the proposed order of implementation of the measures with the caveat that the Rule Part 101 consent provision not be relaxed or removed until, or unless, subsequent proposed measures are in place.

1.7 Federated Farmers supports drones having their own standalone Rule Part to provide greater clarity of the aviation rules that particularly apply to the operation of drones as distinct from other unmanned aerial vehicles.

1.8 Federated Farmers considers the 4km minimum flight distance from aerodromes should be reviewed. It has been related to us that the minimum flight distance is too indiscriminate and impractical in some rural situations.

1.9 Federated Farmers would be concerned to see 'safe distances' implemented as an alternative to the current consent provision in Rule Part 101 in the absence of stock disturbance trials being undertaken on a variety of New Zealand farms to inform appropriate 'safe distances' on farms.

1.10 Federated Farmers opposes removal or replacement of the consent provision in Rule Part 101 as it relates to flying drones above property unless, or until, subsequent proposed measures are in place.

1.11 Federated Farmers opposes removal or replacement of the consent provision in Rule Part 101 as it relates to flying drones above people unless, or until subsequent proposed measures are in place.

1.12 Federated Farmers opposes the introduction of 'safe distances' as a replacement to the consent provision currently in CAA Rule Part 101 unless, or until, stock disturbance trials are undertaken to inform the setting of 'safe distances' appropriate to rural settings.

1.13 Federated Farmers considers the ease with which a drone user can apply for a Rule Part 102 licence that obviates the need for the drone user to seek the prior consent of the property owner must be reviewed.

1.14 Federated Farmers recommends that a plain English approach is taken to CAA Rule Parts 101 and 102 to ensure clarity of the requirements and expectations of drone users. Producing a standalone drone Rule Part would assist in ensuring this could happen without necessarily affecting those aspects of Rule Parts 101 and 102 that apply to unmanned aerial vehicles that are not drones.

1.15 Federated Farmers has no opinion on the proposed minor Rule Changes.

1.16 Federated Farmers has no feedback to offer on other changes the Ministry should consider.

1.17 Federated Farmers supports the introduction of a basic pilot qualification for Part 101 drone pilots.

1.18 Federated Farmers is happy to provide its most recent rural connectivity report and otherwise assist officials in their deliberations on the format the basic pilot qualification test ought to take.

1.19 Federated Farmers considers there should be a minimum age for taking the basic pilot qualification test, and recommends this be set at 14 years of age for consistency with the minimum age proposed for a person registering a drone.

1.20 Federated Farmers supports special authorisations being provided to Part 141 and Part 101.202 approved training organisations from having to take the basic pilot qualification on the proviso that such organisations ensure their staff and students are recorded in the same manner as drone users more generally.

1.21 Federated Farmers has no opinion to offer on whether any other special authorisations ought to be granted, so long as all drone users are recorded in the same manner as drone users more generally.

1.22 Federated Farmers supports the introduction of the proposed drone registration system.

1.23 Federated Farmers supports the introduction of a digital platform for the registration of drones and establishing drone ownership.

1.24 Federated Farmers considers the information expected of drone owners in the registration of drones they own seems reasonable and straightforward to both identify the drone being registered and the owner registering the drone.

1.25 Federated Farmers has no opinion on the matter of minimum weight thresholds for drones that will need to registered.

1.26 Federated Farmers has no opinion to offer on whether drones flown indoors or within specific designated areas need to be registered.

1.27 Federated Farmers supports the introduction of Remote ID in New Zealand as an important tool in encouraging responsible drone use.

1.28 Federated Farmers supports the introduction of geo-awareness to support safe and responsible drone use and the ability for farm properties to be geo-caged during sensitive times in the farming calendar.

2. GENERAL COMMENTS

2.1 Federated Farmers of New Zealand welcomes the opportunity to comment on the Ministry of Transport's *Enabling Drone Integration* discussion document.

2.2 The Federation has a history of supporting the responsible use of new and emerging technologies that have the potential for supporting the farm business. The use of such technologies is in many cases vital to enabling farms to continue to both face the myriad and ever-changing challenges of operating a farm business and the pursuit of emerging opportunities to improve the way our members farm their lands.

2.3 Examples include the rollout of high-speed broadband to overcome the tyranny of distance experienced on many rural properties, approval of agrichemicals for weed and pest control, advocacy of genetic engineering for biosecurity, and research into vaccines and compounds for reducing livestock greenhouse gas emissions.

2.4 The positive aspects to the responsible use of drones on farms are still being explored and yet to see widespread uptake by farmers. That said, the Federation is interested to see the potential and emerging opportunities for drone use to improve farm management and better support the farm business.

2.5 Drones are known to be used to support weed control programmes on some farms with targeted application in often difficult to reach terrain. Barking drones have been trialled to explore their ability to remotely assist in moving livestock around farm. The use of drones to provide aerial scans of farm properties to assist with farm management and support farm sustainability efforts are known to occur to a limited extent. Drones are also being used to remotely view stock on some sheep and beef farms prior to lambing to identify those sheep needing attention and enabling that to occur without disturbing stock during a sensitive period in the farm calendar. Federated Farmers has itself attended a demonstration of drone use to support Transpower's line inspection programme in a manner that is less intrusive and disruptive to the farm business than in-person inspections by contractors.

2.6 Drones also have the potential to assist in adverse event responses through remote inspections of affected rural properties to better direct assistance to where it is needed. Another example would be better targeted application of farm nutrients to support pasture growth and minimise risk of sub-optimal application. Drones could also at some point be used to provide more accurate data to support the registration and subsequent accounting of carbon sequestered on farms to meet climate change objectives.

2.7 The negative aspects of drone use on farms largely relate to the irresponsible or unwanted intrusion on private property by often unknown third parties.

2.8 Animal rights and environmental groups are known to have operated drones on New Zealand farms without the farmer's consent. Use of drones in this manner has raised widespread concerns for farmers around intrusion on a farmer's rights to privacy, their right to control access to the farm property, and to protect the welfare of their livestock and crops.

2.9 The risk of stock disturbance leading to injury is high given the currently limited use and experience of drones on farms. Should drones continue to be used irresponsibly or without the consent of farmers. This is especially relevant in situations where drones are flown near milking sheds or farmyards, where the disturbance of stock in tight confines risks the welfare of the animal, as well as the health and safety of farm staff.

2.10 Many of the questions the Federation has fielded in recent years from its members have centred around the options available to farmers to deal with drones they discover other people are operating on their farm without their consent. The answer, frequently, is there is very little a farmer can do.

2.11 Current regulations under Rule Parts 101 and 102 administered by the Civil Aviation Authority (CAA) are such that the most a farmer can do is file a complaint with the CAA and hope something comes of that. Farms tend to be extensive properties and the remote operation of drones often means a farmer will not be able to locate and identify the drone operator to support a prosecution or compliance and enforcement proceedings.

2.12 Further, comments on the radio by an environmental activist last year brought to light the reality that activists have been applying for a Rule Part 102 certificate, thereby avoiding the requirement under Rule Part 101 to obtain a property owner's consent before operating a drone over their property. Similarly, local authorities have been known to use drones to remotely inspect farm properties to support compliance and enforcement efforts.

2.13 In essence, the current situation is one where the negative consequences of drone use on farms tends to be more prominent in the minds of most farmers than the emerging positive benefits of drone use to the farm business. However, the future use of drones on farms is important for increasing the uptake of drones as an enabling technology and realising the many benefits of their use on farms.

2.14 The Federation's interests as regards drone use on farms is best understood as:

- Support the responsible use of drones to support the farm business.
- Enable the uptake and pursuit of new opportunities from drone use on farms.
- Reduce the extent to which irresponsible drone use on farms intrudes on a farmer's right to privacy and risks the welfare of animals on the farm.
- Empower farmers to hold accountable those that do irresponsibly operate drones on their farms.

3. SPECIFIC COMMENTS

Q1: What is your view on the proposed series of measures? Are there any other alternatives you suggest we consider?

3.1.1 Federated Farmers considers the proposed series of measures an improvement on the compliance and enforcement procedures currently in place.

3.1.2 It is our experience that CAA Rule Parts 101 and 102 awkwardly describe the expectations and requirements of drone users within rules that cover the operation of a broader range of unmanned aerial vehicles. The Rules also use terminology that is opaque to those with limited aviation sector experience. Updating CAA Rules to more clearly describe the expectations and requirements of drone use would unarguably be an improvement to the current situation.

3.1.3 Further, there are currently no measures in place that require a drone operator to understand the rules before they operate a drone, nor means of identifying the operator of a drone beyond tracking them down in person. This is especially difficult for farmers to do given the extensive scale of many farming properties and the time lost to the farmer in attempting to locate a drone user operating a drone on the farm without prior consent.

Q2: Would the proposed approach help achieve the desired objectives?

3.2.1 Federated Farmers considers the proposed approach should help achieve better integration of drones through more effective accountability of drone use.

3.2.2 The proposed series of measures described in the *Enabling Drone Integration* discussion document has the appearance of an all-or-nothing package of measures to be implemented over time, comprising:

- CAA Rule updates.
- Basic pilot qualification.
- Drone registration.
- Remote identification.
- Geo-awareness.

3.2.3 Packaged in this way, it appears each measure builds on the capabilities of earlier implemented measures to support the introduction of a broader system that provides some assurance that drone use is responsible and enforceable. Such an approach should ensure drone operators can more easily understand the requirements expected of them, and support the traceability of drones and their use back to drone operators to assist in more effective compliance and enforcement of responsible drone use.

3.2.4 An important outcome of this consultation and implementation of proposed package of measures must be the eventual enabling of situational awareness in real-time of drone use to ensure drone use is responsible and supports the realisation of the full range of benefits of their use for New Zealand.

Q3: Would the proposed approach help address the problems and opportunities identified?

3.3.1 Federated Farmers considers the proposed measures will help ensure responsible drone use is compliant with more easily understood requirements.

3.3.2 Such a system would provide some assurance to our farmer members that drone users are operating drones responsibly on their farm while also providing a greater range of more effective options for holding drone users accountable for unwanted or irresponsible drone use.

Q4: Are there any other problems and opportunities you can think of?

3.4.1 Federated Farmers considers the proposed measures will struggle to address problems and concerns around irresponsible drone use where drone users intentionally do not comply with requirements to pass the basic pilot qualification test or register the drones they operate.

3.4.2 The proposed approach would require drone users to register themselves when gaining the basic pilot qualification, and their drones in order to be held accountable for their actions and behaviour while operating a drone.

3.4.3 There does not appear to be any particular way to prevent the use of unregistered drones by unqualified drone users or otherwise ensure compliance with CAA Rules requirements should a drone user intentionally choose not to do so. This is a factor when considering drones are readily accessible for purchase by the public, many drone types are relatively affordable to purchase, and the ease for someone to operate a drone without complying with any of the proposed requirements.

3.4.4 Treating the operation of a drone when the user has not gained the basic pilot qualification, or failed to register their drone before operating it, as offences will have a deterrent effect towards such behaviours.

3.4.5 Increasing the size of penalties for non-compliance could assist with enhancing the imperative to comply with requirements, but would risk over-reaction to instances of technical non-compliance or, for example, where minor errors are made in the registration of drones. Further, increasing the size of penalties does risk giving rise to a cooling effect on the growth of the drone sector and realising the benefits of responsible drone use.

3.4.6 Similarly, creating a broader range of offences and penalties risks over-complicating and over-inflating the imperative for drone users to comply with requirements. This is an especially relevant consideration when it comes to encouraging and supporting responsible drone use in New Zealand as it may contribute to deter the pursuit of emerging opportunities through drone use.

3.4.7 Federated Farmers considers further work is needed to explore the full range of options and opportunities available to identify non-compliance and enforce compliance in a way that both supports responsible drone use and addresses the risks of irresponsible or unwanted drone use.

Q5: Do you agree with the proposed order of implementation of the measures?

3.5.1 Federated Farmers supports the proposed order of implementation of the measures with the caveat that the Rule Part 101 consent provision not be relaxed or removed until, or unless, subsequent proposed measures are in place.

3.5.2 The first stage of measures comprising CAA Rule updates, basic pilot qualification and drone registration appear to be straightforward to implement in the short-term. The creation of a standalone drone rule would, in itself, improve the clarity and ease of understanding regulatory requirements expected of drone users, with proposed updates being relatively straightforward to incorporate into existing CAA Rules. Basic pilot qualification and drone registration benefit from existing examples elsewhere in the transport sector to guide their swift implementation. Transition periods can be introduced to ease drone users into the new requirements before they become mandatory, easing any initial difficulties to the drone sector.

3.5.3 Subsequent stages of measures appear to require capital investment in the development of new IT systems to support remote identification of drones and geo-awareness of their location as they are operated. Further, it would seem that geo-awareness systems have yet to be deployed in other jurisdictions, suggesting extended timeframes before it could be deployed in New Zealand. As such, it makes sense for a staged approach to be taken towards implementation of the package of measures over time.

3.5.4 The primary caveat the Federation would have towards the swift implementation of CAA Rule updates relates to the proposal that the consent provision in Rule 101 be relaxed or removed as a requirement of drone users.

3.5.5 The relaxation or removal of the consent provision makes sense when considered as functioning within broader proposed measures. Remote identification of drones and their drone operators as well as geo-awareness of drone locations ensure a level of accountability for their use on farms. In the absence of those subsequent measures, the relaxation or removal of the consent provision risks making it more difficult for farmers to hold unwanted or irresponsible drone users accountable for their intrusion on the farm.

3.5.6 Further, the extended timeframes required before one could expect remote identification and geo-awareness to be deployed suggests that the transition period between CAA Rule updates and subsequent measures could cover many years.

3.5.7 Delaying the relaxation or removal of the Rule Part 101 consent provision should have little to no impact on the swift implementation of other CAA Rule updates proposed in the discussion document.

Rules updates

Q1: Should drones have their own standalone Rule Part?

3.6.1 Federated Farmers supports drones having their own standalone Rule Part to provide greater clarity of the aviation rules that particularly apply to the operation of drones as distinct from other unmanned aerial vehicles.

3.6.2 Our own experience of Rule Part 101 and 102 is that there is little clarity to a lay reader of the relevance of various requirements in either Rule to the operation of drones in particular, and the use of jargon unique to the aviation sector throughout both Part 101 and 102 makes it difficult for a lay reader to easily discern whether drone use is or is not permitted under the Rule Parts.

Q2: Should we review the four-kilometre minimum flight distance from aerodromes?

3.7.1 Federated Farmers considers the 4km minimum flight distance from aerodromes should be reviewed. It has been related to us that the minimum flight distance is too indiscriminate and impractical in some rural situations.

Q3: Should we change the requirement to gain consent to fly above property by:
a) Using 'safe distances' as an alternative?
b) Relaxing the requirement in another way?
c) Removing the requirement completely?

3.8.1 The Federation accepts that the consent provision for flying drones over property is difficult to enforce. The experience of our own members backs this up with comments in recent years that they have noticed drones intruding on their farm property with no easy way of identifying the drone operator. Such difficulties make it difficult for compliance and enforcement actions to be taken against such operators.

3.8.2 Introducing a presumptive right of access to fly drones over private property is mentioned in the discussion document as a possible alternative to the status quo. While this would make it reduce the compliance burden on regulatory agencies, it would have little to no effect on the intrusions on property and privacy endured by property owners, particularly on farms.

3.8.3 It is a long-held private property right for owners to be able to manage access to their property. In general circumstances, this is important for health and safety compliance, and biosecurity management among other considerations.

3.8.4 Farmers need to be able to consent to drone users operating their drones on farms to ensure that the operation of drones is appropriate and occurs in a manner that does not disturb livestock, or at least allows the farmer to take steps to minimise the risk of stock disturbance.

3.8.5 'Safe distances' is put forward as one possible alternative to the status quo. Stock disturbance trials on farms of different production types would need to be undertaken to determine what might constitute 'safe distances' on farming properties. The Federation is not aware of stock disturbance trials having taken place on a representative variety of New Zealand farms to inform an appropriate 'safe distance'.

3.8.6 Federated Farmers would be concerned to see 'safe distances' implemented as an alternative to the current consent provision in Rule Part 101 in the absence of stock disturbance trials being undertaken on a variety of New Zealand farms to inform appropriate 'safe distances' on farms.

3.8.7 Removing the consent provision entirely from Rule Part 101 on the basis that subsequent proposed measures will be sufficient to mitigate identified safety and security risks poses its own problems. As previously discussed, there is a timing disconnect between the short timeframe required to update CAA Rule Parts and the longer timeframe to implement remote identification and geo-awareness systems.

3.8.8 Federated Farmers opposes removal or replacement of the consent provision in Rule Part 101 as it relates to flying drones above property unless, or until, subsequent proposed measures are in place.

Q4: Should we change the requirement to gain consent to fly above people by:

a) Using 'safe distances' as an alternative?
b) Relaxing the requirement in another way?
c) Removing the requirement completely?

3.9.1 The Federation accepts that the consent provision for flying drones over people is difficult to enforce. The experience of our own members backs this up with comments in recent years that they have noticed drones intruding on their farm property with no easy way of identifying the drone operator. Such difficulties make it difficult for compliance and enforcement actions to be taken against such operators.

3.9.2 We further accept that government agencies other than the Ministry of Transport or the CAA have responsibility for enforcing instances where drones intrude on the privacy of individuals. We also understand the difficulties an agency would face in attempting to enforce compliance obligations administered by another agency.

3.9.3 That said, CAA Rule Updates should be approached with a mind to better enabling agencies other than the Ministry of Transport or the CAA in pursuing compliance and enforcement actions. In the instance of privacy complaints arising from the use of drones over people the Police and Privacy Commissioner must be involved in the development of CAA Rule updates.

3.9.4 With regard to using safe distances as an alternative to providing consent, it is difficult to see how 'safe distances' would minimise privacy concerns around the flying of drones above people. It is not unusual for drones to be equipped with cameras and a 50m minimum distance could prove insufficient to protect the privacy of individuals.

3.9.5 With regard to relaxing the requirement another way, it is difficult to see how a presumptive right to fly a drone over a person without their consent could be done in a manner that still protects their privacy, or allows the individual to continue to consent to being flown over.

3.9.6 Federated Farmers opposes removal or replacement of the consent provision in Rule Part 101 as it relates to flying drones above people unless, or until subsequent proposed measures are in place.

Q5: If we use 'safe distances' as an appropriate alternative to the consent provision, what distance(s) would you consider is appropriate?

- **a) 10 metres**
- **b) 30 metres**
- **c) 50 metres**
- **d) Other**

3.10.1 There is little reason to assume that flying a drone at a 'safe distance' at any of the suggested distances would necessarily be any safer to a person below a flying drone.

3.10.2 An individual is arguably more likely to notice a low-flying drone than one flying at a greater height and so have greater ability to decide for themselves whether they are prepared to be under where a drone is flying. That said, the risk of disturbance and annoyance to the individual is necessarily greater from low-flying drones.

3.10.3 Similarly, a high-flying drone would prove less disturbing or annoying to an individual under where a drone is being flown. However, in being less aware of the drone the individual is less able to decide for themselves if they are prepared to remain under where the drone is being flown or able to take steps to avoid being hit by a falling drone.

3.10.4 Of more particular concern to farm businesses is the risk of drone use disturbing animals on farms. As a novel element to most farm properties and the unlikelihood of livestock being used to drones flying near or above, trials must be undertaken using various drone types to better assess 'safe distances' in rural settings. The consequences to animal welfare and animal production from drone use could be significant, if not severe, for many farm businesses.

3.10.5 Federated Farmers opposes the introduction of 'safe distances' as a replacement to the consent provision currently in CAA Rule Part 101 unless, or until, stock disturbance trials are undertaken to inform the setting of 'safe distances' appropriate to rural settings.

Q6: Are there any other major Rules changes we should consider?

3.11.1 While deemed out-of-scope within the discussion document, the ease with which a drone user can apply for a Rule Part 102 licence to obviate the need to seek the prior consent of a property owner needs to be reviewed.

3.11.2 The Federation's reading of Rule Part 102 is that a drone user merely needs to say it will be too difficult to seek the prior consent of a property owner to be able to apply for the licence. It is not clear whether there is a requirement of the drone user to explain why it might be too difficult to secure the prior consent of the property owner, let alone whether a property owner's expected refusal plays a role in the granting or otherwise of a Part 102 licence.

3.11.3 Property owners have valid animal welfare and privacy reasons for not providing drone users with consent to fly drones above themselves, their livestock and their farm properties more generally. Other legislation and regulation, like the Electricity Act 1992, has regard for sensitive times during the year when access onto the property should be avoided. Stock disturbance from intrusion onto the farm poses greater risk of harm during those times of the year for lambing, calving and the roar. There are also more day-to-day times when drones should not be operated on farms, such as when cows are in the tight confines of milking sheds or sheep mustered in the yards.

3.11.4 Federated Farmers considers the ease with which a drone user can apply for a Rule Part 102 licence that obviates the need for the drone user to seek the prior consent of the property owner must be reviewed.

Q7: Are there any minor changes to the Rules that would make them easier to understand?

3.12.1 The CAA Rules Part 101 and 102 are written in a way that is difficult for a lay reader, or one with little experience of the aviation sector, to understand what exactly is required of drone users.

3.12.2 In attempting to advise our own members of the requirements of drone use and potential options for dealing with irresponsible or unwanted drone use on farms, it has been our experience that Rules Parts 101 and 102 are framed in a manner that would benefit from translation into plain English and clearer identification of rules relevant to drones as distinct from other unmanned aerial vehicles. Whether from the use of jargon particular to the aviation sector, or from requirements being framed in a manner that only readily makes sense to the aviation sector, some rewriting of the Rules is required.

3.12.3 Federated Farmers recommends that a plain English approach is taken to CAA Rule Parts 101 and 102 to ensure clarity of the requirements and expectations of drone users. Producing a standalone drone Rule Part would assist in ensuring this could happen without necessarily affecting those aspects of Rule Parts 101 and 102 that apply to unmanned aerial vehicles that are not drones.

Q8: What do you think of the proposed minor Rules changes?

3.13.1 Federated Farmers has no opinion on the proposed minor Rule Changes.

Q9: Are there any other changes we should consider?

3.14.1 Federated Farmers has no feedback to offer on other changes the Ministry should consider.

Basic pilot qualification

Q1: Should we introduce a basic pilot qualification for Part 101 drone pilots?

3.15.1 The introduction of a basic pilot qualification for Part 101 drone pilots would help ensure that drone operators are aware of essential requirements of responsible drone use. In doing so, the basic pilot qualification should help support the uptake of drone services in the knowledge drone service providers should at least know how to responsibly use drones. Further, the basic pilot qualification should assist farmers in understanding the requirements expected of them when they operate drones of their own on-farm.

3.15.2 Further, the basic pilot qualification should support the registration of qualified drone users as part of the traceability of drone users to the drones they operate under the broader package of measures. This is important to provide both an element of accountability for irresponsible or unwanted drone use, while also providing some level of assurance to drone users of their own responsible drone use. It would be reasonable for the same identity authentication data to be required of potential drone users taking the basic pilot qualification test as are proposed for drone owners under the drone registration system.

3.15.3 Federated Farmers supports the introduction of a basic pilot qualification for Part 101 drone pilots.

Q2: What impact would a basic pilot qualification likely have on you?

3.16.1 The introduction of a basic pilot qualification for Part 101 drone pilots should contribute towards improvements in the responsible use of drones on farms, which is a positive aspect. The basic pilot qualification should also make it easier for farmers to understand what is required of them in the use of drones on their own farm.

3.16.2 A potential negative aspect is that the introduction of a basic pilot qualification could be a deterrent for farmers to take up drones to support their farm business. The extent to which this is a risk largely depends on the requirements of potential drone operators, the cost to drone users of taking the basic pilot qualification test, and the ease with which rural people could take the basic pilot qualification test.

Q3: What format should this test take?

a) Electronic / online theory test
b) Paper based written theory test (at a provider)
c) A practical examination of skill and a paper based written theory test (at a provider)
d) Other

3.17.1 The Federation would not want to see the basic pilot qualification test undertaken in a manner that limits the participation of rural people.

3.17.2 Suggested formats involving a provider do present a risk that the distances involved and time required to travel to a provider could dissuade rural people from becoming qualified drone pilots. We have seen similar issues with reduced numbers vehicle testing sites in many rural areas, leading to farmers needing to travel great distances to certify the fitness of their on-road vehicles.

3.17.3 Further, rural connectivity is patchy or non-existent in many parts of the country, making reliance on an online only test available only to those parts of the country with reliable internet connections. The Federation produces a report every year analysing the rural experience of connectivity, whether internet connections, mobile coverage or landline services. These reports provide geolocational breakdowns highlighting areas experiencing poor connectivity.

3.17.4 Federated Farmers is happy to provide its most recent rural connectivity report and otherwise assist officials in their deliberations on the format the basic pilot qualification test ought to take.

Q4: Should there be a minimum age for basic pilot qualification?

3.18.1 The use of vehicles in New Zealand generally comes with a mandated minimum age to ensure their use is by responsible persons. That said, the risks arising from drone use are different to that of land transport vehicles like cars, trucks and motorcycles. While there is no mandated minimum age for the use of bicycles, the use of bicycles tends not to pose the same risks to person, property or privacy as is the case with drones.

3.18.2 Perhaps of more relevance is the matter of whether a minimum age should be expected or assumed for a potential drone user to understand CAA Rule requirements, and have the maturity to abide by those requirements. A level of personal maturity should be expected of those looking to take the test for the test to work as a measure that supports responsible drone use. Later commentary in the discussion document related to drone registration suggests a minimum age of 14 years of age for a person registering a drone. It makes sense for the minimum age to operate a drone and to register a drone were consistent for ease of understanding and avoidance of doubt.

3.18.3 Federated Farmers considers there should be a minimum age for taking the basic pilot qualification test, and recommends this be set at 14 years of age for consistency with the minimum age proposed for a person registering a drone.

Q5: Do you agree with the proposed special authorisations given to Part 141 and Part 101.202 approved training organisations?

3.19.1 Federated Farmers supports special authorisations being provided to Part 141 and Part 101.202 approved training organisations from having to take the basic pilot qualification on the proviso that such organisations ensure their staff and students are recorded in the same manner as drone users more generally.

3.19.2 This is important to ensure there is a single register of qualified drone users, which in itself is an expected as assumed consequence of implementing the basic pilot qualification test.

Q6: Is there any other special authorisations you would like to see? Why?

3.20.1 Federated Farmers has no opinion to offer on whether any other special authorisations ought to be granted, so long as all drone users are recorded in the same manner as drone users more generally.

Drone registration

Q1: Should we introduce the proposed drone registration system? Why?

3.21.1 A drone registration system must be introduced to ensure there is traceability between drone users and the drones they operate.

3.21.2 Currently, it is very difficult to trace a drone to its user as a person affected by the irresponsible or unwanted use of a drone must take steps to locate the operator themselves, or somehow be able to provide enough information for the Police or Privacy Commissioner to pursue compliance and enforcement steps themselves.

3.21.3 A drone registration system in itself will not immediately resolve the problems affected person have in identifying the ownership of an irresponsibly operated or unwanted drone. What such a system would do, however, is assist in identifying the owner of a drone under the broader package of proposed measures.

3.21.4 Further, such a system is necessary for the broader package of measures to deliver assurances of more responsible drone use / less irresponsible or unwanted drone use.

3.21.5 Federated Farmers supports the introduction of the proposed drone registration system.

Q2: What impact would drone registration likely have on you?

3.22.1 Drone registration is unlikely to have much of an impact on our farmer members registering their own drones, beyond challenges they already experience in online interactions as a result of poor connectivity in many rural areas.

3.22.2 More broadly, a mandatory requirement that drones are registered would deliver positive benefits for our members in increasing the accountability of responsible drone use in rural areas.

Q3: What do you think of the proposed system design (e.g. digital platform) and requirements (e.g. identity authentication)?

3.23.1 Federated Farmers supports the introduction of a digital platform for the registration of drones and establishing drone ownership.

3.23.2 The introduction of a digital platform helps ensure the drone registration system is responsive and can be relatively easily interrogated to support compliance and enforcement efforts. Further, enabling the system to be accessible to drone owners both online and by mobile should help those in rural areas register their drones where they suffer patchy or no connectivity on the farm.

3.23.3 Federated Farmers considers the information expected of drone owners in the registration of drones they own seems reasonable and straightforward to both identify the drone being registered and the owner registering the drone.

3.23.4 Further, the proposal in the discussion document that drone registration be a one-time event, while there be an on-going requirement that drone owners keep their details up-to-date and notify the CAA of changes of drone ownership seems entirely reasonable. Approaching the matter in this manner reflects the relative risks to data currency of drone operation and drone ownership. We have experience of database registries that have failed to account for livestock that have died, become lost or missing, leading to avoidable over-inflation in statistics. That the approach proposed in the discussion document would avoid such situations from occurring is a positive sign.

Q4: Should there be a minimum weight threshold for registering a drone? If so, is 250 grams appropriate? If not, what would be an appropriate weight threshold and why?

3.24.1 Federated Farmers has no opinion on the matter of minimum weight thresholds for drones that will need to registered.

Q5: Should certain drones not need to be registered (such as drones flown solely indoors) or within specific designated areas (e.g. Model Flying New Zealand sites) from registration? What other drones should not need to be registered and why?

3.25.1 Federated Farmers has no opinion to offer on whether drones flown indoors or within specific designated areas need to be registered.

Remote ID

Q1: Should we consider introducing Remote ID? Why?

3.26.1 Remote identification of drones is a key aspect of the broader package of proposed measures in that it would allow farmers to remotely identify a drone that is being operated in an irresponsible or unwanted manner.

3.26.2 Without such a system, it would be particularly difficult for a farmer to identify the owner and/or operator of a drone, hampering compliance and enforcement measures. Further, introducing such a system should prove an additional encouragement towards responsible drone use, given the consequences to drone users and drone owners from a drone being found to being operated in a non-compliant manner.

3.26.3 Drone use in New Zealand is increasing, but is still very much in its infancy. Further, drone technologies are continually evolving, especially as regards more efficient power storage and consumption. Turnover in the drones operated in New Zealand is such that it is likely that drone models already in operation will be replaced with more modern drone models, thereby reducing the extent to which retrofitting is necessary over time.

3.26.4 Federated Farmers supports the introduction of Remote ID in New Zealand as an important tool in encouraging responsible drone use.

Q2: What impact would Remote ID likely have on you?

3.27.1 Our farmer members would see a positive impact from the introduction of a system that enables the remote identification of drones being operated above their farms.

3.27.2 A potential negative aspect of Remote ID would be that farmers would either need to purchase drones for use on their own farms that already come with Remote ID technology or are capable of being retrofitted with Remote ID technology. This may have an impact on the drone services they are currently employing, and complicate decision-making around purchasing drone for their own use on-farm. Such impacts should reduce over time as it becomes clearer to drone service providers and drone importers / manufacturers that drones should be made available with Remote ID technology already built-in.

3.27.3 The costs of Remote ID on drone users remains largely unknown at this stage, but could have a negative impact on drones being used to support the farm business.

Geo-awareness

Q1: Should we consider introducing geo-awareness? Why?

3.28.1 The introduction of geo-awareness would support the objective of better integration of drones into the transport network, especially as it relates to aviation and assisting in the minimisation of near misses and collisions between drones and other aircraft.

3.28.2 Geo-awareness would also presumably support an element of geo-caging or otherwise identifying those geographical areas where drones should not be operated. The Federation is not advocating that farms should be automatically deemed no fly zones. That said, there should be an ability for farmers to indicate to geo-cage their farm properties during sensitive times in the farming calendar to minimise the extent to which drone use above the farm risks the farm business.

3.28.3 Further, having both geo-awareness and Remote ID would assist in ensuring that responsible drone use through providing greater accountability to drone use than is currently the case.

3.28.4 Federated Farmers supports the introduction of geo-awareness to support safe and responsible drone use and the ability for farm properties to be geo-caged during sensitive times in the farming calendar.

Q2: What impact would geo-awareness likely have on you?

3.29.1 A positive aspect arising from geo-awareness for our farmer members is the greater accountability to drone use and the encouragement that provides towards responsible drone use. Another is the potential geo-caging of farm properties during sensitive times in the farming calendar to minimise the risk of drone use impacting the farm business.

3.29.2 A negative aspect might see similar impacts on drone uptake by farmers, whether in their own right or as contracted services, as would be the case for Remote ID. The costs of geo-awareness on drone users remains largely unknown at this stage, but could have a negative impact on drones being used to support the farm business.

Submission Ends

Garrick Wood

From: [redacted]
Sent: Friday, 21 May 2021 4:57 PM
To: Enabling Drone Integration
Subject: DJI Submission: Enabling Drone Integration
Attachments: DJI Response Enabling Drones MOT 210521.pdf

Dear Ministry of Transport team,

Please find DJI's submission for the Enabling Drones Discussion Paper attached. We would be happy to discuss any elements in further detail.

Kind regards,

[redacted]

[redacted]
DJI
[redacted]

THE FUTURE OF POSSIBLE

DJI

Response to

Ministry of Transport

Enabling Drone Integration Discussion Document

May 21, 2021

THE FUTURE OF POSSIBLE

Introduction:

DJI appreciates the opportunity to submit our comments regarding the Enabling Drone Integration Discussion Paper. We fundamentally agree with the main pillars that the Ministry is looking to implement. But we also recognize that much of the detail around implementation is where we may find issues. We hope to continue to be invited to work with other industry players in giving supportive input in to what will necessarily be a deliberative process on how to implement the initiatives raised.

By way of introduction, DJI is the world's largest civilian drone manufacturer. We were founded by people with a passion for Remotely Piloted Aircraft Systems (RPAS) or drones. As such we are keen to cooperate with regulators and legislators to ensure drone users retain their admirable safety record and the sector continues to thrive.

DJI has participated in policy discussions across Asia Pacific, the US and EU regarding safety, accountability, privacy, and other core issues raised by the growth in drone use. In each of these processes we have held to the principle that all stakeholders want to see safe skies that are open to innovation.

In fact, we have harnessed our research and development resources to this cause. By engaging with government and industry stakeholders and understanding the relevant issues, DJI has been able to develop and voluntarily adopt technologies to ameliorate core concerns by:

- implementing geofencing of airports and critical national security areas in 2013 and continuing to upgrade and add to this system in an effort to minimize risks in airspace around controlled aerodromes and secure areas.
- creating a remote ID system that works for all DJI craft and is now used at airports and security sites and by law enforcement globally to ensure accountability and enforcement of existing laws, as well as for ensuring security at sensitive sites.
- adopting ADSB-in receiver technology on our larger drones to ensure operators have advanced warning of ADSB-equipped aircraft in the vicinity so that they can avoid conflict. We have also committed to incorporate this technology in all DJI drones over 250 grams going forward.
- instituting other safety innovations including smart batteries to detect anomalies, smart return to home functions to ensure our products return to their take-off point avoiding obstacles along the way, as well as altitude limits and other features.

General comment:

One general point we would like to make is that we should all acknowledge the current safety record in the drone sector. We looked at drone operations in the US using FAA estimates on DJI share of market and the data from DJI users who voluntarily shared flight logs with us. We extrapolated that some 10.3 million flight hours using small drones occurred in the US last year. There were zero fatalities recorded. Compare this to the US general aviation safety record of anywhere from .935 to 1.305 fatalities per 100,000 flight hours annualy from 2012 to 2018[1] and we see that the drone safety record is enviable.

Of course drones are unmanned and so fatalities are far less likely. But the point is that when we look at the need for change and the safety case for change, we must look at the data as well. And although drone technology is new, we should not allow that to mean we overemphasise the threat or risk associated. We need to reground all our discussion in data wherever possible. Early efforts to regulate

[1] https://www.avweb.com/flight-safety/accidents-ntsb/u-s-civil-aviation-fatalities-increase-in-2018/

the sector were rightly cautious due to the lack of data. As data becomes more readily available, we should be able to better assess risks and provide opportunities to open the skies further for innovation.

Efforts should focus on building on this admirable safety record and ensuring we sustain and grow the culture of safety among drone users. This will require that all regulations, future UTM requirments and other changes to current legislation or rules are seen to be:

- reasonable and rational – users will need to understand the necessity of any changes and the benefit.
- easy to comply with – we should eliminate friction in compliance wherever possible.
- affordable – we should ensure that costs are fair and as low as possible as high costs will drive down compliance.

Failing on any of the above fronts will undermine the very safety culture we all want to foster.

<u>Of the questions outlined in the paper, we have the following comments:</u>

Please note we have not tried to answer every single question as some of our answers would be repetitive.

<u>General section</u>

1) What is your view on the proposed series of measures? Are there any other alternative you suggest we consider?

The measures cover all of the basic building blocks that DJI believes should be put in place in every market: registration, online testing, Remote ID, and clear and uniform geo-awareness data. And the measures also take on issues particular to New Zealand, such as landowner consent, which we believe would greatly hinder the growth of the industry and because of its overly restrictive nature could well create a culture of non-compliance. Our answers to the further questions below will expand on why we think each measure is needed.

In terms of alternatives or additional measures, we do believe there are some additional early and relatively easy opportunities:

I) Changing legislation to enable drone surveillance technology to be deployed – currently there are technologies available of varying quality that will track and provide warning of drones in areas that are either safety or national security risks. Current legislation in New Zealand prohibits the use in most cases and therefore takes away a key tool for helping ensure airports and security areas remain safe.

II) Taking advantage of New Zealand's ADSB mandate for manned aviation within controlled airspace. There is an opportunity to require ADSB-in on drones either above a certain weight class, or for accessing certain areas such as the 4km controlled airspace around aerodromes. ADSB-in would give the drone operator a clear warning of any approaching aircraft equipped with ADSB, thereby allowing the drone operator to land and avoid any potential conflicts. Please note, we do not endorse equipping ADSB-out for drones as this would saturate the signal and provide users with too much noise and actually decrease safety as a result.

2) Would the proposed approach help achieve the desired objectives?

The core areas in the measures would put New Zealand in a strong position for future growth in drone use.

I) Registration provides a clearer picture of the number of drones in the airspace and provides a direct means of communication with drone operators. This enables better policy making based on real numbers of drones and also allows better policy and regulatory communication to drone operators.

II) Remote ID combined with registration provides a 'license plate' for drones that gives law enforcement and other authorities the ability to enforce existing rules. It will also enable security and aviation safety stakeholder to have early warning of drone intrusions and provide the general public with a sense that drone operators are easily held accountable for any transgressions.

III) Basic pilot qualifications if done correctly will provide all operators with a quick, efficient, and hopefully fun method of understanding the core rules and responsibilities of drone operation. This would clearly impact safe operations given the MoT's surey results showing widespread lack of knowledge of the current rules.

IV) Geoawarness data would provide all airspace users with a clear and easily understandable depiction of levels of risk in operating in various airspace and the required approvals or accreditation needed to access specific areas. Again, the safety dividend from this is clear.

V) The rule changes, and most specificially the doing away with landowner consent, feel necessary for three reasons. First, feedback from drone operators is that this rule is rarely adhered to and so by leaving it in place there is a risk of breeding a non-compliance culture among drone operators. Secondly, it will be close to impossible to do any more advanced operations if approvals are needed by each and every landowner. Thirdly, it does not directly address safety, which is related to distance to individuals and not to property.

Finally, the above building blocks will strengthen New Zealand's approach to Unmanned Traffic Management by setting down a clear foundation of the exact services that are needed now.

To put it simply, if all of these areas are implemented you would have a cadre of registered users who have awareness of the basic rules of operation, and who are electronically conspicuous as well as having easy electronic access to understandandable data regarding airspace risks and are no longer confined by a rule that requires verbal permission from landowners. This seems like an admirable basis from which to continue to innovate.

3) Would the proposed approach help address the problems and opportunities identified?

Yes

4) Are there any other problems and opportunities you can think of?

As referenced above, utilizing ADSB-in on drones to make operations safer inside controlled airspace and changing legislation to enable use of existing drone surveillance equipment.

5) Do you agree with the proposed order of implementation of the measures?

If practical, it would be of great value to move forward the provision of clear geo-awareness data. Given some manufacturers or app providers might need time to be able to become compliant to a hard mandate, a voluntary period might be acceptable in which some manufacturers or app providers could begin incorporating the data set in to their apps as soon as it becomes available.

THE FUTURE OF POSSIBLE

Rule Changes

1) Should drone have their own standalone rule part?

Clearly yes. The different nature of the technology and the fact that the drone sector is moving forward rapidly in terms of capability, and the need for regulations to adjust for these advancements and allow for new use cases to be catered for, means that having a separate part makes absolute sense.

2) Should we review the four-kilometer minimum flight distance from aerodromes:

Yes, but with caveats. If we understand the proposal, it is to redraw these boundaries to ensure they accurately reflect risk for that specific airport. As the discussion paper alludes to, this would need to be linked to comprehensive geoawarness data and a culture of operators checking that data. Remote ID would also be beneficial so that air traffic control could ensure the drone is not straying from the newly established safe zones.

3) Should we change the requirement to gain consent to fly above property by using "safe distances" as an alternative?

A) Safe Distance: Safe distance from people is the right measure. As the discussion paper states, the point of the rule was originally to maintain safety and lower risks to property. At the time, with little safety data to go on this might have been appropriate. We would still argue that the permission to fly over property was never the issue when it comes to safety, it is the distance from an individual that counts. We would also argue that any damage to property should be dealt with via other legal channels. In place of this rule, there is an opportunity to focus on a genuine safety rule around distance from individuals.

There are real issues with defining a specific safe distance. A large drone travelling at speed versus a small drone travelling slowly or hovering in place present very different risk profiles to those around them. By defining a distance too distinctly you are likely going to be far too conservative for the small drone use case and possibly far too liberal for the larger drone.

The other issue is that it is very hard for an operator to judge a set distance in meters without first measuring and setting up barriers or markers and in many applications this might not be practical. However, a responsible operator should be able to self-define a safe distance from others.

Leaving the safe distance undefined admittedly means enforcement could be an issue, but it seems preferable to defining things incorrectly and thus giving the bulk of operators the sense that the rules are overly conservative as this would again encourage operators to ignore the defined distance.

The FAA under Part 107 has left safe distance undefined. The safety record under Part 107 has been commendable.

4) Should we change the requirement to gain consent to fly above people by:

B) Relaxing the requirement in another way: The permission for flight over people restriction should only be removed for specific products – for instance a drone below a specific weight threshhold or a drone with a proven mitigation technology or an airworthiness certification.

For any other operation, consent for flight overhead should remain. This would maintain the strong safety record of drones to date.

5) If we use safe distance as an appropriate alternative to the consent provision, what distance would you consider appropriate?

   D) Other: As stated in the answer to question 3 above, this should be left as “safe distance”.

6) Are there any other major rule changes we should consider?

   ADSB-in for all drones over a specific weight or for accessing areas within controlled airspace for unshielded operations. One of the critical questions for integrating drones is how to make all air users conspicuous to one another. ADSB-in is not a complete solution. It would make other aircraft equipped with ADSB visible to operators of ADSB-in equipped drones. But it would not make those drones visible to the manned aircraft.

   However, the safety benefits are clear. If the drone operator has advanced warning of nearby aircraft they can land immediately.

   DJI believes the benefits of having all drones equipped with ADSB-in are strong enough that we voluntarily equipped our enterprise drones two years ago and have committed to all drones over 250 grams from January 2021 onwards to come equipped with ADSB-in. While it is difficult to compile data showing the safety benefit, the anecdotal evidence and user feedback is strongly supportive.

8) What do you think of the proposed minor Rules changes?

   The move to change the FPV rule to allow indoor operations without a spotter is a good common sense change. Wording should ensure that the operator must be sure to warn others in the indoor space and to ensure that they have an unobstructed flight area.

<u>Basic Pilot Qualification</u>

1) Should we introduce a basic pilot qualification for Part 101 drone pilots?

   Yes. The safety benefits of mandating all airspace users to take a short test to ensure they know the rules for safely operating a drone in New Zealand are clear.

2) What impact would a basic pilot qualification likely have on you?

   This very much depends on the burden this puts on users. A lengthy exam would be detrimental and cause a decline in sales. The focus of the test should be on clear, digestible and core rules for safe operations. This would be best done online in a format that is quick and relatively low friction for the user.

3) What format should the test take?

   A) Electronic/online theory test: The exam has to be online. If it is not, then the paperwork involved and the volume would be overwhelming and costly. Our one query is on what is meant by “theory”. We would see the need for a practical “rules of the sky” type test. Essentially what is needed is a short introductory video to the rules followed by a short 5-10 minute online quiz to ensure the rules have been understood. Something more prolonged would see dropouts from consumers and potentially a damping effect on adoption of the technology.

4) Should there be a minimum age for basic pilot qualification?

DJI has a stated guideline stating that our products over 250 grams should be used by those 14 and older. But as the paper correctly states, anyone capable of passing the exam should be able to fly. And given the exam will be taken irrespective of weight class, the lack of an age limit is reasonable. It might be advisable however for a test taker under 14 to nominate a parent or guardian on the test website to receive a notification of the responsibility the parent or guardian is taking on.

<u>Drone registration</u>

1) Should we introduce the proposed drone registration system? Why?

Yes. Registration serves a number of basic functions.

First, it gives government and the public an accurate count of how many drones are actually in the market place.

Second, registration provides the basis for a remote ID system that will return the actual drone owner's identity in real time. This enables existing drone regulations and laws to be enforced.

Third, registration allows regulators to email registered drone owners to communicate new regulations or changes to existing regulations.

2) What impact would drone registration likely have on you?

DJI supports registration. But we believe it must be low cost or no cost. If costs are higher than a relatively nominal sum, we suspect that compliance will be low. We also believe that an online registration system should be online and easy to complete (5-10 minutes).

If the system imposes higher than nominal costs and is time-consuming we believe that it will undermine the system and lead to high levels of non-compliance.

3) What do you think of the proposed system design (e.g. digital platform) and requirements (e.g. identity authentication)

A digital platform with an API allowing multiple apps to connect is an ideal choice. Although it is worth noting some app developers may prefer to send the user directly to a registration portal to avoid collecting or avoid the appearance of collecting any identifying information.

Realme is one choice, but a variety of options including driver's license as means of identity might make the process easier for the majority.

The fields expected to be filled in seem appropriate and the process we would hope would take 5 minutes to complete. For a consumer, asking more than that would risk dropouts.

4) Should there be a minimum weight threshold for registering a drone? If so, is 250 grams appropriate? If not, what would be an appropriate weight threshold and why?

   250 grams is the correct threshold. DJI has long argued the 250 gram safety threshold is too low. Our own drop testing shows that even a 2.2 kg drone should be considered safe (see DJI Proposes Safe Weight Category). Having said this, as the discussion paper points out, the 250 gram weight class has become an international default. A more real assessment of risk would be based on kinetic energy. But we can all probably agree that it is impractical to use kinetic energy as a guideline.

5) Should certain drones not need to be registered (such as drones flown solely indoors) or within specific designated areas (e.g. Model Flying New Zealand sites)? What other drones should not need to be registered and why?

   Drones flown indoors inherently pose a different risk profile and the ability to find the operator is obviously more straightforward should an incident occur. Exempting these drone seems practical.

   Most aeromodelling clubs have a strong safety culture. If this is true in New Zealand, then the right path is to exempt.

<u>Remote ID</u>

1) Should we consider introducing Remote ID? Why?

   Yes. DJI believe Remote ID is essential in order to inject accountability in to the drone sector and to ensure public acceptance of what is still a relatively new technology.

   In many countries, including New Zealand, there are already good safety regulations in place. The missing piece of the puzzle is how to enforce them.

   DJI has proven that there is enormous pent up demand for RID by police, fire agencies, airports, national security sites, nuclear power facilities and others across the globe. We created AeroScope which reads RID signals from our products and displays serial number, make and model, telemetry data (displayed on a map in real time), along with a field for operators to fill in that will display the intent of their flight and contact information if they would like to share it. We have sold hundreds of units and this has become the default detection and tracking capability for government agencies and airports.

   But this capability to detect, identify and track drones should not remain confined to one manufacturer. All drones should be visible and traceable to the owner in much the same way as cars are via a license plate system.

   There is also a case for having some form of Remote ID available to the general public. While this second case has not been proven in the real world yet, it seems intuitive that if the general public can access an app that displays the serial number and purpose of a drone operation that many will feel considerably more comfortable with a drone operating nearby.

   For example, a householder who is initially concerned about a drone flying over a neighbor's house that could conceivably be looking into his or her backyard, could use the app to identify the serial number of the drone and a drone operator data field on why that operation is being done. By seeing a roofing inspection is underway, the situation is resolved. If this doesn't resolve the issue or the scenario is more sinister, then the homeowner can report the serial number to police for inquiry and potential action.

2) What impact would Remote ID likely have on you?

Impacts depend on the details. The current paper references the ASTM standard that is being implemented in the US. We believe this flexible standard is the ideal. It gives multiple paths to compliance. For us the critical path is WiFi broadcast remote ID. This would enable us to perform a simple firmware update and bring the vast majority of existing drones in the market into compliance.

Other forms of remote ID, such as network remote ID (which was rejected by the FAA), would create larger development costs for us and create an ongoing cost for the user that we believe would impinge on compliance. Any user that has to pay 5-10 dollars per month for RID, might see fit to cancel that service.

We also need to acknowledge that 4G networks do no cover all of New Zealand. By comparison, WiFi broadcast will work anywhere these is a drone and a phone that can be used as a receiver. The signal goes directly from the drone to the phone antennae or other receiver without needing to go via a telecommunications network.

<u>Geo-awareness</u>

1) Should we consider introducing geo-awareness? Why?

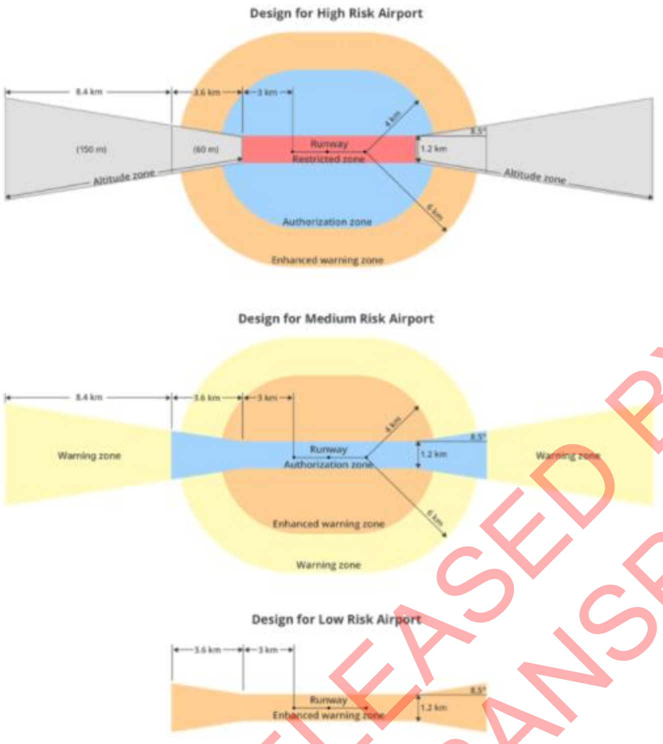
Yes, but with caveats (see answer to questions 4 for those). Geowareness, if done correctly, can provide all airspace users with a common view of the relative risks associated with different sectors of airspace and the permissions needed to access higher risk areas.This can greatly reduce hazards by giving an operator a clear understanding of the current airspace they are operating within and when coming into a sector such as controlled airspace that the risks and permissions needed have changed.

2) What impact would geo-awareness likely have on you?

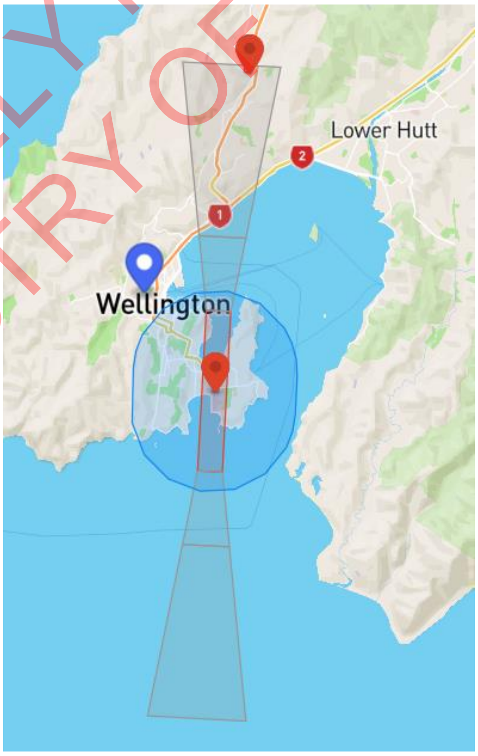
The impact on DJI and our users will be highly dependent on how this is implemented. As you know, we already have our own form of geo-awareness on our DJI Go and Pilot apps, and even go a step further by having introduced geofencing for airports and sensitive sites in 2013.

We would likely maintain our own distinct geofencing based on ICAO's Annex 14 (see example below).

medium and low risk



And you can see below how this is currently applied in Wellington as an example:



But we would display additional geoawareness data as “regulatory zones” or “warning zones”. This would enable us to maintain what we believe is a high degree of safety while giving the benefits of the additional geo data to our users.

What we would like to access in all markets is clear data on:

- airports, where the runways are located, risk level at those airports (amount of traffic)
- similar data for heliports
- prisons and national security sites
- dynamic events that can give immediate alerts via an API for fires or other incidents that might necessitate a temporary flight restriction for that area

What might concern us is if this was done in a way that forced us to display an airspace covered in warnings or exclusions. If for instance, landowner consent is maintained, then one way to implement geoawarness would be to display every property other than your own as needing permission before flight.

This would make the geoawarness data unusable and I do not believe it is the intent of the MoT or other stakeholders involved in this process.

But if that route was taken, drone operators would be greeted with a sea of red whenever they opened the app. And users would then likely either ignore everything they are being told by the geoawareness display, or be so discouraged they would not see the point in owning a drone.

Conclussion:

We believe the initiatives outlined are absolutely correct and are needed to enable the industry to progress. However, the details of how these measures are to be implemented will be critical. If we want operators to comply with rules, the rules must be reasonable, be clearly seen to be reasonable, and be as easy to comply with as possible while maintaining safety. If we fail on any of these fronts, we will undermine compliance and undermine safety.

Finally, while the discussion paper does not address costs, it is impossible to discuss potential regulatory and technology solutions without addressing the issue of financial burdens. We recognize, and believe the majority of the industry recognize, the need to pay our way as best we can for the kinds of services that will keep our sector safe and compliant. However, there is a question of how much capacity to pay there is in such a nascent industry. This means that any cost impost should measure whether it is for a necessary or beneficial service. We hope that these financial issues will be subject to further public consultation before any decisions are made.

We thank you for this opportunity to comment.

[redacted]

[redacted]

DJI

Garrick Wood

From: Richard Sutherland [redacted]
Sent: Friday, 21 May 2021 6:29 PM
To: Enabling Drone Integration
Subject: Submission - enabling drone integration
Attachments: NZ input.pdf

Please see attached

regards
Richard

DISCUSSION DOCUMENT - ENABLING DRONE INTEGRATION

Please see my comments below:

1) EVIDENCE BASED POLICY ONLY - not knee jerk reaction

How about some EVIDENCE based policy - In the 10 years since recreational multi-rotors have been around, there have been ZERO fatalities worldwide ever! Compare this to shockingly poor safety record of manned aircraft in NZ where there are fatalities, and serious incidents year after year after year!

This CAA proposal represents the poorest form of regulation, since:

a) it is unjustified - trying to address a perceived issue that doesn't exist.

b) it is based on ignorance - there is no scientific evidence to suggest a weight limit as low as 250 grams.

c) will be ineffective - there are already regulations which place restrictions around airports. Those that currently ignore the existing regulations are unlikely to register under the proposed regulations.

d) will deflect CAA resources away from REAL issues - there fatalities and serious incidents in manned aviation in NZ each and EVERY year! (compared to ZERO fatalities from recreational drones WORLDWIDE EVER.

e) it is a blatant revenue raising exercise - an annual TAX for registration? Do ultralights, hang gliders and paragliders have to pay CAA an anual tax?.

The overwhelming consensus among the hobbyists that I have spoken to, is that CAA has lost all credibility and has demonstrated zero expertise in recreational Remote Piloted Aircraft Systems (RPAS). Never helpful when a regulator is seen as an incompetent joke, and I suspect it will take many years for CAA to rebuild the trust lost.

The proposed registration scheme MUST be changed to:

a) allow children to participate in the sport,

b) remove the requirement to pay an ANNUAL TAX for no benefit.

c) distinguish between "multi-rotors" and "fixed-wing" models, and

d) the exempt weight must be increased to at least 500 grams for "multi-rotors" and 1000 grams for "fixed-wing" models.

CAA should start doing its job, and prevent the unacceptable number of manned aviation fatalities that occur year after year after year in NZ, instead of hassling safe hobbyists!

2) 250 GRAM EXEMPT WEIGHT THRESHOLD

Requiring all flying toys over 250 grams (such as the 300gram Barbie Hoverboard drone or the 450 gram GWS Slow Stick) to be registered and taxed annually is beyond ridiculous. These toys represent zero risk to manned aviation.

As for personal safety, compare the Barbie drone weight (300 grams) with:

Aussie rules ball: 500 grams;
Soccer ball: 450 grams;
Basket ball: 620 grams;
Net ball: 450 grams;
Soft ball: 200grams,

which children kick and hit at each other. They also ride bicycles and skateboards and yet you want them to register and pay an tax of up to $300 per year for a 300 gram toy? And also ban them from using a toy for 10 to 14 year olds until they are 16?
The exempt weight must be increased to at least 500 grams for "multi-rotors" and 1000 grams for "fixed-wing" models.

3) BEYOND VISUAL LINE OF SIGHT

CAA needs to wake up to the reality of FPV operations. FPV technology provides the pilot a far greater situational awareness and field of view than any 'spotter' can.

Blanket bans on flying FPV with harmless toys that can weigh under 20 grams must be revoked.

4) AIRSPACE SEPARATION SHOULD BE THE PRIMARY RISK MITIGATION

CAA's requirements need to be based on actual risk not some ignorant view of perceived risk.

The primary safety measure should be airspace separation - RPAS below 400ft, manned aircraft above 400ft. This equals no safety issue (and no need for onerous requirements). If CAA believes a safety issue arises from the pilots of manned aircraft disregarding minimum altitudes, then CAA should address this matter directly and not purversly by imposing onerous requirements on hobbyists.

SUMMARY

I am forced to quote Henry Thoreau (circa 1850) “Any fool can make a rule, and every fool will mind it”. ÇAA - don’t be the fool that makes unnecessary, unjustified rules, unworkable rules that will be ignored by the wise and which are impossible to enforce.

[redacted]

From: [redacted]
Sent: Saturday, 22 May 2021 11:01 PM
To: Enabling Drone Integration
Subject: Jackson UAS - Enabling Drone Integration Response
Attachments: Jackson UAS - Enabling Drone Integration - Joint Statement.pdf

Please find attached response to the MOT - Enabling Drone Integration discussion document,

Thanks,

--
[redacted]
Jackson UAS Ltd
www.jacksonuas.com - [redacted]

JACKSON UNMANNED AEROSPACE
ABOVE & BEYOND

JACKSON UNMANNED AEROSPACE
ABOVE & BEYOND

Auckland, New Zealand | [redacted] | [redacted] | www.jacksonuas.com

23/5/2021

Enabling Drone Integration – MOT Discussion Document

After significant consideration of the potential outcomes, we believe the best way forward for the industry is to evolve into a license-based system, which will enable standards to be introduced regarding all facets of the industry – from piloting, to engineering, and training.

The Enabling Drone Integration document does not address some of the core issues within the industry.

Because of this, we believe UAVNZs proposed framework or similar to have the most potential. It requires a large degree of further detail and discussion. However, it is likely the best way forwards to enabling a prosperous, functional, safe, and integrated RPAS aviation sector.

CAR101.202 Removal

The paper suggests removal of CAR101.202, whilst this rule is poorly documented and has no standards associated with how an "Approved Organisation" is approved, in function when applied correctly is effective.

Numerous potential, and some likely, incidents have been averted due to CAR101.202 since the rules implementation. Of note the recent Alauda Airspeeder incident[1] in the UK would likely not have occurred in New Zealand due to CAR101.202. The incident report notes numerous failings in the rules and UK CAA practices, which are currently mitigated in NZ.

Without approved, experienced, and independent people and organisations which can apply industry best practice engineering standards, removal of CAR101.202 without an equivalent replacement will significantly increase the risk of an incident.

UAVNZ Joint Statement

We thank the Ministry of Transport for releasing the discussion document entitled Enabling Drone Integration and inviting submissions from industry and the public. Our organisation generally does not support the proposed regulatory measures documented in the discussion document. This submission

[1]https://assets.publishing.service.gov.uk/media/602bb22f8fa8f50388f9f000/Alauda_Airspeeder_Mk_II_UAS_reg_na_03-21.pdf

outlines why we do not support most of the measures, but also provides clear alternatives that we believe achieve the same intentions. The two biggest areas for improvement should be the areas of safety promotion and enforcement, tied in with rule changes that are consistent with our existing aviation system and do not unfairly stigmatise unmanned aircraft operations.

Our organisation supports funding to the Civil Aviation Authority to support safety promotion efforts of the current rules, and eventually the proposed framework presented below. Our organisation also supports legislative changes that would provide Police with the necessary powers to (1) require an unmanned aircraft to land, and (2) require the operator of an unmanned aircraft to provide their details to an enforcement officer. Where appropriate, legislative change should also allow for organisations to utilise tools that allow for tracking of rogue operations (e.g., frequency trackers and radio frequency spectrum analysers). These are consistent with evidence that suggests the two most effective strategies for preventing rule violations are better safety promotion (to prevent violations caused by ignorance) and better enforcement (to punish deliberate violations). Funding for these initiatives can be obtained by re-allocating funding for other proposed regulatory measures such as registration.

Our organisation supports updating the rules applied to unmanned aircraft, however, we provide an alternative solution under the section entitled Alternative Rules Changes.

The proposed basic pilot qualification will not be sufficient for many unmanned aircraft operations and may detract from the higher level of training that many Part 101 operators already undertake through Part 141 organisations. It does nothing to stop rogue operators from operating their aircraft unsafely, whilst providing little benefit to those undertaking low-risk operations.

Drone registration and remote identification do not prevent rogue operators from operating their aircraft unsafely, however, they do increase the regulatory burden for compliant operators. The assertion that these will improve situation awareness is specious. One does not need to know the registration of an unmanned aircraft to know where it is located in airspace (when radio calls are made for current unmanned aircraft operations, typically these will be in the form of "[Organisation's Name] Unmanned"). Remote identification is also not necessary as separation from manned aircraft can already be achieved through operating within visual line of sight (below 400ft and outside 4km of published aerodromes), using air band radio to give position reports (when above 400ft or within 4km of an uncontrolled aerodrome), or flying within controlled airspace under the instruction of air traffic control. There are also other forms of electronic conspicuity that may be more appropriate (e.g., ADS-B/FLARM), but these should only be applied using a risk-based approach rather than being a blanket requirement under Part 101 or Part 102. Such an approach is consistent with operations that currently occur in manned aerospace and within some Part 102 organisations.

New Zealand already has a single standardised map that provides all necessary aeronautical information, it is called a visual navigation chart (VNC). These can be purchased as a physical map or can be purchased through apps on tablets and smart phones. They have been used for decades within manned aerospace. The AIMS CONOPS programme undertaken by CAA is currently dealing with what will comprise a future higher level of digitisation for all aeronautical navigation documentation. The proposal to examine geo-awareness appears to be duplicating this work. Evidence suggests that current unmanned aircraft operators are already more likely to use VNCs than Airshare and are also more likely to be able to correctly read VNCs than maps on Airshare. An Official Information Act request to Airways New Zealand also shows that during the period 1 January to 22 November 2019, there were only 2,894 unique unmanned aircraft operators who used Airshare. This suggests that the proposed geo-awareness approach will be less effective than simply mandating the use of VNCs prior to unshielded operations.

Alternative Rules Changes

Our organisation supports a three-tiered approach to the regulation of unmanned aircraft operations, alongside supporting rule parts that are consistent with current approaches within the aviation industry. The three tiers of this system are:

1. General operating rules (potentially more restrictive that the current Part 101) – these allow for anyone to fly an unmanned aircraft within certain parameters.
2. A licensing regime (create an equivalent to Part 61 for unmanned aircraft) – this will allow for tighter standards around theory requirements and flight testing, accompanied with greater permissions in terms of the operations that can be undertaken. Many current operations occurring under Part 102 would move into this category. Ratings would also be a feature, allowing for qualifications to match more specific operating settings (e.g., night ratings, FRTO ratings, type ratings for large aircraft, etc.).
3. A certification process (similar to the current Part 102, but only for Part 101 variances that cannot be achieved with standardised licensing proposed under tier 2) – this will allow for more nuanced risk-based approaches for organisations undertaking higher risk operations (e.g., BVLOS, autonomous operations, urban air mobility, etc.)

Our organisation also supports the introduction or adaptation of the following supporting rule parts:

1. An equivalent (or adaptation) of Part 149 for recreational organisations operating unmanned aircraft, such as Model Flying New Zealand. This would allow such organisations to establish their own licensing systems for their own members.
2. An equivalent (or adaptation) of Part 141 for unmanned aircraft. This will ensure that the organisations conducting pilot training apply consistent standards, supported by syllabi that would be advisory circulars to the Part 61 equivalent for unmanned aircraft.
3. An equivalent (or adaptation) of Part 66 for unmanned aircraft. This will ensure that persons who conduct maintenance on unmanned aircraft above a certain weight threshold have appropriate qualifications and experience. This would also allow for persons to obtain certificates of maintenance approval and certificates of inspection authorisation for aircraft above a certain weight threshold.
4. An equivalent (or adaptation) of Part 147 for unmanned aircraft. This will ensure that organisations conducting maintenance training apply consistent standards, supported by syllabi that would be advisory circulars to the Part 66 equivalent for unmanned aircraft.
5. Equivalents of Part 145, 146 and 148 for organisations that maintain, design and/or manufacture unmanned aircraft above a certain weight threshold.

This proposed system would be highly beneficial to the unmanned aerospace industry in New Zealand, providing far greater airspace integration by having commonality between manned and unmanned aircraft operations. Contrary to the assertions presented by the Ministry of Transport, our organisation does not believe that unmanned aircraft operations require a fundamental re-design of airspace or operating requirements. Rather, our organisation believes that a translation of existing standards to unmanned aerospace will serve the New Zealand aviation system better in the long-term. A tiered system allows for a risk-based approach to regulation, where the inherent air-based and ground-based risk of different operations require different standards to be met.

While the specifics of the three-tiered approach and supporting rules changes would need to be discussed in detail, the diagram below presents a high-level picture of how a risk-based approach could be taken to apply the correct regulatory measures to the correct operations.

Lower Risk (general operating rules)	Moderate Risk (licensing)	Higher Risk (certification)
Visual Line of Sight (VLOS)	Extended VLOS (EVLOS)	Beyond VLOS (BVLOS)
Under 5kg	5 – 25 kg	Over 25 kg
No flight over people or other people's property without consent	Above people and property	Above crowds or sensitive infrastructure (e.g., major airports)
Photography, remote sensing, etc.	Dropping of articles, agricultural spraying, etc.	Passenger carrying operations, fully autonomous operations, etc.
Shielded areas and below 400ft in uncontrolled airspace	Class G airspace (above 400ft), controlled airspace, special use airspace, and unshielded operations within 4km of a published aerodrome	
Day flying and shielded night operations	Night flying (outside shielded areas)	

Conclusion

Whilst the MOT/CAA Project staff may have good intentions for the future regulations, we believe that the short comings in various current regulations and policy are causing large issues within the RPAS sector. These issues will not be resolved within the current suggest rule change program. Any issues around lack of compliance with new entrants with COTS multirotor can be addressed with proper education and enforcement resourcing.

Sincerely,

[redacted]

Garrick Wood

From: [redacted]
Sent: Tuesday, 25 May 2021 6:01 PM
To: Enabling Drone Integration
Subject: Submission from Kevin Barnes
Attachments: KB CL MoT Submission on Drones .pdf

Greetings

Please find attached my submission

Regards

[redacted]

Enabling Drone Integration - Consultation
Ministry of Transport
PO Box 3175
WELLINGTON 6140

[redacted]
25 May 2021

Dear Sir/Madam,

Thank you for the opportunity to comment on your consultation document.

In general I am supportive of efforts to bring New Zealand's regulatory regime for drones into line with international standards to avoid any possible infringements of privacy, health and safety issues, or conflict with full-size aircraft.

I am an experienced aeromodeller (40 years+) with particular interests in control-line and free flight model aircraft. I have flown at seven control-line world championships. In this submission I particularly comment with regard to control-line model aircraft.

The key characteristic of a control-line model aircraft is that it is physically constrained by two control cables (on rare occasions single or three line control may apply). These cables are no more than 22m long (limited by New Zealand and international rules). This means the models can only physically operate within a 50m circumference circle and cannot go over 24m altitude, allowing for pilot movement and height. These models are not remotely piloted but are piloted through the physically constraining control cables.

The aircraft are light with very few models over 2kgs in weight with the vast majority under 1800 grams.

These models are only operated for recreation including sporting competitions.

Specific Comments:

- Page 5 includes control-line model aircraft within the definition of Unmanned aircraft, then in Page 6 in the introduction para 1 defines "Drones are aircraft that con be remotely piloted or flown autonomously"

  Control-line model aircraft cannot by either remotely piloted (given the physical control constraints) or flown autonomously.

  On this basis they would not fall under the definition of a drone

- Page 15, para 42 talks to "who flies what". A control-line aircraft is physically connected to the pilot through the control cables. This means pilot identification is always able to be established.

- Page 29 para 108 and following.

  - The existing rule CAA para 101.205 covers remotely piloted aircraft or free flight model aircraft.
  - Control-line model aircraft are not covered by this rule
    - This is due to the physically constrained environment (50m) a control-line model operates in.
  - It would be reasonable that control-line aircraft retain this exemption due to their limited operational requirements.

- Page 30, paragraphs 115 and 116 talk to 'tethered drones". While this may be needed it is suggested that a limitation of greater than 25m is applied. This would enable control-line model aircraft to continue to operate in their limited physical environment.

  - The existing rule CAA para 101.203 limits operation of control-line model aircraft to control systems of 30m or less

- Page 48, Question 5. I note the intent that drones operated under MFNZ rules and in designated areas will not be expected to be registered and agree that this is practical. This is also particularly applicable to control-line model aircraft

- Page 53, Q2. Given that control-line aircraft operate in a limited physical environment it would seem unnecessary for remote ID to apply

- Page 53 Para 215, suggests that drones "have a life span if one to two years". This is incorrect with regard to model aircraft in general (not just control-line model aircraft) in that model aircraft may last decades. I personally own model aircraft that are over 20 years old. Care will need to be taken with any regulation that it does not, unintentionally, cause existing model aircraft to be made redundant in a short period.

- Page 57, Q4. Given that the operation of control-line model aircraft is physically constrained the requirement of remote ID and the related potential Geo regulation would not be practical or relevant.

A suggested way forward:

It would be reasonably simple to apply an exemption to control-line model aircraft that are physically constrained by control lines of less than 25m. This is in line with the rules applying in the UK.

I am happy to contribute further to this discussion, if required.

Yours faithfully

[redacted]

[redacted]

[redacted]

From: Richard Mcfadden [redacted]
Sent: Wednesday, 26 May 2021 2:07 PM
To: Enabling Drone Integration
Subject: Control line model aircraft submisssion
Attachments: CL MoT Submission on Drones.docx

Please find attached my submission on the subject

Regards

Richard Mc Fadden

Enabling Drone Integration - Consultation
Ministry of Transport
PO Box 3175
WELLINGTON 6140

[redacted]

26 May 2021

Dear Sir/Madam,

Thank you for the opportunity to comment on your consultation document.

In general I am supportive of efforts to bring New Zealand's regulatory regime for drones into line with international standards to avoid any possible infringements of privacy, health and safety issues, or conflict with full-size aircraft.

I am an experienced aeromodeller (53 years+) with particular interests in control-line and free flight model aircraft, my children have joined me in this activity, we have competed at natonal level. In this submission I particularly comment with regard to control-line model aircraft.

The key characteristic of a control-line model aircraft is that it is physically constrained by two control cables (on rare occasions single or three line control may apply). These cables are no more than 22m long (limited by New Zealand and international rules). This means the models can only physically operate within a 50m circumference circle and cannot go over 24m altitude, allowing for pilot movement and height. These models are not remotely piloted but are piloted through the physically constraining control cables.

The aircraft are light with very few models over 2kgs in weight with the vast majority under 1800 grams.

These models are only operated for recreation including sporting competitions.

Specific Comments:

- Page 5 includes control-line model aircraft within the definition of Unmanned aircraft, then in Page 6 in the introduction para 1 defines "Drones are aircraft that con be remotely piloted or flown autonomously"

  Control-line model aircraft cannot by either remotely piloted (given the physical control constraints) or flown autonomously.

  On this basis they would not fall under the definition of a drone

- Page 15, para 42 talks to "who flies what". A control-line aircraft is physically connected to the pilot through the control cables. This means pilot identification is always able to be established.

- Page 29 para 108 and following.

  - The existing rule CAA para 101.205 covers remotely piloted aircraft or free flight model aircraft.
  - Control-line model aircraft are not covered by this rule
    - This is due to the physically constrained environment (50m) a control-line model operates in.
  - It would be reasonable that control-line aircraft retain this exemption due to their limited operational requirements.

- Page 30, paragraphs 115 and 116 talk to 'tethered drones". While this may be needed it is suggested that a limitation of greater than 25m is applied. This would enable control-line model aircraft to continue to operate in their limited physical environment.

  - The existing rule CAA para 101.203 limits operation of control-line model aircraft to control systems of 30m or less

- Page 48, Question 5. I note the intent that drones operated under MFNZ rules and in designated areas will not be expected to be registered and agree that this is practical. This is also particularly applicable to control-line model aircraft

- Page 53, Q2. Given that control-line aircraft operate in a limited physical environment it would seem unnecessary for remote ID to apply

- Page 53 Para 215, suggests that drones "have a life span if one to two years". This is incorrect with regard to model aircraft in general (not just control-line model aircraft) in that model aircraft may last decades. I personally own model aircraft that are over 20 years old. Care will need to be taken with any regulation that it does not, unintentionally, cause existing model aircraft to be made redundant in a short period.

- Page 57, Q4. Given that the operation of control-line model aircraft is physically constrained the requirement of remote ID and the related potential Geo regulation would not be practical or relevant.

A suggested way forward:

It would be reasonably simple to apply an exemption to control-line model aircraft that are physically constrained by control lines of lessthan 25m. This is in line with the rules applying in the UK..

Yours sincerely

Richard Mc Fadden

Garrick Wood

From: Jonathan Shorer [redacted]
Sent: Wednesday, 26 May 2021 5:10 PM
To: Enabling Drone Integration
Subject: Response to discussion document
Attachments: Enabling Drone IntegrationresponseJS.docx; Questionaire response.docx; Drone threat to Commercial Air Transport.pdf; qinetic_drone_collision_study_redacted - Copy.pdf

Please find attached my response to the discussion document. I have also attached two papers which I refer to in the answers.

Many thanks,
Jonathan Shorer

Enabling Drone Integration

[redacted] I am a Life Member of Model Flying New Zealand and worked with CAA and MoT for many years on Unmanned aircraft matters. I have made a detailed response to the document which will hopefully help further refine the ongoing work.

Glossary / Introduction

One of the basic requirements for clarity is to define exactly what we are talking about. The current Rules Part 101 reference “Unmanned aircraft”. This was a change in 2015 from the previously used term “Model aircraft”. The Introduction on page 6 explains that the term “drone” is to be used throughout to mean “Unmanned aircraft”. Drone has no definition in Part 101 or anywhere else in CAA rules. This is not to say that drones are a new phenomenon. They have been in use for almost 100 years. Using a colloquialism leads to much confusion. By grouping model aircraft under the catch-all term drone, many highly misleading statements are introduced which do nothing to promote understanding. “There is currently a lack of compliance from drone pilots” (Page 17) is simply untrue where applied to model aircraft pilots or indeed, Part 102 operators. If the author is unable to define the problem accurately, there is no hope of finding appropriate solutions. I contend that there are three distinct groups of unmanned aircraft that need solutions. Namely, small recreational aircraft (which the public perceive to be drones), commercial unmanned aircraft, from real estate photography platforms to flying taxis and lastly, model aircraft. Each has unique uses and needs. Overarching rules will automatically disadvantage some or all of these groups.

The problem is amply illustrated at Paragraph 179 “ MFNZ gives members special privileges to operate model aircraft and drones”. Are they the same thing or two separate types?

Paragraph 7, Figure 1

The author states that Part 101 includes 12 prescriptive rules. In fact, it includes 9 rules in Subpart A General and 9 rules in Sub part E, Remotely piloted aircraft, Control line model aircraft and Free Flight model aircraft.

Paragraph 8

“An organisation approved by the Director” Prior to 2015, CAA issued a Certificate of approval to a suitable organisation. When the last certificate expired, MFNZ applied for a renewal and the response was that the Part 102 certificate was its’ replacement. The Part 102 exposition relates to Part 102 operations. How this can cover the obligations of an approved organisation for Part 101 operations is by no means clear.

Paragraph 11

The drone muddle continues with the reference to Appendix 1. Here, all of the depictions of unmanned aircraft operating below 500ft are of multirotors. If the paper is all encompassing, might not one of the 4 illustrations have been a fixed wing unmanned aircraft?

Paragraph 18

The “exact number” is most definitely uncertain. Successive attempts to determine the numbers have been deeply flawed and the authorities have steadfastly refused all attempts to assist with improving the understanding of the scope on the target audience. Is it important to know the exact number? There is no central register of bicycles or boats. Both of these generate multiple fatalities every year, yet the current rules for using them seem to be acceptable.

An Effective commitment to drone integration is necessary.

Paragraphs 30 – 35 attempt to provide justification for all that follows in the rest of the document. There are two themes: To facilitate the economic and social benefits and to remain aligned internationally. The subsequent 50 pages of the document make no real attempt to integrate commercial unmanned aircraft with manned airspace usage. Instead they focus almost entirely on ways to restrict the use of small recreational drones. In so doing, they do a disservice to the developing innovative commercial sector and run a very real risk of doing serious damage to the model aircraft hobby.

Paragraph 31

The Drone Benefit Study did not quantify the economic benefits of drones. It took an unsubstantiated guess at what contribution drones might make to key industries and multiplied that by the total worth of the sector. The study had to use a 25 year period to produce some eyecatching numbers. It is ridiculous to suggest that we know where the technology will be in 2045. Twenty five years ago, a GPS was a large cumbersome box, now, a ubiquitous chip.

Paragraph 47, Table 2

Examining the data in the table shows that almost all categories of drone reports show a strong decline in incidents. The exception is reports of lack of consent from people under the flight path. The paper later proposes to remove the potential for these reports to be made by deleting the consent requirement. Therefore the data does not support the need for other actions that the paper contends.

Paragraph 48 Table 3

This table shows clearly that 2018 was the peak for Incursions and that the trend is improving rapidly.

Benefits, costs and risks associated with the proposed approach.

The document makes frequent references to the allegation that drones pose a risk to aviation and the general public that must be managed by the introduction of new rules. This stems from media hysteria, ill-judged press releases and vested interests. An example is the study commissioned by the British Airline Pilots Association in which a drone was turned into a projectile that could be fired into the windscreen of an airliner. Although the study did produce a dramatic photograph, the real conclusion was that such an incident could only happen above 10,000 ft by virtue of the closing speeds required. Independent analysis of this data concluded that such an incident might occur once every 2,100 years. Despite the assertions of ALPA that a serious incident is only a matter of time unless tougher regulations are introduced, there is no evidence of a drone having been struck by an airliner anywhere in the world, ever. Given that, in a normal year, there are 70 Million airliner flights, rigorous statistical analysis is likely to prove that the threat is less than the accepted standard for aircraft safety of less than 1 in 10^{-7}.

There seems to be a preconception that recreational drones must be brought under control to facilitate commercial drones and better manage all airspace. This runs counter to what some describe as the "Big Sky theory". During World War 2, there were 654 active airfields in UK, an area the same size as New Zealand. At that time, vast numbers of aircraft were operated in very arduous conditions, often by inexperienced pilots, sometimes damaged, often at night and with no Air Traffic Control system as we know it today. And yet, mid air collisions were incredibly rare. Separation in time and 3 dimensions makes the sky a big place.

We refer to the 4km exclusion zone around an airfield as a small area. Up to 400ft, that airspace contains 6.2 billion cubic metres of air. The average drone occupies about 1 litre of space.

Sitting in an office in Wellington, a look at Flight radar 24 shows the sky to be quite busy. Looking out of the window, it is very rare to see more than 1 aircraft and often, there are none at all.

Paragraph 61

The post event reports into the events at Gatwick airport in December 2019 found no evidence to support the alleged drone activity. There appears to have been some kind of mass hysteria exacerbated by the Police authority flying their own drones around during the incident which led to the prolonged shutdown. The paragraph could usefully explain that there is a difference between the perceived impact of incursions and reality. An example is a documented incident on the CAA database of an incursion at a South Island Airport. Here, a drone was sighted in proximity of the aerodrome and the aerodrome was closed. No aircraft had arrived in the half hour before the sighting and no aircraft were expected in the hour after the aerodrome was closed. Whilst it may have been an exercise in caution, there was no disruption.

Paragraph 62

Aerodromes are not automatically closed for 15 minutes when a bird is sighted, nor should they be if a drone is sighted. In each case, the decision should be with the pilot to assess the risk. There is ample evidence of bird strikes and resultant damage, why is an inverse standard applied?

Paragraph 64

The author makes no attempt to distinguish between aviation related injuries and workplace injuries. It is quite possible that many of the injuries are caused by equipment being operated on the ground and not as part of flying the UAV. CAA reporting relates to the time that an aircraft is in flight or taxying. These statistics should be assessed to the same standard.

Paragraph 73

The author has over-simplified the rule. Discussion of the rule needs to include consideration of the provisions of sub paragraph (d).

Paragraph 82

There is an inherent contradiction between the second and third sentence. Cost recovery means splitting the cost to the Government of implementation of the measures between the users of the system. A fair share of the costs based upon the risks that they pose is quite a different calculation. The costs shown in Paragraph 83 demonstrate a wild variation between the attitude taken by different countries. There is a potential danger that a very expensive system is created based upon the inaccurate data previously outlined and then a small body of users is expected to fund the result.

Paragraph 97

The author makes no suggestion as to how the separated rules would be divided. Is the proposal for a set of rules for Unmanned aircraft and another set for Gyrogliders, Parasails, Balloons, Kites and Rockets?

Major Rule changes.

The section would be clearer if the rules were dealt with in numerical order.

Paragraph 103

The rule was created with no risk assessment or safety case other than an intuitive thought that it might be safer if consent were obtained. If an operator is flying over an empty field, there is no safety advantage gained by having consent. If a drone is being used to film a sporting event, the crowd is not safer because they know it is happening, they are safer when plans are in place to assure safety.

Paragraph 108

The rule 101.205 is over simplified. The explanation in note 24 relates only to the small number of controlled airfields. The rule is poorly written and has the hierarchy backwards. The parts should be dealt with in the order: Any aerodrome / Controlled aerodrome / Uncontrolled aerodrome.

Paragraph 109

The 4km radius rule is much, much older than 5 years. A check of the 1997 rules is required. Around the world, this provision dates back to the Second World War.

Paragraph 110

It is difficult to see the advantage of what is being proposed. Why is it better for an aerodrome operator or ATC to nominate random areas where drones might be operated rather than approve specific requests. If a single 4km circle is difficult to communicate to operators, is the Airways proposal of a number of concentric rings with reducing height limits an improvement or a further complication?

Paragraph 112, Table 5

Why are the changes not listed in numerical order?

There is no discussion or explanation of the proposed changes to Rule 101.202. What is the relationship between Commercial off the shelf drones and approved organisations?

I understand from the workshop meetings that there is a desire to change the status of MFNZ from that of an approved organisation to being a Part 149 Aviation Recreational organisation. The demands of Part 149 are wholly out of proportion with the activity of flying model aircraft. Complying with Part 149 would be an intolerable burden on an organisation that is administered by one part time contractor. Many clubs would be incapable of meeting the Quality assurance demands of the CAR. It is likely that clubs would disband, as the advantage of having a 149 compliant certificate would be less than the privileges of an individual operating under Part 101. Why have an expensive qualification that restricts one to only flying from a designated area when one could simply notify the CAA of the aircraft details and fly anywhere?

Why is the need to amend Rule 101.205 listed in both major and minor changes?

Rule 101.7 does need to be reviewed. However, there is no reference to “permission” in sub para (c). This provision mirrors the conditions under which other manned aircraft may enter Danger Areas.

101.209 VLOS is defined over more than a page of the rules. What more is proposed?

101.215 There is no discussion or explanation for the proposal to remove the 15-25kg category. Since MFNZ is by far the manager of the largest number of aircraft in this category, some consultation would be appreciated. Is the special provision threshold to be lowered to 15kg or are the current controls on 15 -25kg aircraft to be abandoned?

Paragraph 126

The author states that current measures have been ineffective in reducing the number of risk events. This directly contradicts the evidence shown elsewhere in the document.

Paragraph 129

It is unclear how an on-line theory test can assess skills.

Paragraph 147

There is no such thing under Rule 101.202 as an approved **training** organisation.

Chapter III Drone registration

The author clearly defines the specific differences between registration and notification. The paper then goes onto to explain that drones should be notified to the CAA and then persists in using the term "registration" throughout the document.

Paragraph 178

There is nothing in Part 101 that refers to "MFNZ designated areas". The term used is airspace used by the organisation before 1 Aug 2015. There has been no discussion around designating areas. No other form of aviation is confined to designated areas and no risk case has been created to examine whether this would be an enhancement to safety. It seems more likely that it is envisaged as an aid to enforcement of the rules.

Paragraph 179

The author seems to be under the impression that "designated areas" are "danger areas". This is completely false. MFNZ maintains a list of more than 300 flying sites where model aircraft takes place and there are 27 Danger areas where model aircraft activity can take place to a greater extent than under normal Part 101 rules. There are extended limits of varying heights in model aircraft danger areas. Although Danger areas used by model aircraft are a welcome feature, the fact that General Aviation aircraft can fly through them, somewhat blunts the perceived safety advantage.

Paragraph 180

The statement that "model aircraft are flown under the supervision of MFNZ" is misleading. MFNZ provides a structure and guidance to model clubs and individuals throughout the country. It does not "supervise" model aircraft flying any more than AOPA supervises GA flying or any other comparable body. Adherence to rules is promoted by best practice, peer pressure and the requirements of our insurance scheme.

Paragraph 201

Which drones are likely to require Remote ID? The subsequent paragraphs make it clear that the only perceived benefit is to identify rogue drones and yet the consensus is that determined disrupters would disable such a system. The Figure 5 diagram illustrates well the futility of the system. If an enforcement agent were to visit a park and see the display on his device, how is he to identify which drone is being flown by which person or if there is a number mismatch between pilots and aircraft?

The paper does not propose that model aircraft will be exempt from the Remote ID requirement. Although, there is an implied suggestion that this is the case in the phrase that "Remote ID will only apply to certain aircraft" it requires a more definitive decision. Also, it is difficult to see how Remote ID would be workable for model aircraft that have not been notified to CAA and thus have no identity.

Paragraph 205

Remote ID is not the same as Detect and Avoid. This paragraph muddles the two.

Paragraph 215

The statement that the majority of drones have a life of one to two years does not relate to model aircraft. My oldest aircraft is 37 years old and I have many that are in their teens. Technology will not automatically be incorporated into self built model aircraft and would be expensive and or difficult to retrofit into many of them. The last time that MFNZ surveyed the membership the average ownership was in excess of 20 per person giving a fleet total in New Zealand well over 40,000.

Summary

It is clear that there is a need to be seen to be doing something about drones. The current policy of education, coupled with the decline in sales of recreational drones is having a positive effect on reported incidents. This will be further improved by repealing the ill-conceived consent rules.

There is no need to "box in" model aircraft to facilitate commercial drone deliveries or to introduce a registration system for drones to improve safety for airliners. There is a need to consider how an aircraft without a pilot on board can integrate into the flow of piloted aircraft using an airport. The paper makes no progress in this direction.

What the paper continues to do is to muddle which solutions are appropriate for which problem. Drawn into this maelstrom are model aircraft enthusiasts and clubs. They have a history of almost 100 years of safe operation and were once described by a senior CAA representative as the most rules compliant group in aviation. There is no advantage to removing model aircraft from Part 101. Instead, it is suggested that rules changes that have been under consideration for many years are implemented and model aircraft are left alone to fly safely as they have done for many years.

Questions

Q.1 What is your view on the proposed series of measures? Are there any other alternatives you suggest we consider?

The project is attempting to tackle the topic of drone integration, however the time taken seems to be excessive and the interaction with participants very sporadic. Some of the envisaged rules changes have been registered with CAA for more than 5 years. An interim solution that will have taken 8 years to get to the next step is not in keeping with the pace of technological change.

Q.2 Would the proposed approach help achieve the desired objectives?

Throughout the paper there is a lack of clear thinking about the constituent parts of the sector. It starts from a bucket of rules applied to a variety of non-conventional aviation players, some manned, some unmanned and then attempts to find cross sector solutions to specific problems. There needs to be a much clearer linkage between problem-objective-proposed solution. An example is the thought process around Remote ID. It is suggested as a solution to enforcing the control of airspace incursions. But then justified as being a help to drone users. Model aircraft are judged to be rules compliant and then it is suggested that Geo-caging by used by clubs to confine members aircraft to designated areas.

Q.3 Would the proposed approach help address the problems and opportunities identified?

The Rules updates have been held in abeyance for some time to be part of this bigger picture. They are urgently needed. All of the subsequent topics (Pilot qualification, Drone Registration, Remote Identification and Geo Awareness) need to be proven to be necessary through a rigorous process. Are they justified? Has a Risk assessment been undertaken? Has a similar measure been used elsewhere in the word and been seen to be both cost effective and safety enhancing?

Q.4 Are there any other problems and opportunities you can think of?

There is no discussion of actual integration of UA into existing airspace. There a whole classes of UA development that need to be addressed. Small package delivery, unmanned taxis, unmanned freight aircraft. Use of UA air corridors. These topics are completely absent. The paper concentrates on fixing existing problems, some of which are already being cured and then tosses a handful of technology developments into the equation to gauge reaction.

Q.5 Do you agree with the proposed order of implementation of the measures?

The Rules updates are needed urgently. The need for the other restrictive measures is very much unproven. Until there is a risk and cost/benefit analysis, there is no justification for further measures. In 2015, the consent rule was introduced on a whim. It has been widely unpopular, ineffectual and should be repealed. It would be unfortunate to spend large amounts of money and effort introducing a qualification and ownership notification schemes only to find later that they had no benefits.

Questions - Rules updates

Major changes to the Rules

Q.1 Should drones have their own standalone Rule Part?

Yes Separate Rules as follows:

i. Unmanned aircraft.

ii. Model aircraft, non person carrying balloons, kites and rockets.

iii. Gyrogliders and Parasails should be aligned with other person carrying aircraft.

Q.2 Should we review the four-kilometre minimum flight distance from aerodromes?

No. The current rule is easy to understand. The Rule needs to be written more logically. (See later response for draft wording).

Q.3 Should we change the requirement to gain consent to fly above property by:

a. Using 'safe distances' as an alternative?

No

b. Relaxing the requirement in another way?

No

c. Removing the requirement completely?

Yes

Q.4 Should we change the requirement to gain consent to fly above people by:

a. Using 'safe distances' as an alternative?

Yes Rule 101.207 or Rule 101.13 should include a clause requiring a 30m separation from persons not involved in UA operations. Consent is not a factor.

b. Relaxing the requirement in another way?

No

c. Removing the requirement completely?

No

Q.5 If we use 'safe distances' as an appropriate alternative to the consent provision, what distance(s) would you consider is appropriate?

a. 10 metres

b. 30 metres See above

c. 50 metres

d. Other.

Q.6 Are there any other major Rules changes we should consider?

Yes Rule 101.209 is poorly written. Although VLOS is widely used, it is incorrect. A line of sight extends to infinity. One can clearly see the Moon and the Sun. What is relevant is the range of vision. A Remotely piloted aircraft must remain within visual range of the pilot or observer. The Military use BVR as a descriptor rather than BVLOS.

Minor changes to the Rules

Q.7 Are there any minor changes to the Rules that would make them easier to understand?

Q.8 What do you think of the proposed minor Rules changes?

They have not been discussed with the stakeholders. The proposed changes show a poor understanding of the current rules and the way in which they affect stakeholders.

Q.9 Are there any other changes we should consider?

Rule 101

Sub part A General

101.1 Needs to be rewritten to separate out drones, people carrying craft and other UA.

All other sections will need to reflect the separation of these three groups.

101.3 Needs additional definitions as described. Needs a definitions of Model aircraft, barrier, minimum mass of 250gm.

101.5 No change

101.7 No change

101.9 No change

101.12 No change

101.13 No change The minimum safe operating distance from un-involved persons could be placed here.

101.15 No change

Sub part E Title should be changed to replace Remotely piloted aircraft with Model Aircraft.

101.201 No change

101.202 Should make it clear that the Director will issue a certificate of qualification to an approved organisation.

101.203 No change

101.205 Requires re-writing to:

101. 205

(a) A person operating a model aircraft from an aerodrome as listed in AIPNZ, or within 4km of an aerodrome boundary must:

i. Be the holder of, or be under the direct supervision of the holder of, a pilot qualification issued by an approved organisation or hold a pilot licence or certificate issued under Part 61 or Part 149.

ii. Have an observer in attendance.

iii. Have permission from the aerodrome operator or, in the case of a controlled aerodrome the relevant ATC unit.

(b) A person operating a free flight aircraft within 4km of an aerodrome boundary must ensure that the aircraft is launched downwind of an active runway.

(c) A person must not operate a model aircraft, a control line model aircraft or a free flight model aircraft on or over any active movement area of an aerodrome or any active runway strip.

101.207 Requires re-writing

101.209 No change. The paper does not explain any problem that requires a re-write.

101.211 No change

101.213 No change

101.215 No change. The paper does not explain any problem that requires a re-write. The meaning of aircraft mass is already defined elsewhere.

Questions - Basic pilot qualification

Q.1 Should we introduce basic pilot qualification for Part 101 drone pilots?

We should examine overseas experience and whether it has any benefits. The proposed Basic Pilot qualification is a lower standard than the MFNZ Achievement scheme Basic level and thus of no relevance to members.

Q.2 What impact would a basic pilot qualification likely have on you?

Q.3 What format should this test take?

a. Electronic/online theory test

b. Paper based written theory test (at a provider)

c. A practical examination of skill and a paper based written theory test (at a provider)

d. Other

Q.4 Should there be a minimum age for basic pilot qualification?

Q.5 Do you agree with the proposed special authorisations given to Part 141 and Part 101.202 approved training organisations?

Q.6 Is there any other special authorisations you would like to see? Why?

Questions - Drone registration

Q.1 Should we introduce the proposed drone registration system? Why?

We should examine overseas experience and whether it has any benefits. There is no justification for the model aircraft owned by MFNZ members requiring to be notified to CAA. Such a system would be burdensome when, on average, each member owns more than 20 aircraft and produce no benefits.

Q.2 What impact would drone registration likely have on you?

Q.3 What do you think of the proposed system design (e.g. digital platform) and requirements (e.g. identity authentication)?

Q.4 Should there be a minimum weight threshold for registering a drone? If so, is 250 grams appropriate? If not, what would be an appropriate weight threshold and why?

The definition of Drones and Model aircraft should have a 250gm lower threshold and thus all of these measures would not relate to them.

Q.5 Should certain drones not need to be registered (such as drones flown solely indoors or within specific designated areas (e.g. Model Flying New Zealand sites) from registration? What other drones should not need to be registered and why?

The paper has invented the concept of designated areas for model aircraft flying. It then confuses them with Danger areas. Rule 101.207 refers to airspace in use before 2015. This is quite a different concept. We are not aware of any other airspace user that is confined to operating in specific areas. Gliders, Hang gliders, Balloons and General Aviation are able to operate anywhere that it is safe to do so. This includes taking off, overflying and landing. This principle should also continue apply to model aircraft.

Questions - Remote ID

Q.1 Should we consider introducing Remote ID? Why?

Q.2 What impact would Remote ID likely have on you?

This topic is of no relevance to MFNZ. Remote ID equipment would be a considerable cost burden to operators, be totally impractical in many cases and produce no benefits.

Questions - Geo-awareness

Q.3 Should we consider introducing geo-awareness? Why?

Q.4 What impact would geo-awareness likely have on you?

This topic is of no relevance to MFNZ. Geo awareness/fencing/ caging equipment would be a considerable cost burden to operators, be totally impractical in many cases and produce no benefits

An assessment of the threat to airliners from small drones in the United Kingdom

(Including the mitigating effects of SERA implementation)

Author: Cliff Whittaker
Date: 20th May 2019

Summary

1. This report uses CAP1627 "Drone Safety Risks: an assessment" and the speed restrictions imposed by the implementation of the Standardised European Rules of the Air (SERA) as the basis for an assessment of the threat that small drones pose to airliners only (excluding consideration of the threat to smaller aeroplanes and helicopters). This assessment concludes that the most severe consequences of a collision between an airliner and a 2kg drone below 10,000ft are the shutting down of one engine or the obscuration of the view through one windscreen. Neither of these events would be a significant threat to the safety of the airliner.

2. This report also presents a basic analysis of the probability of occurrence of collisions between airliners and small drones. It is predicted that the general risk of collision with drones of up to 2kg when flying below 10,000ft altitude is that they will occur less frequently than 1 every 27 years on average. For the specific case of a drone operating within 500m of an airport runway the method predicts a collision frequency of one in every 2,700 take-offs/landings that take place whilst the drone is present.

3. This review concludes that the threat that small drones pose to airliners is economic damage to the operators, not a threat to flight crew or public safety. It is therefore suggested that the management of the drone risk could be delegated to aircraft operators. i.e. When the alleged presence of a drone is reported in airspace with the potential for proximity with airliners, rather than a blanket closure of that airspace being enforced, the information could be passed to the aircraft commanders who could react in accordance with the policies laid down by their airlines.

Introduction

4. In 2018 the UK Civil Aviation Authority (CAA) published CAP1627 – "Drone Safety Risks: an assessment". That document presents information and analysis on the potential consequences of collisions between manned aircraft and small drones. Whilst the main body of CAP1627 identifies that the level of protection of light aircraft and helicopters against the effects of a drone collision is lower than for large aeroplanes (airliners), the conclusions and declared actions do not make that distinction. This is significant because the general application of the findings of CAP1627 for all categories of aircraft may mean that the measures taken to address the threat from drones are disproportionate for large aeroplanes. For example, is it appropriate to close an airport because of the presence of a small drone that may be a significant hazard to light aeroplanes and helicopters, but presents a much lower risk to the safety of an airliner?

A factor that is not mentioned in CAP1627 is that the implementation of the Standardised European Rules of the Air (SERA) imposes a speed limit of 250kts throughout the UK on all civilian aircraft when flying below 10,000ft. This restriction defines the maximum speed for any impact with a drone below 10,000ft.

This report reviews CAP1627 as it applies to large aeroplanes only. The objective is to provide a realistic assessment of the threat that irresponsible or reckless operation of small drones may pose to airline operations. As the threat is from those who are ignorant of the rules or will deliberately disregard them, the analysis takes no credit for airport Flight Restriction Zones nor the general prohibition on flying drones above 400ft.

The potential for small drones to cause damage to large aeroplanes (airliners)

5. Paragraph 2.33 of CAP1627 states:

   "....these factors lead the CAA to consider that the likelihood of drone collision with other aircraft is highest in relation to small drones operated by recreational users. Given the cost and mass relationship in Figure 2, it is further considered likely that the majority of recreational small drones will be of less than 2kg mass. This is the category of drone covered by this assessment."

6. The severity of the damage that may be caused by a collision with a bird, drone, or any other object is primarily dependent upon the kinetic energy of the impact, which is proportional to the mass of the object and to the square of the impact velocity.

   Documents issued by NATS concerning the implementation of the Standardised European Rules of the Air advise that the Class A airspace around Heathrow (and presumably any other airports) is being changed to Class D. When that change is made all lower level airspace in the UK will be Class D, E or G. This means that there will be a maximum speed limit throughout the UK of 250kts for all civilian aircraft flying below 10,000ft. CAP1627 says that 95% of drone related airprox reports are for altitudes below 10,000ft. It follows that the case that should be considered when assessing the risk of a drone collision is a drone mass of up to 2kg and a velocity not exceeding 250kts.

7. As part of the type certification process for large aeroplanes the aircraft design organisations must satisfy the regulators that their products can continue safe flight and landing following an impact with a bird, typically a 4lb (1.82kg) bird at a speed that is defined by the design cruise speed of the aeroplane (Vc). As noted in CAP1627 this 'bird impact speed' is typically 340kts.

8. For a given object mass, lowering the impact speed from 340kts to 250kts results in a large reduction in kinetic energy. The kinetic energy of a collision with an object with a mass of 2kg at 250kts will be only 60% of the kinetic energy of the 4lb bird impact design case. The conclusion to be drawn from this is that a collision with a 2kg drone would not be expected to inflict more than superficial damage to an airliner flying below 10,000ft in UK airspace. The change in kinetic energy level for the reduced maximum impact speed is so great that this conclusion is considered valid, even allowing for the statement in CAP1627 that:

   "... the CAA recognises, and the recent FAA modelling work suggests, that the design and materials used in drone construction are likely to mean that drones cause more damage than birds for equivalent impact levels".

9. The first conclusion of this assessment is that the most likely collision with a drone - up to 2kg and below 10,000ft - will be at a kinetic energy level that is less than 60% of the bird impact design case for airliners and so should not cause damage to the aircraft that would degrade its airworthiness. It is only collisions above an altitude of 10,000ft with a 2kg drone that may potentially cause damage that could degrade the structure or systems of an airliner.

The probability of a collision

10. Figure 5 in CAP1627 presents the probability of a sighting/conflict with a drone at speeds between 304kts and 340kts. CAP1627 summarises the analysis as follows:

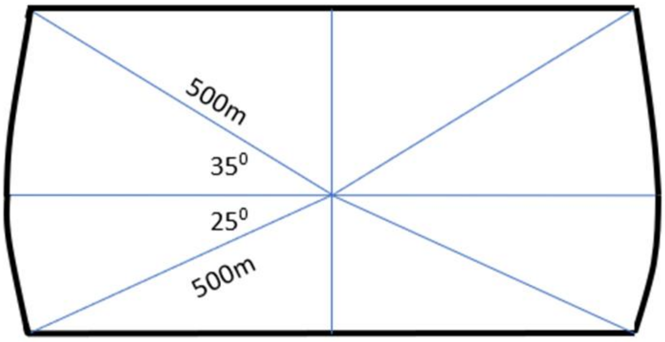
> *"....the probability of a passenger airliner experiencing a drone in proximity whilst above 340kt and at or below 12,000ft in the London TMA was about $2x10^{-6}$ per flight. This equates to a probability of two drone proximity incidents above the velocity to which airliner windscreens are certified per million aircraft flights".*
>
> *"A proximity incident is far more likely than a collision. Furthermore, proximity reports relate to all areas of the aircraft and not just the windscreen. It therefore follows that the estimated probability of a drone collision damaging an airliner windscreen, and causing immediate harm to the crew (resulting in subsequent harm to passengers or third parties) is, at present and based on this data, very much lower than the probability of a drone being in proximity of an aircraft".*

11. CAP1627 does not offer any estimate for the probability of a collision or of an airliner being in proximity with a drone below 10,000ft. A method based on pilot field of view and aircraft size has been developed by the author to provide estimates of the probability of proximity below 10,000ft and of the probability of collision below 12,000ft.

<u>Method</u>

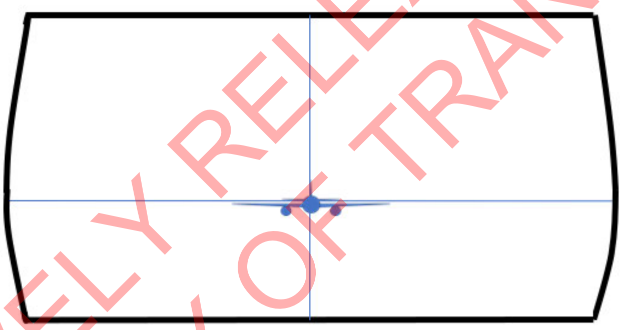
12. For this analysis it is assumed that the velocity of a drone is negligible compared with the velocity of the aircraft (as is assumed for bird impact) and that the maximum distance for the visual detection of a small drone is 500m (the limit applied by the CAA for Visual Line Of Sight operation of drones). It is further assumed that the words 'a drone in proximity' in CAP1627 mean a drone that comes within 500m of the aircraft and within the field of view of the flight crew.

13. Based upon the FAR 25 AC 25.773 "Pilot Compartment View, Design Considerations" and data obtained for a modern in-service airliner, the typical field of view from the cockpit for each pilot is up to 25^0 downwards, 35^0 upwards and 120^0 to each side. The area of sky ahead of the aircraft within which the pilots will be able to see a drone as the aircraft moves forward will be the forward projection of this cockpit field of view. See Sketch 1. This projected field of view has an area of $430,000m^2$; ($Area_{FoV}$)



Sketch 1
The area ahead of the aircraft within which a drone will come into the view of either or both pilots

For a collision to occur a drone would have to be aligned with the frontal area 'footprint' of the aircraft; $Area_{A/C}$. See Sketch 2.



Sketch 2
For a collision the drone would have to be located within the aircraft outline.

The probability of a collision with the aircraft is then the probability of a drone being within the field of view area multiplied by the frontal area of the aircraft and divided by the projected field of view area.

i.e.
Collision probability = Probability of entering field of view area x ($Area_{A/C}$ / $Area_{FoV}$)

If the probability of a drone entering the field of view area is known, this formula can be used to calculate the probability of a collision with:

- any part of the aircraft (by using the total frontal area of the aircraft);
- the cockpit area (by using the fuselage nose cross-section as the frontal area); or
- any engine (by using the sum of the nacelle intake areas of the engines as the frontal area).

According to the formula the likelihood of collision increases with aircraft size. Therefore, for this analysis, the frontal areas have been estimated for the largest airliner currently in service, the Airbus A380. The Field of View Area is 430,000m^2. See Table 1 for the ratios of frontal areas to Field of View Area.

	Frontal area - m^2	$\frac{Area_{A/C}}{Area_{FoV}}$	$\frac{Area_{FoV}}{Area_{A/C}}$
Complete Aircraft	158	0.00037	2,700
Cockpit (fuselage nose)	39	0.00009	11,000
4 Engines	50	0.00012	8,600

Table 1 – Area Ratios

Table 1 implies that only 1 in 2,700 drone encounters will result in a collision with any part of the A380 aircraft. For the cockpit area the figure is 1 collision in 11,000 encounters. For any of the four engines it is 1 collision every 8,600 encounters. As the A380 is the limiting case, these area ratios will be used as the basis for calculations in the remainder of this document; calculated collision frequencies for smaller aircraft will be correspondingly lower.

<u>The probability of a collision at or above 340kts (between 10,000ft and 12,000ft)</u>

14. In CAP1627, the CAA estimates that there will be two drone proximity incidents per million flights at airspeeds of 340kts or higher. CAP1595 “Aviation Safety Review 2016” states that there are 2.4 million flights per year in UK airspace. Combining these two figures implies 4.8 drone encounters per year at speeds of 340kts or higher. Using this encounter rate with the area ratio formula given above we should expect the collision rates to be:

0.0018 per year or 1 per 560 years for a collision with any part of the aircraft;
0.0004 per year or 1 per 2,300 years for a collision with the cockpit area; and
0.0006 per year or 1 per 1,700 years for a collision with any one of the 4 engines.

So, this method predicts that collisions at speeds that could cause damage that is comparable to a critical bird impact will occur at intervals of several hundred years. Even if this crude method is wrong by a factor of 10, we should still expect such collisions to occur no more frequently than 1 every 50 years.

In this context it is noteworthy that the Department for Transport publication “Aviation 2050” quotes a Fatal Accident Rate (due to all causes) of 0.2 per million flights for European airlines. According to CAP1595 “UK Aviation Safety Review for 2016”, UK airlines complete 1.2 million flights per year. Together these figures imply that the statistical level of safety for UK airline operations is a probability of one fatal accident every 4.2 years on average. The probability of collision with a drone at high speed is insignificant compared with the overall probability of a fatal accident involving a UK-registered airliner due to all causes.

<u>The probability of a collision below 10,000ft at up to 250kts.</u>

15. The number of UK airprox reports from all sources (commercial and general aviation) concerning objects that may be small drones has risen to a level of around 100 per year. Using an encounter rate of 100 per year with the area ratio method set out above gives expected collision rates of:

0.037 per year or 1 per 27 years for a collision with any part of the aircraft;
0.009 per year or 1 per 111 years for a collision with the cockpit area; and
0.012 per year or 1 per 83 years for a collision with any one of the 4 engines.

So, the collisions at speeds below 250kts (which should not cause harm to passengers in aeroplanes that are designed to withstand a 4lb bird impact at 340kts) are also predicted to be extremely rare.

Does this method give credible estimates?

16. There are about 100 UK airprox reports per year from all sources (commercial and general aviation) concerning objects that may be small drones. Combining an annual rate of 100 alleged drone reports with 2.4 million flights per year in the UK, gives a probability of encountering a drone below 10,000ft as 41 encounters per million flights. The total number of commercial flights worldwide is approximately 35 million per year. Combining those two figures suggests a worldwide drone encounter rate of 35 x 41 = 1,435 per year. Applying the area ratio method above to that figure gives a predicted rate of 0.53 collisions per year for impact with any part of a commercial aircraft. That implies that there will be one collision between a drone and an airliner somewhere in the world about once every 2 years.

Given that multi-rotor drones have been widely available to the public for about 5 years this method predicts the occurrence of between 2 and 3 collisions between drones and airliners worldwide in that time period. That estimate is consistent with the statement in CAP1627 that:

"At the time of writing there have been seven confirmed cases of direct in flight contact between drones and civil or military manned aircraft worldwide."

(The 7 confirmed collisions will include all categories of civil aircraft, not just airliners, plus military aircraft).

The calculation method is sensitive to the assumptions of maximum visual range (500m) and the probability of encountering a drone. If we take a very conservative view and assume that pilots will first see a drone at a distance of only 300m and that they currently see and report only 1 in 5 of the drones that actually come within 300m of the aircraft, the calculations for an aircraft flying below 10,000ft would be based on a Field of View Area of 155,000m^2 and 500 drone encounters per year. Using these values, the predicted collision rates would be:

0.515 per year or 1 every 2 years for a collision with any part of the aircraft;
0.125 per year or 1 every 8 years for a collision with the cockpit area; and
0.167 per year or 1 every 6 years for a collision with any one of the 4 engines.

It is considered that these collision frequencies are still acceptable for impacts at only 60% of the kinetic energy of the bird strike design case; particularly when compared with the Fatal Accident Rate for commercial flights by European operators.

Alternatively, one could take the contrary view that the annual number of drone encounters in the UK is less than 100 because pilots may be mistakenly reporting airborne debris or distant manned aircraft as drones, and so are over-reporting. If that were the case then the predicted frequency of collisions would be proportionately lower than calculated in paragraph 15 above.

The probability of a collision at an airport

17. The estimates calculated above rely on the accuracy of the figure for the probability of a drone coming into the field of view of the flight crew. If we take the case of airliners operating from a runway at a time when a drone is being flown deliberately within 500m of that runway, the probability of the drone entering the field of view will be unity – i.e. it will always be there. For that scenario the method gives the following estimated collision rates:
   - 1 collision with any part of the aircraft every 2,700 take-offs/landings;
   - 1 collision with the cockpit area every 11,000 take-offs/landings; and
   - 1 collision with any 1 of 4 engines every 8,600 take-offs/landings – (for a twin-engine aircraft the rate is 1 collision with an engine every 17,200 take-offs/landings).

This calculation assumes that the drone will be in a random position within 500m of the runway. This is consistent with it being operated irresponsibly, but without the intent of colliding with an airliner. Clearly, if the drone pilot is trying to cause a collision, the likelihood of impact will be greater, but the severity of such a collision will be very low because airliner speeds during final approach to land and initial climb after take-off are less than 200kts. The kinetic energy of any impact with a 2kg drone at 200kts or less will be less than 35% of the bird impact design condition and therefore no damage should result from any collision. The most severe consequence would be a 'turn back' and precautionary landing for a departing aircraft to inspect for damage – assuming that the collision was noticed by the crew.

What damage could a drone of up to 2kg mass cause in a collision at a velocity not exceeding 250kts?

18. Given the very significant mitigating effect of the 250kt speed limit it is considered worth reviewing the potential damage that could be caused to an airliner in a collision with a 2kg drone - as discussed in CAP1627 – with this speed restriction applied.

19. **Windscreen and fuselage nose.**
Given that all airliner windscreens must comply with the bird impact certification requirements (1.82kg bird, circa 340kts) a 2kg drone would not be expected to rupture the windscreen of an airliner flying at 250kts. It is possible that a windscreen impact could cause damage that would make that particular screen unusable. But airliners have 6 windscreens and two of those screens (Direct Vision – DV – windows) can be opened below 200kts - to provide sufficient external reference (to be used in addition to the instruments) to land safely in the unlikely event that all 6 windscreens become opaque.

There are many reasons why a single airliner windscreen may become opaque – such as failure of the anti-icing system for that screen or adhesion of debris from a non-critical bird impact. It is inherent in the design of airliners that loss of vision through a minority of the windscreens will have negligible effect on continued safe flight and landing.

The nose radome could suffer localised damage from a drone impact, but this would not prejudice continued safe flight and landing.

20. **Engines**
CAP1627 reports the expert opinion of a leading turbine engine manufacturer that it is unlikely that the ingestion of a drone would significantly affect the ability of an engine to produce thrust; and extremely unlikely that drone ingestion would compromise the

ability of the engine to shut down safely. So, the most severe consequence of a drone being ingested by an airliner engine would be the necessity to shut down the affected engine.

As is recognised in CAP1627, compliance with the Type Certification requirements for large aeroplanes assures continued safe flight and landing following sudden, complete and unrecoverable loss of thrust from any one of the engines at any point during a flight. Indeed, flights over the world's oceans by twin-engine aeroplanes are predicated on evidence that, following the failure of one engine, the aeroplane will continue to fly for at least 3 hours and land safely using the remaining engine.

21. **Wing and tailplane leading edges**
It is not credible to believe that a drone collision at up to 60% of the kinetic energy specified by the bird impact requirements would cause significant damage to the leading edges of the wing or horizontal / vertical tail surfaces of an airliner.

22. **Landing Gear**
Landing gear components are amongst the strongest parts of the aircraft structure as they must withstand vertical landing loads and longitudinal wheel braking forces. The landing gear systems, including hydraulic and electrical components and all associated routing and moving parts, are designed and segregated to maintain functionality after impacts from birds, tyre debris (if a tread separates or a tyre deflates at high speed on the runway) and water impingement during landings on contaminated runways. It is considered extremely unlikely that any part of the landing gear of an airliner would sustain significant damage from a collision with a drone.

23. **High Lift Devices**
High lift devices are fitted to the leading and trailing edges of the wings. Leading edge devices (slats, Krueger flaps or leading edge droop) and trailing edge devices (flaps) are certified to the same bird strike requirements as the rest of the aircraft in both the retracted and deployed positions. A drone impact might cause superficial localised damage or at worst, jam the operation of the leading edge devices, but would not prejudice continued safe flight and landing.

24. **Primary Flying controls including spoilers**
Primary flying controls (other than the spoilers) are fitted to the trailing edges of the wings and the horizontal / vertical tailplanes. Due to their location they would not be expected to suffer any more than an insignificant glancing blow from a drone impact. Spoilers hinged from the upper surface of the wing that can be operated in flight are certified to the same bird strike requirements as the rest of the aircraft and a potential drone impact would not be expected to cause anything other than superficial damage. Furthermore, it is a Type Certification requirement for large aeroplanes that losing the use of a single control surface shall not compromise continued safe flight and landing. All airliners have multiple control surfaces actuated independently of each other by multiple power systems. i.e. There is multiple redundancy of control surface function. The failure or jamming of any single moving surface would have negligible effect on the ability of the crew to control the aircraft.

Loss of control / passenger injury caused by manoeuvring to avoid a collision.

25. CAP1627 lists as a threat the possibility that pilots may lose control of their aircraft through manoeuvring to avoid a collision with a drone, or that such manoeuvring may cause injury to passengers. However, CAP1627 offers no analysis to support this.

26. Assuming that a conflicting small drone can first be seen at a distance of 500m, the pilot of an airliner flying at 150-250kts has between 4 and 6.5 seconds to:

- see the drone;
- recognise that it is not moving laterally or vertically relative to the airliner and so presents a collision risk;
- take hold of the controls (as the aircraft will probably have the autopilot engaged); and
- initiate an avoidance manoeuvre.

This assumes that the pilot is looking directly forward with eyes focussed at infinity when the drone first comes within visual range.

Human vision gives optimum performance for detecting movement when an image moves rapidly across the retina of the eye; it is least effective when the image is stationary on the retina. This is unfortunate because, when two aircraft are going to collide, the angle of approach is constant and so the aircraft do not move across the pilots' fields of view. In the context of avoiding a mid-air collision the most demanding case for human eyesight is a threat from directly ahead because the image does not move and the closing speed is greatest.

27. Given the small size of the drones being considered here and airliner operating speeds in the range 150-250kts, it is considered extremely unlikely that pilots will see a drone that will hit or pass very close to the aircraft in time to initiate any avoidance manoeuvre. This is confirmed by several of the airprox reports submitted by airline pilots which include statements to the effect that 'there was no time to react'.

A comparison with the bird hazard is directly relevant here. Mid-size birds such as gulls are comparable in size to 2kg drones and are far more abundant; yet there is no history of loss of control or passenger injuries caused by pilots attempting to avoid colliding with them. Therefore, it is concluded that loss of control or injury arising from pilots manoeuvring the aircraft to avoid a collision with a drone is not a credible scenario and should be discounted.

Flight crew incapacitation

28. The analysis presented above justifies the conclusion that a 2kg drone collision at 250kts will not have sufficient kinetic energy to penetrate the windscreen of an airliner. The analysis also concludes that a drone impact in the region of the cockpit at 340kts (which could rupture a windscreen) will have a frequency of 1 every 11,000 years. However, as pilot incapacitation is highlighted in CAP1627, that issue is addressed here.

29. The first point to note is that, in addition to the windscreen strength requirements, the design certification requirements specify in CS/FAR 25.775(c) that:

> *"Unless it can be shown by analysis or tests that the probability of occurrence of a critical windshield fragmentation condition is of a low order, the aeroplane must have a means to minimise the danger to the pilots from flying windshield fragments due to bird impact."*

Thus, the design certification requirements include a level of protection for pilots from debris following windscreen rupture.

30. The second point is that pilot incapacitation is a frequent event that has minimal effect on the safety of aircraft that have more than one pilot in the cockpit. The report "Pilot incapacitation occurrences 2010-2014" published by the Australian Transport Safety Bureau may be found here:
https://www.atsb.gov.au/media/5768970/ar-2015-096-final.pdf

The summary of this report states:

> *"In the past 5 years, there have been 23 pilot incapacitation occurrences reported per year on average.*
> *Nearly 75 per cent of the incapacitation occurrences happened in high capacity air transport operations (about 1 in every 34,000 flights), with the main cause being gastrointestinal illness, followed by laser strikes. In the majority of the occurrences reported, the incapacitation was severe enough for the pilot to be removed from duty for the remainder of the flight. With multi-pilot crews in high capacity operations, these occurrences usually had minimal effect on the flight.*

75% of 23 incapacitation occurrences is 17 events in airline operations every year, or one pilot incapacitation aboard Australian-registered airliners every 21 days on average. Within the body of the report, in the context of airline operations, it is further stated:

> *"In less than 10 per cent of flights, a return to the take-off airport or diversion to another airport en route was initiated due to the severity of the incapacitation".*

31. The third point is that we have already had the most severe windscreen-related accident – British Airways flight BA5390 on 10th June 1990 – and the aircraft landed safely. Due to a maintenance error the captain's primary windscreen was not properly installed and the complete windscreen departed the aircraft as it was climbing through 17,300ft pressure altitude. The captain, who had released his shoulder harness and loosened his lap strap, was pushed half way out of the windscreen aperture by the cabin air as the aircraft depressurised. The first officer, who initially believed the captain to be dead, took control of the aircraft, diverted and completed a safe landing. In the event the captain survived and later returned to commercial flying. One other crew member suffered minor injuries. There were no passenger injuries.
The AAIB report may be found here:
https://www.gov.uk/aaib-reports/1-1992-bac-one-eleven-g-bjrt-10-june-1990

Whilst no-one would argue that the occurrence of events of this kind is acceptable, this incident serves to demonstrate that continued safe flight and landing can follow loss of a windscreen combined with pilot incapacitation and aircraft de-pressurisation.

Conclusions

32. The implementation of SERA means that the assessment of the risk of a drone collision should focus on a drone mass of up to 2kg and a velocity not exceeding 250kts. Such a collision would have a kinetic energy of less than 60% of the bird impact design case that is applied to the Type Certification of airliners and would not the expected to cause damage to the aircraft that would degrade its airworthiness. It is only for collisions above an altitude of 10,000ft that there is the potential for a 2kg

drone to cause damage that could degrade the structure or systems of an airliner. The probability of a collision above 10,000ft is predicted to be less than 1 every 500 years.

33. This review has found that the most severe consequences of a collision with a 2kg drone below 10,000ft are the shutting down of one engine or the obscuration of view through one windscreen. Pilots are tested regularly on their ability to respond correctly to sudden engine failure. The obscuration of view through one windscreen can be dealt with by simply transferring control of the aircraft from one pilot to the other. Thus, neither of these events would be a significant threat to the safety of the aircraft. The frequency of drone collisions with windscreens or engines below 10,000ft is predicted to be less than 1 every 80 years on average.

34. This report also addresses the likelihood and severity of an impact with a drone that is operating within 500m of an airport runway. The probability of collision is calculated to be 1 per 2,700 take-offs/landings during the period that the drone is operating, but the severity of such a collision would be very low because airliner speeds during final approach to land and initial climb after take-off are less than 200kts. The kinetic energy of any impact with a 2kg drone at up to 200kts will be less than 35% of the bird impact design condition and therefore no appreciable damage should result from any collision close to a runway. The most severe effects would be minor damage to one windscreen or loss of thrust from one engine, which would not be a threat to safety.

35. The threat that small drones pose to airliners is of economic loss, not a threat to the safety of either flight crew or the general public. i.e. A collision may result in the affected aircraft having to turn back or divert and be taken out of service for inspection and repair. But that is no worse than any inflight engine shutdown, bird impact, Foreign Object Damage, collision with a ground service vehicle, or indeed the failure of a component or system that must be repaired before further flight. Airlines cope with such issues every day. They cost the operators money, but there is no threat to aircraft safety. It is therefore suggested that the management of the drone risk (which is of economic damage) could be delegated to aircraft operators.

36. It is suggested that if the possible presence of a drone is reported where it could come into proximity with airliners, an alternative to closing the airspace or airport could be to give the aircraft operators that information. Operators could then implement their own measures for responding to the threat to their aircraft, such as:
   (i) Suspending all departures and diverting all incoming aircraft.
   (ii) Suspending all departures but allowing incoming aircraft to continue to land.
   (iii) As (ii) but requiring the pilots of incoming aircraft to fly at less than 200kts in the vicinity of the airport to reduce the severity of any impact.
   (iv) Continue with all scheduled departures and arrivals but with a speed limit below 200kts in the vicinity of the airport to reduce the severity of any impact.
   (v) Continue with all scheduled departures and arrivals as normal.

If an operator were to be very unlucky and a collision occurred the most severe outcome would be the return or diversion of a single aeroplane that would have to be taken out of service for inspection.

37. The overall conclusion is that the threat to the safety of the general public from the irresponsible operation of small drones causing conflict with airliners is negligible.

About the author:
Cliff Whittaker is an aeronautical engineer with 39 years of experience in aviation, comprising:

- 15 years working as an aerodynamicist and project engineer on the design and certification of airliners and business aircraft;
- 20 years working in civil aviation regulation, including rule-making and head of policy roles in design airworthiness and flight crew licensing;
- 4 years working on aircraft performance in a design research environment.

Military Aviation Authority
MAA

Rear Admiral P Chivers OBE RN
Director Military Aviation Authority

Military Aviation Authority
Juniper #5003,
MOD Abbey Wood North,
BRISTOL BS34 8QW
Military Network: 9679 84178
Telephone: 030 679 84178
Email: DSA-MAA-D@mod.uk
www.maa.mod.uk

Member Nations
North Atlantic Treaty Organization
STANAG 4703 and
STANAG 4746 Custodial Support Team

Reference:
20170726 – RPAS Collision Study
Release of Results

27 Jul 2017

REMOTELY PILOTED AIR SYSTEMS (RPAS) MID AIR COLLISION (MAC) STUDY RESULTS

1. You are receiving a copy of the enclosed report as an interested organisation with responsibilities for aviation safety.

2. I would like to draw your attention to the security classification of the document. A classification of Official-Sensitive has been applied which means that the information could have potentially damaging security consequences if it were lost, stolen or published in the media. Specifically for this document, the combination of RPAS masses and speeds could be used for malicious purposes to deliberately endanger aircraft.

3. The purpose of the Official-Sensitive classification is to emphasise the need to control distribution to those with a need to know, which has been defined for this work as the organisations listed in the Additional Release Conditions of the report. The report may be replicated and distributed internal to members of the receiving organization who have a need to know, but must not be distributed externally. The document must be protected in such a way as to prevent release.

4. The UK Official-Sensitive classification is equivalent to EU Restricted and Sensitive Security Information (SSI) in the US.

5. Thank you for your understanding and cooperation with these handling instructions. I would appreciate it if you could reply, by email, confirming receipt of the report and your agreement with the conditions for handling it.

Yours sincerely,

Paul Chivers
Rear Admiral RN

//signed electronically//

Enclosure:

1. QinetiQ/17/01224/1.0, Small RPAS Collision Study – Final Report, dated 10 Apr 17.

Handling Instruction: Not to be distributed outside the organisations listed in the Additional Release Conditions section of the enclosed QinetiQ report. Recipients must ensure the protections around Official Sensitive are fully enforced. Guidance on this can be found in Government Security Classification Scheme; Industry Security Notice Number 2014/01.

Small RPAS Collision Study

Stakeholder Report Summary

10 April 2017

Military Aviation Authority MAA

BALPA

Department for Transport

UAS CDC

Enclosure: QinetiQ/17/01224/1.0, *Small RPAS Collision Study – Final Report*, dated, 10 Apr 2017.

Report Summary

REMOTELY PILOTED AIR SYSTEMS (RPAS) MID AIR COLLISION (MAC) STUDY

Introduction

1. The Military Aviation Authority (MAA), the British Airline Pilot's Association (BALPA) and the Department for Transport (DfT), hereafter referred to as the Stakeholders, have conducted a 14-month study to better understand the risks that RPAS may pose to manned aviation. Specifically, this study focussed on the severity of a Mid Air Collision (MAC) between small RPAS and manned aircraft components.

Scope

2. The Stakeholders undertook this study to address the following issues:

a. The Stakeholders regularly receive comments and feedback from aircrew regarding the importance of gaining a better understanding of the MAC risk of RPAS, to determine the most appropriate way forward with regard to enforcement and regulation. In order to make a complete assessment, a quantitative analysis of RPAS MAC severity was required.

b. Current MAA regulation for RPAS operation in the UK military[1], establishes the harmless threshold[2] at 200g; below this threshold RPAS are not subject to any MAA oversight activity. The MAA required investigation as to whether this threshold is set too low, which could allow it to be raised and alleviate some of the regulatory oversight on slightly heavier RPAS types.

c. Whilst much is already understood about the degree and type of damage likely to be caused to aircraft structures by a bird strike, little is known about the potential risks presented by RPAS to manned aircraft. The Stakeholders were brought together by a shared interest in gaining a greater understanding as to what extent damage caused by collision with an RPAS can be equated to that caused by a birdstrike.

d. The MAA and DfT play a critical role in balancing proportionate and pragmatic safety requirements for the vast number of RPAS types available on the market without hindering emerging RPAS operation and technology. BALPA's first-hand experience, involving an increasing frequency of near-misses with drones, highlights a key concern that airline pilots have for the safety of crew and passengers. BALPA is therefore keen to support the DfT and the MAA in their mandate to assure safety by influencing requirements such as minimum design and operational standards for RPAS. This study serves to inform the Stakeholders whether a significant risk is present, and whether further work should be completed to fully understand how design requirements for RPAS could mitigate against the severity of a MAC should it occur.

---

[1] RA 1600 – Remotely Piloted Air Systems
[2] The weight threshold at which damage to property, or injury to people, is highly unlikely.

e. Whilst risk is the combination of the probability of the event occurring and the severity of that event, this study served to inform only the hazard severity of an RPAS MAC with a manned aircraft. This will help to inform the overall risk picture of a MAC between an RPAS and a manned aircraft.

3. Scoping of this study required consultation with design organisations, international regulators, engineers, operators and industry experts. To consolidate, organise, and scope this project was a significant task which was greatly assisted by the Unmanned Air System Capability Development Centre (UASCDC) within MoD. The UASCDC were instrumental in guiding the tender process, following which they project managed the study to the final delivery of the enclosed report. QinetiQ and Natural Impacts were chosen by the Stakeholders to conduct the study. Both organisations have a wealth of experience in their respective fields, and are highly regarded organisations who conduct studies for Defence, international companies and regulators. They also have first-hand experience with birdstrike testing and impact modelling.

Modelling and Testing

4. In setting the requirements for the study, the Stakeholders analysed the market and took a considered approach in selecting RPAS classifications and manned aviation components to be used. After considering the types and sizes of RPAS in use it was decided that the four different classes of RPAS chosen to reflect the most common RPAS configurations currently in use by leisure and commercial RPAS operators would be;

a [redacted]

[redacted] [redacted]

The selection of manned aircraft components, to model and test, was significantly more challenging. Extensive consultation needed to be undertaken; there was also a need to balance the practicalities of testing, timescales, availability of hardware and available funding. Based upon these considerations, the manned aircraft components selected were:

a. Rotary Wing – non-birdstrike certified windshields (NBCW helicopter)

b. Rotary Wing – birdstrike certified windshields (BCW helicopter)

c. Rotary Wing - tail rotor blades

d. Fixed Wing – birdstrike certified large commercial aircraft windshields (CS-25)

5. Experimental techniques were developed that enabled projectiles, [redacted], to be launched over the full range of typical in-service collision velocities. It is important to note that the mass of these representative projectiles was less than the nominal mass of the RPAS class type. As this was believed to be the first time such a comprehensive RPAS modelling and testing study had been undertaken, key decisions regarding experimental method needed to be taken by the Stakeholders and QinetiQ. One critical decision was to select only key components [redacted] This decision maximised the opportunity to

focus on the RPAS components of most significance in an impact. This led to a simplification of the modelling and the representative test items.

6. Use of impact-modelling software can provide additional insight into the mechanism of failure, and can enable a wider range of impact conditions to be considered, but to do so reliably requires that the models be calibrated and validated by experimental tests. This calibration and validation activity was at the centre of the study's requirements. The scope of the project included development of equivalent material models [redacted] However, there was insufficient scope for detailed calibration of material and failure models for the windscreens. It was therefore necessary to rely upon data gained from literature reviews and by conducting a small number of calibration impacts on windshields.

7. Despite the technical challenges associated with calibration, predicting the failure response of glass structures, the complexity of the RPAS configurations and with the dearth of information that was initially available, the modelling activities produced strong correlation with the physical tests of the two helicopter windshields. The results for the large commercial passenger aircraft windshield correlated less strongly for the particular collision conditions examined.

8. It should be noted that the velocities modelled and tested represent closing speeds of the aircraft and RPAS. For a Quadcopter RPAS and Fixed-Wing RPAS, a typical true airspeed (TAS) of approximately 20kts and 50kts, respectively, was assumed. Furthermore, when considering practical implications of the results with respect to operational speeds of an aircraft (climb, cruise and approach speed for example) it is important to note that an aircraft is flown by reference to an Indicated Airspeed (IAS) in knots (nautical miles per hour) as shown by the aircraft instruments, rather than the True Airspeed (TAS) i.e. actual speed of the aircraft through the air. The difference between IAS and TAS of an aircraft increases by approximately 2% per 1000ft altitude. For example, an aircraft at 10000ft altitude being flown at IAS of 250kts will equate to a TAS of approximately 300kts. The speeds referred to in the results are therefore equivalent to the TAS of an aircraft.

Results

9. Prior to conducting this research, the resistance of aircraft components (particularly windshields) to an RPAS strike was open to considerable speculation. An important finding from the extensive literature review (which was reinforced throughout this test and modelling study) indicated that the damage created from such a collision is not determined solely by the mass and velocity of the object, but also by the shear properties of the impactor. [redacted] For this reason, it is not possible to equate the damage caused by a RPAS to the damage caused by the equivalent mass of bird.

10. [redacted]

11. [redacted]

[redacted]

12. The large commercial passenger aircraft windshields (CS-25) were shown to be resistant to the [redacted]

13. The modelling results for the NBCW and BCW helicopters proved to be strongly correlated to the test data, [redacted]. The model predictions for the more-complex CS-25 aircraft windshield produced results which tended to predict damage at lower velocities for the types of collision and failure modes observed in testing. Although some discrepancies were likely to be due to the idealisation of the RPAS components, the greatest discrepancies were probably due to the idealisation of the windshield models: particularly the interlaminar failure-models and the material-properties and failure-model for the glass. Further work is recommended to reduce these discrepancies, particularly further calibration of windshield material and failure models. [redacted]

14. The helicopter tail rotor model considered a collision between a [redacted] It was not possible to conduct any testing of the tail rotor scenario within the scope of the project.

15. This study has resulted in a significant increase in knowledge regarding the severity of a MAC between a manned aircraft and an RPAS. It is therefore helpful to summarise the most important points below:

a. As further described below, a number of factors contributed to the extent and severity of the collision. The design and construction of the RPAS is significant, for example, [redacted] Energy absorption, frangibility and separation-of-masses within the RPAS should be further studied [redacted].

b. The orientation of the projectile and the incidence angle of collision demonstrated that, in some cases, collisions were attenuated [redacted] The leading components also absorbed some of the collision energy as they struck the windshield first and fragmented before the central mass of the RPAS struck the windshield.

c. A key requirement of this study was to understand whether a comparison could be drawn between birdstrike damage certification criteria and resistance to damage caused by RPAS impact. [redacted]

- Birdstrike-certified helicopters at speeds [redacted]
- Large commercial aircraft up to typical arrival speeds of [redacted]

Thus, the birdstrike comparison was partially realised. [redacted]

d. A non-birdstrike-certified helicopter windshield has a high degree of vulnerability to an RPAS strike. [redacted]

e. The birdstrike-certified helicopter windshield shows significant resistance a[redacted] It is therefore likely that if a such a windshield was struck by a 1.2kg Class RPAS at less than [redacted] the windshield would remain largely intact, potentially protecting the pilot from the RPAS penetrating the windshield and entering the cockpit. Collision [redacted]

f. [redacted]

g. This study, supported by data gathered from similar experiments analysed during the literature review, showed equivalent damage was caused by an RPAS [redacted] under the same collision conditions.

h. The component testing showed that [redacted] had a significant effect on lowering the impulse load during the strike.

i. [redacted]

Conclusions

16. The following conclusions are drawn from the RPAS Collision Modelling and Test Study:

a. Birdstrike collision data does not correctly characterise collision with an RPAS; [redacted] than would a bird of similar mass.

b. There is a diverse range of RPAS products on the market, with numerous configurations available. [redacted]

c. Within the limited scope of this study it was not possible to achieve a higher degree of confidence in the correlation between the modelling and testing of the CS-25 large-aircraft windshields, the modelling delivering apparently more conservative results than when testing. The brittle nature of the windshield materials and the complexity of the interlaminar failure-mechanisms were likely contributing factors. Incomplete calibration of the test components and the reduced mass of the projectile representing the RPAS may have also been contributing factors. When assessing the test results, it is important to recognise that penetrating and non-penetrating impacts generally exhibit very different failure modes and that; the transition between these modes is typically sudden once the critical energy/speed is reached. In non-penetrating impact, the shear-forces around the perimeter of the projectile are insufficient to punch a hole, hence kinetic-energy is transferred to the screen. [redacted]. This suggests that modelling of penetrating impacts might be less sensitive to uncertainties related to the modelling of the glass and its lamination.

d. Strong correlation was obtained between the model and the test for the NBCW, and the BCW helicopter, which provides a good indication of likely damage at varying speeds. This implies that modelling may be a useful tool for predicting the performance of other impact scenarios for these classes of windshield.

e. [redacted]

f. [redacted]

g. Unlike a birdstrike, the aviation industry is only beginning to understand the risks of RPAS. This report considers the severity and nature of damage due to an

RPAS collision the windshield of manned aircraft. It does not consider the likelihood of collision which would also be needed to fully determine the overall risk. There are currently significantly fewer RPAS than birds; however, it has been shown [redacted]

h. As a result of this work the operators and designers of both manned aviation and RPAS will have a much better idea of the outcomes of a MAC between the two. This information provides sufficient evidence to allow consideration of potential actions that could be taken to perform an assessment of the risks, and where appropriate make changes in regulation, design or operation of RPAS to reduce the likelihood or severity of any collision.

Recommendations

17. The study Stakeholders are considering the following recommendations as a result of this study:

a. It is recommended that the results of the current study are used to help inform risk assessments for aircraft operations. In particular, [redacted], the vulnerabilities in the event of an MAC with an RPAS should be taken into account and appropriate operational mitigation measures should be considered.

b. This project does not consider the likelihood of a MAC. In order to understand the full risk picture and develop risk-appropriate mitigations, it is recommended that a better understanding of the likelihood of a collision is developed.

c. It is recommended that consideration is given, where complete information was not available on characteristics of some components, to improving this information. This could increase confidence in the results of this study and future work. In particular, improved understanding of the characteristics of windshields and their lamination could help to explain some of the discrepancies between modelling and testing results for non-penetrating impacts (the modelling showed better correlation with testing for penetrating impacts).

d. It is recommended that consideration is given to further research into RPAS frangibility and energy absorption with a potential end state being the implementation of a design requirement for civil and military RPAS.

Small RPAS Collision Study - Final Report

Copy 4 of 5

Bill Austen, Dr Steven Lord, Dr Roger White*, Richard Purver*, Simon Bridges & Kieran Wood
** Natural Impacts Limited*

QINETIQ/17/01224/1.0

10 April 2017
127 pages

Requests for permission for wider use or release must be sought from:
Hazel Chiles – Commercial Manager
QinetiQ Ltd
Cody Technology Park
Farnborough, Hampshire
GU14 0LX

Administration Page

Customer Information	
Customer reference number	N/A
Project title	Small RPAS Collision Study
Customer Organisation	UASCDC
Customer contact	Kevin Griffiths UASCDC
Contract number	MAA Contract HOCS1c/0024 and BALPA Purchase Order No 6155G
Milestone number	D9
Date due	10 Apr 2017

Principal Author	
Bill Austen, Dr Steven Lord, Dr Roger White*, Richard Purver*, Simon Bridges & Kieran Wood	+44 (0)1252 394553
G069-A7, Cody Technology Park, GU14 0LX, UK	[redacted]

Technical Approval	
Name	Andrew Foreman
Post	Chief Engineer – Air Research
Signature	

Additional Release Conditions

Permission is granted for this document to be distributed to the organisations detailed below. Requests for permission for wider use or dissemination should be made to Hazel Chiles – QinetiQ, Commercial Manager.
Civil Aviation Authority (CAA)
European Aviation Safety Agency (EASA)
International Civil Aviation Organisation (ICAO)
The International Federation of Air Line Pilots Associations (IFALPA)
European Cockpit Association (ECA)
European Defence Agency (EDA)
NATO RPAS Working Group
Federal Aviation Administration (FAA)
Vereinigung Cockpit
Transport Canada

Release Authority	
Name	David Bush
Post	Project Manager
Signature	

Record of changes

Issue	Date	Detail of changes
1.0	10 Apr 2017	First Issue

Executive Summary

A programme of work has been completed to evaluate, via analysis and full-scale testing, the impact threat posed by small Remotely Piloted Air Systems (RPAS) to manned aircraft. The work was contracted through the Unmanned Air Systems Capability Development Centre (UASCDC) in close collaboration with the Stakeholders: Military Aviation Authority (MAA), the British Airline Pilots Association (BALPA) and the Department for Transport (DfT).

Within this programme, a sequence of research, development, manufacture and test activities have been undertaken to deliver a set of high-value results and develop a capability for the assessment of this emerging and high profile perceived threat to aviation safety.

Prior to this study, the effect of a small RPAS colliding with manned aircraft structures was subject to much speculation and opinion, but very little substantiated evidence existed. The results of this study provide a step change in knowledge and capability that will support the Stakeholders in making informed and balanced decisions/recommendations on future legislation, aircraft operations, operational airspace management, design standards and research requirements.

[redacted]

[redacted]

Despite the technical challenges associated with modelling the failure response of glass structures, the complexity of the RPAS configurations and the dearth of information that was initially available, the modelling activities consistently produced accurate results against the collision tests.

A key factor in the success of this activity was the incremental validation approach, making best use of available testing facilities and aircraft/RPAS hardware assets, to progressively de-risk and guide the model development.

The modelling results for rotorcraft windshields proved to be exceptionally accurate [redacted]. The predictions for the thicker, more-complex airliner windshields produced overly-conservative results; this can be attributed, in part, to known simplifications to the RPAS material models and suspected differences in the construction of the windshields from the supplied data. This is an area that is worthy of further exploration, to determine whether the existing analysis methods can be legitimately calibrated for this windshield or whether alternative material models might be required for this class of structural transparency.

List of Contents

Blank page

1 Introduction

1.1 Background

1.1.1 The Military Aviation Authority (MAA), the British Airline Pilots Association (BALPA) and the Department for Transport (DfT), share similar concerns regarding the risks and consequences of a collision between a small Remotely Piloted Air System (RPAS) (often referred to as a drone) and a manned aircraft. Figure 1-1 illustrates such a possible collision.

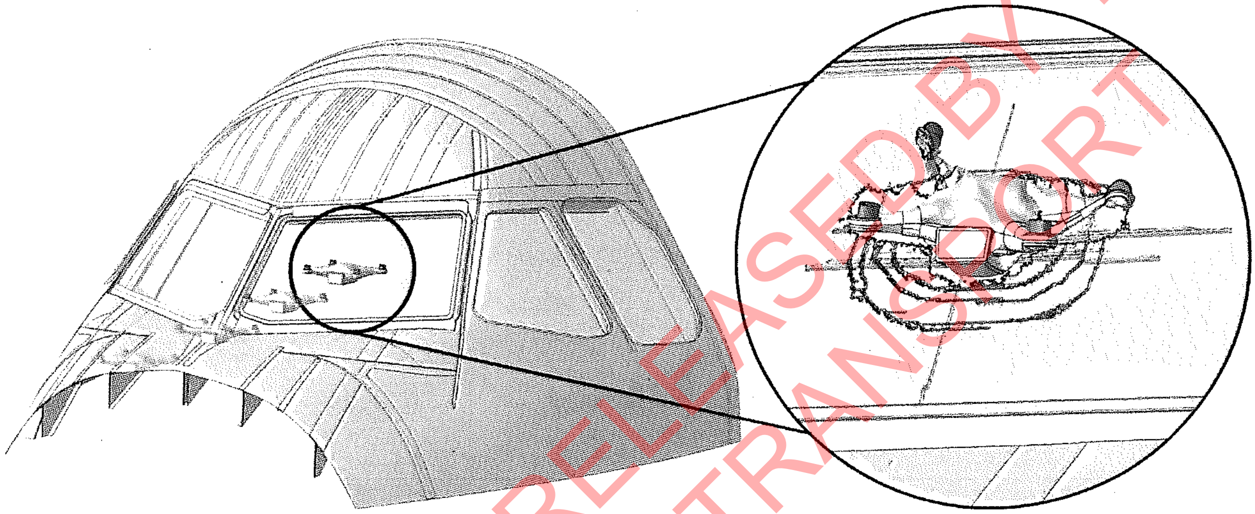


Figure 1-1: Example of RPAS on collision course with Airliner cockpit

1.1.2 The Unmanned Air Systems Capability Development Centre (UASCDC) were tasked by the Stakeholders to manage the project and create a Request for Quotation (RFQ) [1] in order to initiate a study to address the concerns. The objectives of this study were to understand the effects of a collision between a range of example RPAS and specific critical sub-systems of manned aircraft, including windshields [redacted], such that a comparison with Bird-strike collisions can be made by the Stakeholders.

1.1.3 This document constitutes Deliverable 'D9' of MAA Contract HOCS1c/0024 and BALPA Purchase Order No 6155G, and contains details of the "Small RPAS Collision Study" test and modelling programme.

1.2 Study requirement

1.2.1 The focus of this work was to assess and evaluate the effect of small RPAS platforms colliding and impacting onto a specific manned aircraft sub-systems such as windshields [redacted]. Here the primary requirement was to determine the threshold impact velocities at which the [redacted] Secondary, derived requirements were to identify the extent of damage to the windshields [redacted]

1.2.2 The specific requirements of this study were to use full-scale, ground-based physical impact testing and computer-based modelling to assess the level of damage/structural failure that may occur during impacts between various classes of RPAS and specific areas of manned aircraft (i.e. windshields [redacted]. Aligned with this objective is an implicit, enabling requirement to develop and validate new modelling methodologies that could be exploited to:

- Efficiently assess a much wider range of impact scenarios;
- Develop mitigation schemes to reduce the severity of impacts, and;
- Generate data to enable appropriate and proportionate decisions to be made on operational and legislative mitigation measures/controls.

1.3 RPAS class definition

1.3.1 The objective of the study was to assess the effects of impact of RPAS on various manned-aircraft components. The work was intended to be generic, rather than being specific to any particular commercially-available RPAS, and four generic RPAS classes were identified in the RFQ [1]:

- [redacted] ropulsion system was considered to represent a greater impact risk than a tai [redacted]

1.3.2 The above classes were defined in order to reflect the variation in RPAS masses in service, whilst supporting the definition of particular test articles; termed "projectiles" here. The projectiles were defined by selecting key components that prior work [redacted] had indicated to be dominant in determining the impact response, and which were appropriate to the median MTOW value used to identify each RPAS class. These key components were:

- [redacted]

1.3.3 The merit of this approach was that it provided easily comprehensive class definitions for the non-specialist, whilst enabling a scientific approach based on particular components that could be interpreted precisely in any downstream research or policy definition.

1.3.4 It is important to recognise that the projectile masses (stated in Section 3) were less than the masses defining the corresponding RPAS classes: [redacted] where abbreviated names of the projectiles are defined which may be used, where appropriate, throughout the report.

RPAS Class	Class projectile components	Abbreviated projectile name
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]		

Table 1-1: Components in the RPAS projectiles

1.4 Manned aircraft

The manned aircraft considered for the studies are given in Table 1-2; this table shows the nomenclature to describe the aircraft throughout this report along with their class description.

1.4.1 In order to ensure that the boundary conditions of the windshields were representative, the screens were mounted to actual airframes, where available. The impact locations chosen conformed, where applicable, to standard bird-strike specifications.

Aircraft name in report	Impact location	Class description
Rotorcraft-A	Windshield	Helicopter with non-birdstrike certified windshield
Rotorcraft-B	Windshield	Helicopter with birdstrike certified windshield
Airliner-A	Windshield	Large Fixed Wing Civil Airliner with CS-25 certified windshield
Airliner-B	Windshield	Fixed Wing Civil Airliner with CS-25 certified windshield
[redacted]	[redacted]	

Table 1-2: Manned aircraft considered in study

1.4.2 Applicable velocity ranges for RPAS projectiles and manned aircraft collisions are shown in Table 1-3. The values stated in the table are the impact velocities, which are the relative values of the velocity of the projectile to that of the manned platform. The key colour in the table indicates whether the collision scenarios were: modelled only; physically tested only; or both.

1.4.3 As well as considering the physical impact damage during collisions, concerns have also been expressed about the [redacted]articular, lithium [redacted] for all of the above collision tests and report upon any [redacted].

[redacted]

Table 1-3: Collision matrix for RPAS vs manned aircraft

1.5 Approach to the study

1.5.1 QinetiQ's programme of work against the Stakeholder requirements included an integrated programme of structural analysis and physical testing.

1.5.2 The structure of the programme was as described in the [redacted] This programme plan is shown diagrammatically in Figure 1-2. Mid-programme enhancements to this plan included additional testing and analysis work to de-risk the technical output, inform technical decisions and to maximise the level of data derived from the available test assets and resources.

1.5.3 The computer modelling activities were delivered using Dassault Systemes' Abaqus, finite element (FE) package which is well-suited to complex non-linear and dynamic impact problems. Abaqus is a high-end aerospace industry-standard tool that is commonly used to undertake advanced failure analyses and impact assessments such as composite delamination modelling, bird strikes, crash analyses and in the UK, whole-wing virtual test. The use of this commercially available code has ensured that the demonstrated capability is of direct relevance to the UK aerospace industry.

1.5.4 The impact testing was conducted by a specialist sub-contractor, Natural Impacts, who have a wealth of experience designing and conducting certification tests against bird strike, hail, tyre, FOD and blade-off requirements.

1.5.5 All testing was undertaken using various sizes of gas gun, whereupon compressed gases accelerate the RPAS projectile along a barrel and into the stationary target. In order to meet the needs of this programme, Natural Impacts designed and manufactured a new launcher system to allow the [redacted] to be launched as a whole airframe.

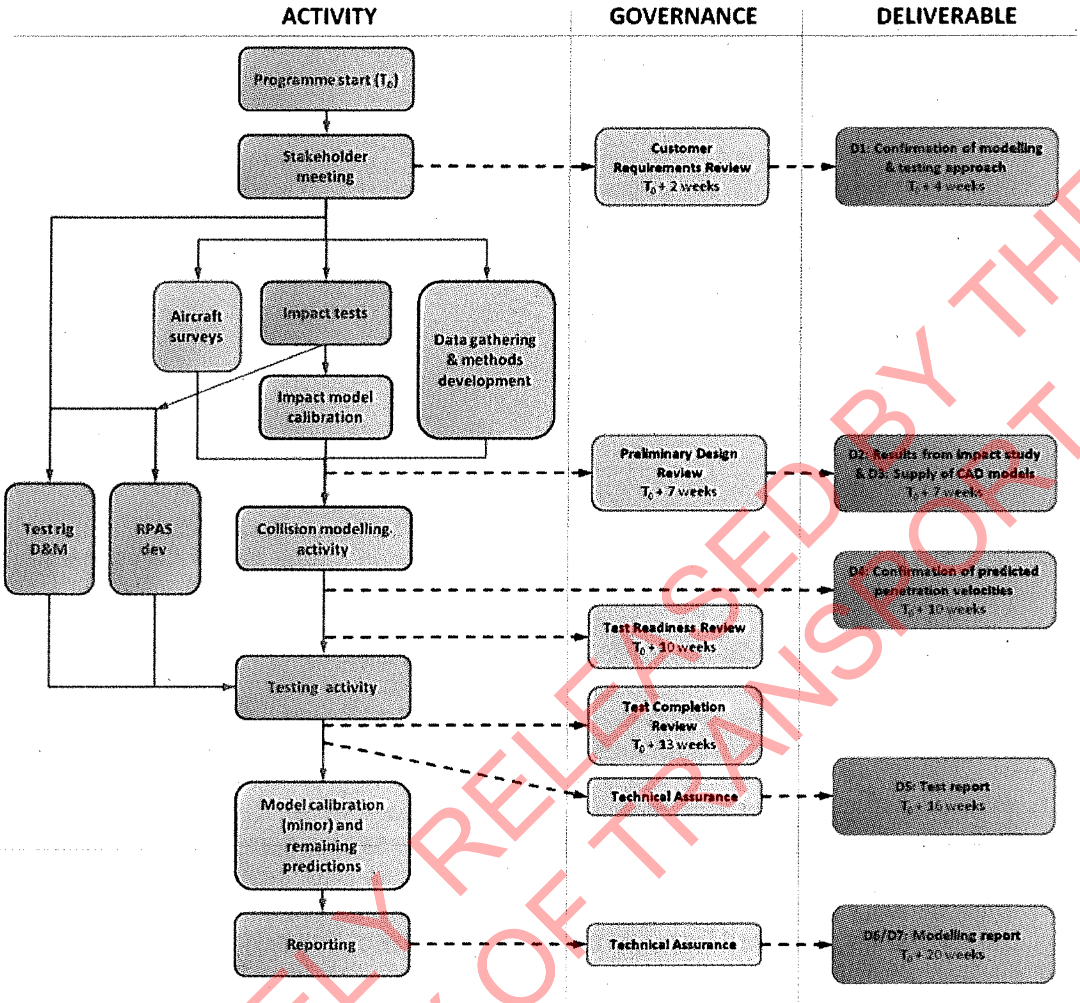


Figure 1-2: QinetiQ's programme of work

1.5.6 It was anticipated that the response of the RPAS components s[redacted] would be very complex to model using geometry and constituent materials data alone. Therefore, the agreed approach to the modelling was to represent each component as a homogenous material characterised by test. Hence, prior to the full impact tests, Natural Impacts performed static crush tests [redacted] and dynamic impact tests of [redacted] the latter tests using high-speed video and instrumented Hopkinson bar targets to record the physical behaviour and force-time response of RPAS threat components. The results from these tests were used to enable characterisation and calibration of material models for the impactor components to be used in the modelling; this process is described in more detail in Sections 8.13 and 8.14.

1.5.7 The resulting RPAS models were combined with accurate representations of the manned aircraft and detailed models of the laminated windshields. These whole assembly models were then used extensively to guide the impact testing and refine the approach based upon observations from test. The final models were then run for all of the required impact configurations (as defined in Table 1-3) and reported herein.

1.6 Report structure

1.6.1 Following this introduction, Section 2 of this report contains a brief review of other work on the subject which is, to date, quite limited. The reader is then taken through the configuration and representation of each of the RPAS types under consideration (Section 3), followed by a description of the relevant manned aircraft components being impacted (Section 4). Section 5 describes details of the impact conditions and associated assumptions.

1.6.2 Section 6 describes the experimental equipment / setup and the bespoke modifications required to launch the various RPAS. Section 7 presents the results of the testing of the various RPAS against the three different manned aircraft, [redacted]

1.6.3 Glass windshields represent the majority of the manned aircraft components being impacted within this programme; hence it has been necessary to investigate the modelling of glass in terms of methods and materials. Section 8 sets out a summary of the materials used, explaining that calibration was required to improve the correlation of some results with test; this was part of the model validation which is detailed in Section 9, along with summary details of the approach developed to modelling this complex and highly dynamic event.

1.6.4 The developed and calibrated models were then used to predict the effect of collisions between the combination of RPAS and manned aircraft specified in Table 1-3. The results of these predictions are presented in Section 10, with associated images from analysis and test recorded in Appendix A, with Appendix B showing predictions of [redacted] The report is finalised with conclusions drawn from the study (Section 11) and recommendations (Section 12).

2 Other relevant studies

2.1 Previous studies in literature

2.1.1 To date the perceived threats posed by RPAS to aviation safety have been the subject of significant speculation but minimal evidence-based substantiation. This programme is therefore unique in its scope and approach, and is one of only a very small number of studies to directly address the topic of RPAS collisions.

2.1.2 While there are many references on the subject of bird-strikes against manned aircraft, where the impacting bird is typically described as a fluid using an 'equation of state', RPAS components such as [redacted] are [redacted]

2.1.3 Due to the compressed timescale of this project and consequential focus on Stakeholder objectives, a detailed survey of all previous relevant studies was not possible. Furthermore, most of the limited work that has been done on this topic appears to be on-going and/or subject to commercial restrictions. However, the following programmes/reports were identified and where possible, reviewed:

- **Dstl/Imperial College study** [2, 3]: *Reviewed below.*
- **Autonomous Systems Underpinning Research, ASUR** [5]: *Research and development consortium led by Dstl that aims to advance technology towards new UAS concepts and enhancing current systems. No details of analysis programmes were available in open literature.*
- **ASSURE initiative** [6]: *FAA led consortium to integrate unmanned aircraft into the air space and to identify and develop criteria and standards required for the civil certification and regulations of UAS pilots, equipment and operations. No details of analysis programmes were available in open literature.*
- **Monash University final year project** [7]: *Broad review of collision threats but relatively low-fidelity analysis of specific components.*
- [redacted]

2.1.4 In addition to the above, numerous academic papers and sources of data have been reviewed to provide information on material property data, material models and numerical representations. These are referenced separately within the relevant Sections of this report.

2.2 Dstl/Imperial College activities

2.2.1 Two reports, sponsored by [redacted] were made available to QinetiQ as GFX. These reports describe modelling (using LS-DYNA) and impact tests that compared the effect of bird-strikes on aircraft with those of nano-UAVs; as represented by [redacted] The work was undertaken to inform the discussion on whether it was safe to operate nano-UAVs in the vicinity of other aircraft. Important distinctions between the impact characteristics of birds and nano-UAVs were identified. It was found that assessment of RPAS impact requires particular consideration, and cannot be inferred directly from bird-strike response. The levels of damage from the UAS impacts were dependent upon the particular components and impact conditions. In some cases it was found, supported by data from similar experiments within the literature review and determined by stakeholders, that equivalent damage could be caused by an RPAS [redacted] From the findings, it can be inferred that, in many cases, particular operational limitations (e.g. separation) and/or certification approaches will be required for RPAS impacts. [redacted]

2.2.2 The modelling included impacts between a representative [redacted] assembly and various aircraft components: a canopy, a composite leading-edge, a metallic leading-edge, and a fan-blade. [redacted] UAS' structural components had a negligible effect. The work identified the importance of using accurate material properties within the modelling, and identified a lack of such data in the open literature for [redacted]. Therefore, impact tests were undertaken to calibrate equivalent homogeneous material properties for the [redacted], and these were used in the impact modelling. Due to health and safety restrictions on testing [redacted] a [redacted] facility, [redacted] was used as a surrogate for the [redacted] materials, and an [redacted] material model was calibrated through impact testing. Further work was recommended, including impact testing of [redacted] and derivation of equivalent material properties.

2.3 [redacted]

2.3.1 [redacted]

2.3.2 [redacted]

- [redacted]

2.4 Outcome of literature review

Although some limited work had been done by other parties to assess various classes of RPAS impacting representative aircraft structures, none of the published findings were sufficient to meet the requirements of this programme. It was therefore concluded that the analysis and test activities performed within the current programme should develop data and modelling methods from scratch (albeit based upon QinetiQ's current approach to impact modelling), rather than inheriting assumptions from adjacent activities.

3 RPAS "projectile" representations

3.1 Introduction

3.1.1 This Section gives an overview of the RPAS configurations assessed within this study, and their "projectile" representation for the purpose of modelling and test.

3.2 RPAS mass classes

3.2.1 Four configurations of electrically-propelled RPAS were considered, [redacted]:

- [redacted]

3.2.2 The above classes were defined in order to reflect the variation in RPAS masses in service, whilst supporting the definition of the projectile test articles, defined by selecting key components deemed to be dominant in determining the impact response. These key components were:

- [redacted]

3.3 Projectile development

3.3.1 [redacted] Thus, the projectiles did not include such additional components unless it was convenient for their assembly and for their integrity when launched from the gas gun. These simplifications had the additional benefit of reducing the complexity of both the projectiles and the corresponding numerical models, which thereby reduced uncertainty when comparing the numerical models and experimental results.

3.3.2 The stakeholders developed concepts for the construction of the RPAS classes using key components [redacted] from Commercial Off-The-Shelf (COTS) sources, together with COTS or representative structural members [redacted]. QinetiQ subsequently worked with the stakeholders to refine both the RPAS concepts and the projectiles used to represent them, balancing the representation of the RPAS with the execution of a practicable and scientific programme.

3.3.3 The designs of the projectiles were influenced by the practicalities of maintaining their integrity when fired from the gas gun that was used to accelerate them. Analysis and testing indicated that fully assembled [redacted] could be fired successfully, but that the [redacted] The decision was taken to remove the [redacted] and to include only components along the longitudinal axis. This eliminated the programmatic and technical risks associated with developing satisfactory techniques to support or reinforce the [redacted] during firing. This decision also increased the simplicity of the projectile, and thereby increased confidence in the testing, modelling, and their comparison.

3.3.4 The mass of each of the four RPAS projectiles are shown in Table 3-1. Also included are the 'Percentage of Class mass', which indicates percentage of the projectile mass to the nominal MTOW.

[redacted]

Table 3-1: RPAS projectile masses

3.3.5 Details of the four RPAS representations are included in the following sub-section. The configurations that were modelled were based upon the test projectiles, in order to allow direct comparison of results.

3.4 RPAS projectile configurations

3.4.1 [redacted]

3.4.1.1 The range of designs, constructions and component mass combinations for most classes of RPAS are great, [redacted] no exception. There are numerous low-cost toys that fall into this bracket, as well as more advanced systems with lightweight frames and [redacted]

3.4.1.2 Figure 3-1 [redacted] that were specified for this class of vehicle, and the basic representation of a [redacted] airframe. [redacted] such that an impact event could result in a train of components [redacted] battery [redacted] impacting the same location.

3.4.2 Although the test matrix for this programme (Table 1-3) did not include physical impact testing between this class of [redacted] and any of the manned aircraft, modelling results were required against all platforms, [redacted]. It was therefore necessary to develop accurate representations of the [redacted]

3.4.2.1 These components were modelled as primitive geometries but, as described later in Section 8.14, calibrated material models were developed to ensure that when they impact the target structures, the forces that they impart are realistic.

3.4.2.2 The [redacted] frame is assumed to be a [redacted] material of [redacted] and a [redacted] This results in a relatively weak construction that readily fails at the impact velocities of interest. Whilst this [redacted] is not based on any particular model of RPAS, it is representative of a [redacted] airframe that is designed to withstand only low velocity impacts.

[redacted]

3.4.3 [redacted]

3.4.3.1 The [redacted] is based upon a [redacted]. On this basis, the projectile configuration is [redacted]

3.4.3.2 It is recognised that many RPAS of this class include small, [redacted]. Although these may represent a [redacted] such systems were not included in the final projectile configuration. Reasons for this include that it would make the projectile very difficult to launch during testing, its complex mechanisms would increase uncertainty in the modelling work, [redacted] and components would have been prohibitively expensive to procure for all of the test assets.

Figure 3-2 shows the [redacted] that comprise the projectile, along with the corresponding FE model. The model was developed from scratch, using measurements and photographic projections to create a detailed Computer-Aided-Design (CAD) model. The plastic Acrylonitrile Butadiene Styrene (ABS) airframe was modelled as two separate components (other minor split lines around the [redacted] were not included) and joints were made at screw and clip locations.

[redacted]

3.4.3.3 Shell elements were used to represent the airframe whilst solid elements (with separately calibrated material models) were used for the [redacted]

3.4.4 [redacted]

3.4.4.1 The [redacted] was assembled from commercially available components, including an airframe kit that is particularly popular within the hobbyist / self-build community.

3.4.4.2 [redacted] large [redacted]

3.4.4.3 Figure 3-3 shows the supplied components and also the FE representation of the final projectile. Note that some modifications to the components were required in order to achieve a configuration that could be successfully launched via gas gun, at the velocities demanded for the Airliner-A collision tests. These modifications included:

- Only [redacted] as the projectile was to be launched from an 8” bore gas gun. This was considered to be an acceptable approximation as the other [redacted] This was a necessary change in order to create an assembly that could withstand the acceleration loads during launch. It [redacted] This was a minor detail and was judged to have minimal effect on the impact case.

3.4.4.4 The model was constructed using a combination of [redacted]. Calibrated material models were used for the [redacted] Semi-calibrated properties were used for the [redacted] as there was insufficient scope to undertake the additional impact testing required to complete the calibration and validation process. Subsequent physcial collision testing established that the impact response of the [redacted] was complex, including [redacted] The current [redacted] is therefore unlikely to replicate this behaviour so future testing and model development would be required to refine the modelled [redacted].

[redacted]

3.4.5 [redacted]

3.4.5.1 A schematic of a representative [redacted]s shown in Figure 3-4; this was simplified greatly for the purpose of creating a test projectile. It was agreed that the components that present the greatest threat in the event of a [redacted]

3.4.5.2 Options for including [redacted] However, initial modelling work suggested that the addition of a [redacted], such as the one used on the [redacted]. It was therefore agreed with UASCDC and the Stakeholders that a baseline configuration of the components shown in Figure 3-4 (no additional payload) would be acceptable.

3.4.5.3 The FE representation of the [redacted] was constructed from [redacted], utilising a calibrated material model for the [redacted] and a semi-calibrated material model for the [redacted]

3.4.5.4 It should be noted that the test configuration also included a balsa wood spacer [redacted] rather than a gap (as modelled); this was necessary to enable the projectile assembly to be launched without breaking up in the barrel of the gas gun. [redacted], but in the absence of appropriate crush and failure data, this feature was not represented in the modelling. It is possible that this balsa spacer [redacted] though it is not unreasonable to assume that a [redacted] would have a similar [redacted] at this location.

[redacted]

4 Manned aircraft components and representations

4.1 Introduction

4.1.1 This Section gives an overview of the manned aircraft structures that were analysed and tested within this study. This includes details of the airframes, their representation as CAD models for analysis, the construction of the respective windshields and assumed [redacted]

4.2 Scope of manned aircraft analysis and test

4.2.1 Activities within the programme included the following:

- **Rotorcraft windshields** of two aircraft (Rotorcraft-A and Rotorcraft-B) were assessed by both modelling and testing;
- **Large aircraft windshields** of a CS-25 class of aircraft (Airliner-A) were assessed by both modelling and testing;
- **Aircraft windshields** of a CS-25 class of aircraft (Airliner-B) were assessed by testing only;
- [redacted]

4.3 Airframes for analysis and test

4.3.1 For the impact analyses and tests to be representative of in-service collisions, it was necessary to ensure that the boundary conditions of the windshields were realistic, so the screens were mounted to actual airframes. The test and modelling activities were therefore undertaken with the windshields installed in genuine fuselage structures. An exception to this was the testing of the Airliner-B windshields; these were redundant windshields obtained by Natural Impacts which were fired into while de-risking projectile launching, and they were only loosely supported at representative angles with laboratory clamps.

4.3.2 Sections of the fuselage with cockpit for each of the test aircraft types (Rotorcraft-A, Rotorcraft-B and Airliner-A) were sourced. Each airframe was reviewed and critical structural components around the windshields were identified for inclusion in the CAD models[1].

4.3.3 Detailed surveys of the frontal cockpit structures were conducted by specialist contractors, using photogrammetric methods to provide an accurate but simplified CAD representation of each of the airframes. Figure 4-1 shows an example of the output from the survey, prior to being processed into a more-useable CAD format. These CAD models were subsequently converted into shell-element based FE representations for the modelling studies.

4.3.4 Photographs of a manned aircraft cockpit and its associated CAD is shown in Figure 4-2.

[1] The surveyed Rotorcraft-B cockpit (say, airframe 1), used for CAD in the modelling activities, was different from the Rotorcraft-B cockpit (say, airframe 2) that was tested. The reason for this was that the windshields supplied for testing did not fit airframe 1, so the alternative airframe 2 was sourced for the tests. However, the structural configuration of the two airframes was judged sufficiently similar to allow the modelling to proceed using survey data from airframe 1.

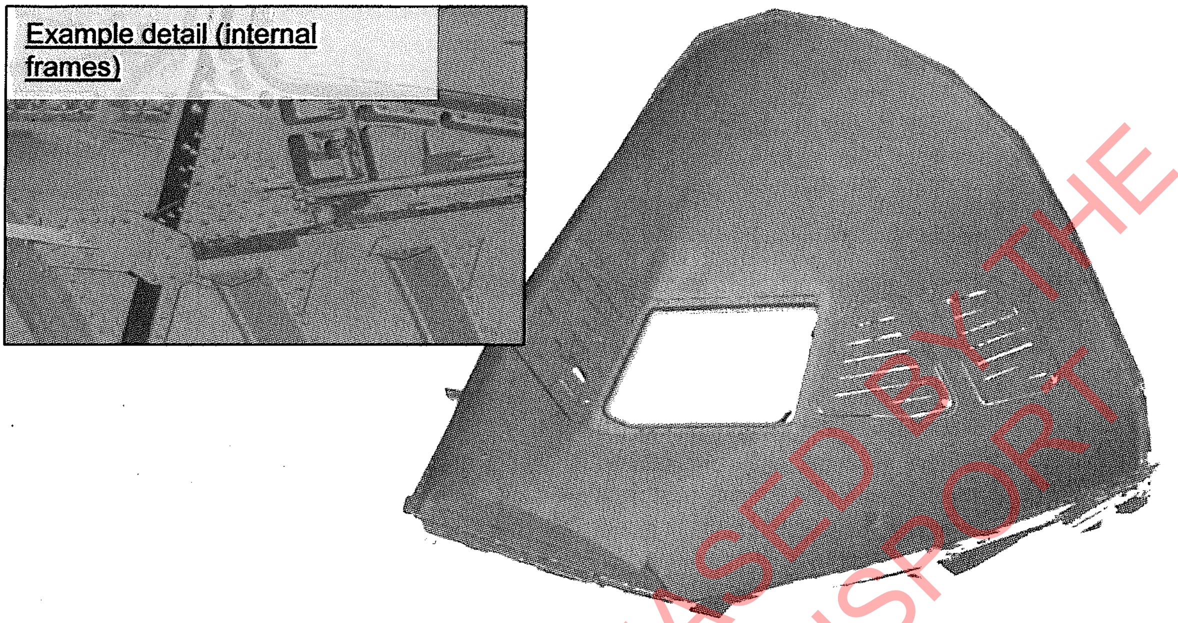


Figure 4-1: Raw data from photogrammetric aircraft survey

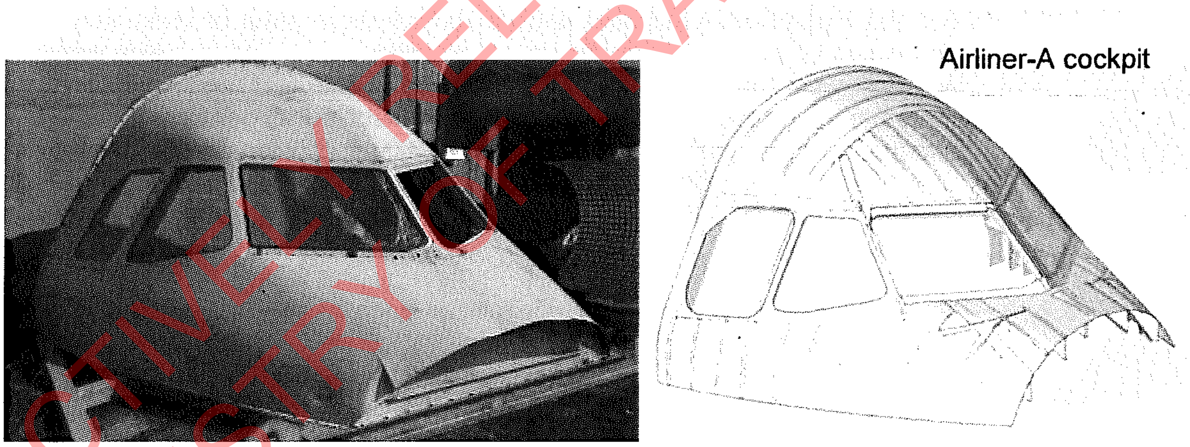


Figure 4-2: Manned aircraft cockpit photos and model representations

4.4 Manned aircraft windshield construction

4.4.1 All of the manned aircraft windshields were laminated glass. The construction of the laminate and their materials are presented below.

4.4.2 Rotorcraft-A windshield

4.4.2.1 The Rotorcraft-A windshield was a laminate, with a total thickness [redacted] as shown in Figure 4-3. The layer thicknesses are defined on manufacturer's drawings.

4.4.2.2 Material property data was not available for the glass or interlayer in the Rotorcraft-A windshield, so appropriate values were researched and are presented in Section 8. Engineering judgement was applied, and an assumption made, that the interlayer mechanical properties could be close to those of Polyvinyl Butyral (PVB) (the material suggested to represent the interlayer of the Airliner-A windshield).

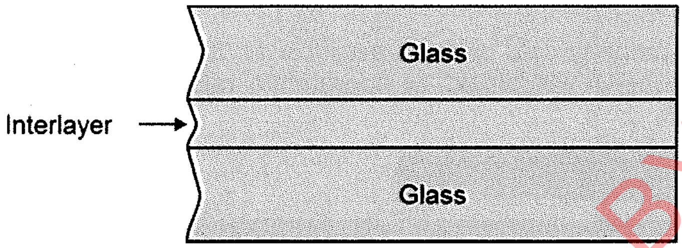


Figure 4-3: Rotorcraft-A windshield laminate

4.4.3 Rotorcraft-B windshield

4.4.3.1 [redacted]

[redacted]

4.4.3.2 Material property data was not available for the glass or acrylic layers of the Rotorcraft-B windshield, so appropriate values were researched and are presented in Section 8.

4.4.4 Airliner-A windshield

4.4.4.1 The Airliner-A windshield laminate, along with the thicknesses, is shown in Figure 4-4. The total thickness of the laminate was taken to be [redacted]

[redacted]

4.4.4.2 Initial information suggested that the both of the interlayers were Polyvinyl Butyral (PVB) [redacted] However, information from the manufacturer's website [12] suggests that the manufacturer has moved away from this design and that the thicker interlayer is now manufactured using Thermoplastic Polyurethane (TPU), whilst PVB is still used to bond the two main glass plies. Although guidance provided to QinetiQ, through UASCDC [11], was to assume that the PVB definition is correct, an initial inspection of a failed Airliner-A windshield suggests that the thicker interlayer is a stiffer material.

4.4.4.3 Material property data was not available for the two grades of glass, PVB or TPU layers in the Airliner-A windshield, so appropriate values were researched and are presented in Section 8.

4.5 [redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

5 Impact conditions

5.1 Introduction

5.1.1 For a given collision, the possible range of possible impact velocities, locations and orientations are too numerous to fully consider within a practical programme of testing. It was therefore necessary to determine an appropriate set of conditions for each collision scenario to represent a likely worst-case condition.

The maximum impact velocities for collisions between each combination of RPAS and manned aircraft were agreed between UASCDC, the Stakeholders and QinetiQ. These figures, presented in Table 1-3, are based upon the maximum velocities at which each platform could be travelling when an impact might credibly occur. Furthermore, they assume that both the RPAS and manned aircraft are on a direct collision course, and are travelling in opposite directions such that the impact velocity is the sum of their true airspeeds.

5.2 RPAS projectile conditions

5.2.1 For calculating the maximum likely impact velocities, the cruise speed of the three classes of [redacted]

5.2.2 The yaw orientation of the [redacted] (i.e. about its own vertical axis) was initially considered to be such that the manned aircraft was impacted with an in-line train of components [redacted] as shown in Figure 5-1 [redacted]. However, due to launching difficulties in the testing, the orientation of [redacted] (also shown in the figure) [redacted]

5.2.3 The [redacted] was tested and modelled as a train of components with zero yaw: [redacted] Figure 5-1.

5.2.4 In the testing, the launch of the [redacted] against the Airliner-A windshield was intentionally inverted in the gun for the last three of the five shots. This modification to the configuration was implemented following the first two tests, one of which showed that Airliner-A windshield withstood an impact [redacted] using the nominal projectile configuration. An observation made when reviewing the high-speed video footage of this test was that the [redacted] Although there was no time available to explore alternative RPAS projectile designs (and the associated sabots and launch procedures), it was decided to invert the system in the barrel to represent [redacted].

5.2.5 For most impact tests, the RPAS projectiles were observed to fly approximately straight and level (S&L) i.e. zero pitch and zero roll. However, as an artefact of the launching of the [redacted] the projectile was pitched ~10° upwards for the nominal configuration and ~10° downward for the inverted configuration. This was therefore applied to the initial conditions of the projectile in the modelling (shown in Figure 5-1).

[redacted]

Figure 5-1: RPAS projectile impact orientations and attitudes against windshields

5.3 Manned aircraft conditions

5.3.1 The maximum velocity of Rotorcraft-A was considered to [redacted] whilst Rotorcraft-B wa[redacted] The maximum velocity of Airliner-A was considered to be [redacted] The attitude of all manned aircraft was considered to be straight and level.

5.4 Impact locations

5.4.1 The location of the RPAS impact relative to the windshield was agreed to be in line with the head of the pilot, which was generally in the central region of each screen. This approach is analogous to that used when testing windshields against bird strike impacts, although bird strike testing can also include impacts in the corner regions (and indeed one test location of the Airliner-A windshield against an inverted [redacted]

[redacted] [redacted]

[redacted] [redacted]

[redacted] [redacted]

[redacted] [redacted]

[redacted]

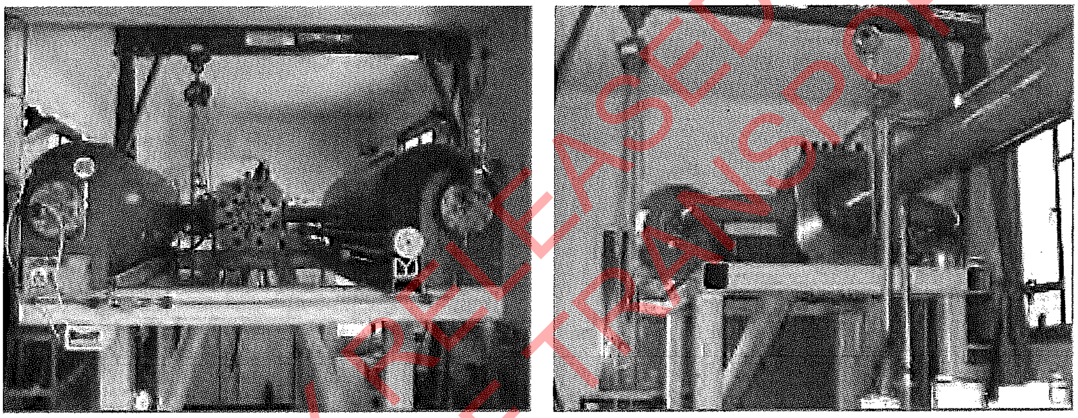
6 Experimental procedures

6.1 Introduction

6.1.1 This Section describes the experimental equipment / setup and the bespoke modifications required to launch the various RPAS projectiles.

6.2 Launch capabilities - 6" & 8" calibre guns

6.2.1 Natural Impacts Ltd has two large gas guns with bores of 6" (152mm) and 8" (203mm) by 18m long, which are capable of launching [redacted] projectiles up to velocities of 580 knots ($300ms^{-1}$). The projectiles are accelerated using nitrogen gas stored in two accumulators and emitted via a high-speed valve. The breech and accumulators for the 6" gun are shown in Figure 6-1.



(a) Breach *(b) Barrel*

Figure 6-1: Photographs of the 6" calibre gun

6.2.2 Projectiles are fitted into an aluminium alloy 'cup' termed a *sabot* that securely holds and seals the projectile in the gun barrel during launch. At the end of the barrel the *sabot* impacts a steel ring termed a 'stripper' and is arrested allowing the projectile to continue through the 'stripper' ring on to the target.

6.3 RPAS projectile launch development

6.3.1 It was apparent from the outset that launching a complete RPAS would be unlikely due to their dimensions being far greater than the bore of the largest gun.

6.3.2 The situation was further complicated by the fact that RPAS consist of [redacted] had negative and positive effects; it limited the force that could be applied to accelerate the RPAS but, being weak in comparison to the deceleration forces generated during impact, it was considered acceptable to omit the weak frame components from the test, thus the RPAS was represented through [redacted]

6.3.3 Due to diversity in the construction and impact velocities, each RPAS type had a bespoke launch solution that enabled representative examples to be launched over the full velocity regimes.

6.3.4 [redacted]

6.3.4.1 The [redacted] were COTS items with a monocoque-style body construction. [redacted]

6.3.4.2 Furthermore, quasi-static strength tests showed the [redacted] were capable of withstanding the forces required to accelerate the [redacted] to the required maximum velocity of [redacted] as specified in Table 1-3. The configuration also allowed the [redacted] to be supported directly during the launch.

6.3.4.3 Based on these findings a novel 'catapult' launcher was constructed to launch a complete [redacted] The launcher is shown in Figure 6-2.

[redacted]

Figure 6-2: Modification to gun barrel for 1.2kg Class QC projectile

6.3.5 [redacted]

6.3.5.1 The [redacted] was supplied as a number of individual components that could be used in the construction of a [redacted] (see Figure 3-3).

6.3.5.2 Quasi-static strength tests showed that due to the [redacted] required to reach the [redacted] maximum impact velocity (see Table 1-3).

6.3.5.3 The [redacted] velocity also meant the [redacted] projectile would have to be launched using the 8" gun rather than the catapult launcher (Section 6.3.4), as this has the longer 18m barrel enabling lower acceleration loads to be applied.

6.3.5.4 The combination of both space and strength limitations dictated the components were aligned along the shot-axis. [redacted]

[redacted]

6.3.5.5 In order to directly push the [redacted] minimise the buckling distances of the axial arms, the QCs were launched in bespoke sabots [redacted] The [redacted] assembly is shown in Figure 6-4.

[redacted]

Figure 6-4: [redacted] *and sabot*

6.3.6 [redacted]

6.3.6.1 With reference to Figure 3-4, [redacted] attached directly onto an [redacted] located immediately in front [redacted]; these were deemed representative as being the key components based on the projectile selection philosophy discussed in Section 3.4. This very significant [redacted] was replicated as shown in Figure 6-5 with [redacted] For launching purposes, the test projectile included a balsa wood spacer between [redacted] (as modelled).

[redacted]

6.3.6.2 The narrow and symmetrical configuration enabled the assemblies to fit in the 6" sabot with adequate clearance for the sabot to crush without contacting the projectile as it slid out (Figure 6-6).

[redacted]

Figure 6-6: [redacted] in sabot

6.4 [redacted]

6.4.1 [redacted]

6.5 Velocity measurement

6.5.1 Impact velocity

6.5.1.1 The velocity of the [redacted] projectiles was recorded 1.22m before impacting the windshields by measuring the time taken for it to pass between two IR beams located 50mm apart (see Figure 6-7).

6.5.1.2 The velocities of the [redacted] and the [redacted] projectiles were recorded 200mm before the gun muzzle by measuring the time taken for it to pass between two IR beams located 200mm apart (see Figure 6-6). In all cases the signals were recorded using a Tektronix oscilloscope (Serial No.C040641, Calibration 2179170002).

6.5.2 Residual velocity

6.5.2.1 There was no attempt made to record residual velocities of the projectiles. There was a high-speed camera recording the event from within the cockpit, but this was placed at an angle [redacted]

[redacted]

Figure 6-7: Location of IR velocity sensors on guns

6.6 Target alignment and impact location

6.6.1 A laser was inserted down the barrel to identify the gun axis; the airframe was then moved until the laser beam coincided with the impact point as shown on the windshield in Figure 6-8.

[redacted]

Figure 6-8: The laser beam (pink dot) positioned on windshield

6.6.2 Table 6-1 gives the impact co-ordinates for the three aircraft tested.

[redacted]

Table 6-1: Impact positions for the three aircraft types

6.7 High-speed videos

6.7.1 The free-flight and impact of the RPAS projectiles were optically recorded from outside and inside the aircraft using two NAC GX1 monochrome cameras operating at 5,000fps with a 20μs shutter speed. Typical outside and inside camera views are shown in Figure 6-9.

[redacted]

Figure 6-9: Snapshot examples from high-speed cameras

6.8 Standard videos

6.8.1 Standard speed (50fps) videos were taken to capture the true speed and intensity of each impact.

6.9 Dummy pilot

6.9.1 In the majority of the tests, a dummy pilot constructed of polystyrene with a gel head was positioned in the cockpit behind the windshield. The pilot appeared in some of the high-speed videos [redacted]

7 Collision test results

7.1 Introduction

7.1.1 This Section presents the results of the testing of the various RPAS against the three different manned aircraft. A summary of the results is presented in Table 7-1; the colour code of this table indicates damage level definitions given in Table 7-2, which is also used to describe the damage levels in the modelling predictions (Section 10).

[redacted]

Table 7-1: Summary of the collision test results

[redacted]

Table 7-2: Damage level definitions by colour

7.1.2 Table 7-3 shows a summary of the test results carried out to de-risk the projectile launching against windshield from Airliner-B, using the same colour damage level definitions given in Table 7-2.

[redacted]

Table 7-3: Summary of the de-risking collision test results

7.2 Rotorcraft-A windshield tests

7.2.1 [redacted]

7.2.1.1 High-speed video stills showing the outside and inside views of Tests 1, 2 and 3 respectively are shown in Figure 7-1.

[redacted]

7.2.1.2 Figure 7-1a [redacted] shows the [redacted] Figure 7-1b shows the [redacted]

7.2.1.3 Figure 7-1c [redacted] shows the [redacted] while Figure 7-1d [redacted]

7.2.1.4 Figure 7-1e [redacted] shows the [redacted] shows the [redacted]

7.2.1.5 The front and rear damage to the windshields is shown in Figure 7-2.

[redacted]

Figure 7-2: Photographs of windshield damage for [redacted]

7.2.1.6 The Test 1 windshield shown in Figure 7-2a and Figure 7-2b [redacted]

7.2.2 [redacted]

7.2.2.1 High-speed video stills showing the outside and inside views of Tests 5 to 8 respectively are shown in Figure 7-3.

[redacted]

Figure 7-3: High-speed video stills of the [redacted] *vs Rotorcraft-A windshield*

7.2.2.2 **Note:** Test 4 was conducted but is not listed in Table 7-1 [redacted] broke-up during launch and the velocity and impact mass were unknown. [redacted] impacted the top of the windshield while the remainder impacted the acrylic cockpit roof. [redacted] was considered usable for subsequent testing. It was successfully impacted as Test 5 with the Test 4 damage circled in Figure 7-3a.

7.2.2.3 Figure 7-3a [redacted] shows the [redacted]. Figure 7-3b shows the [redacted]

7.2.2.4 Figure 7-3c [redacted] while Figure 7-3d shows the [redacted]

7.2.2.5 Figure 7-3e [redacted] shows the heavily distorted [redacted] The impact causes [redacted] (Figure 7-3f).

7.2.2.6 Figure 7-3g and Figure 7-3h [redacted]

[redacted] [redacted]

[redacted]

Figure 7-4: Photographs of windshield damage [redacted]

7.3 Rotorcraft-B windshield tests

7.3.1 [redacted]

7.3.1.1 High-speed video stills showing the outside and inside views of Tests 12, 13 and 14 respectively are shown in Figure 7-5.

7.3.1.2 Figure 7-5a and Figure 7-5b [redacted] show the [redacted]

7.3.1.3 Figure 7-5c [redacted]

7.3.1.4 Reducing the impact velocity [redacted] caused the [redacted] (Figure 7-5e and Figure 7-5f). [redacted] (see Figure 7-6f).

[redacted]

Figure 7-5: High-speed video stills of the [redacted]

7.3.1.5 The front and rear damage to the windshields is shown in Figure 7-6.

[redacted]

Figure 7-6: Photographs of windshield damage for [redacted]

7.3.1.6 Comparing Figure 7-6a and Figure 7-6b [redacted] and Figure 7-6c and Figure 7-6d [redacted]

7.3.1.7 The [redacted] from Test 14 [redacted] is shown in Figure 7-6e and Figure 7-6f. The visibility through the screen is good.

7.3.2 [redacted]

7.3.2.1 High-speed video stills showing the outside and inside views of Tests 9 to 11 respectively are shown in Figure 7-7.

[redacted]

Figure 7-7: High-speed video stills of the [redacted]

7.3.2.2 Figure 7-7a [redacted]

7.3.2.3 Figure 7-7c [redacted]

7.3.2.4 Figure 7-7e [redacted] shows the body of the [redacted] The impact [redacted] (Figure 7-7f). [redacted]

7.3.2.5 The front and rear damage to the windshields is shown in Figure 7-8.

[redacted]

Figure 7-8: Photographs of windshield damage for [redacted]

7.3.2.6 The front view of the Test 9 windshield is shown in Figure 7-8a; the inner view was not available. [redacted]

7.3.2.7 The Test 10 windshield is shown in Figure 7-8c and Figure 7-8d. [redacted]

7.3.2.8 Figure 7-8e and Figure 7-8f show the Test 11 damage. Figure 7-8e shows the [redacted]

7.4 Airliner-A windshield tests

7.4.1 [redacted]

7.4.1.1 High-speed video stills are shown in Figure 7-9 of the impact sequence, from the outside, for a nominal configuration [redacted] against the windshield of Airliner-A; Test 15 [redacted] There was no inside camera employed as this test was essentially a calibration shot to verify the deployment and free-flight characteristics of the projectile. Note that in many of the high-speed video stills there is evidence of other debris not associated with the RPAS projectile construction; this is polystyrene packing material used to protect the projectile during acceleration.

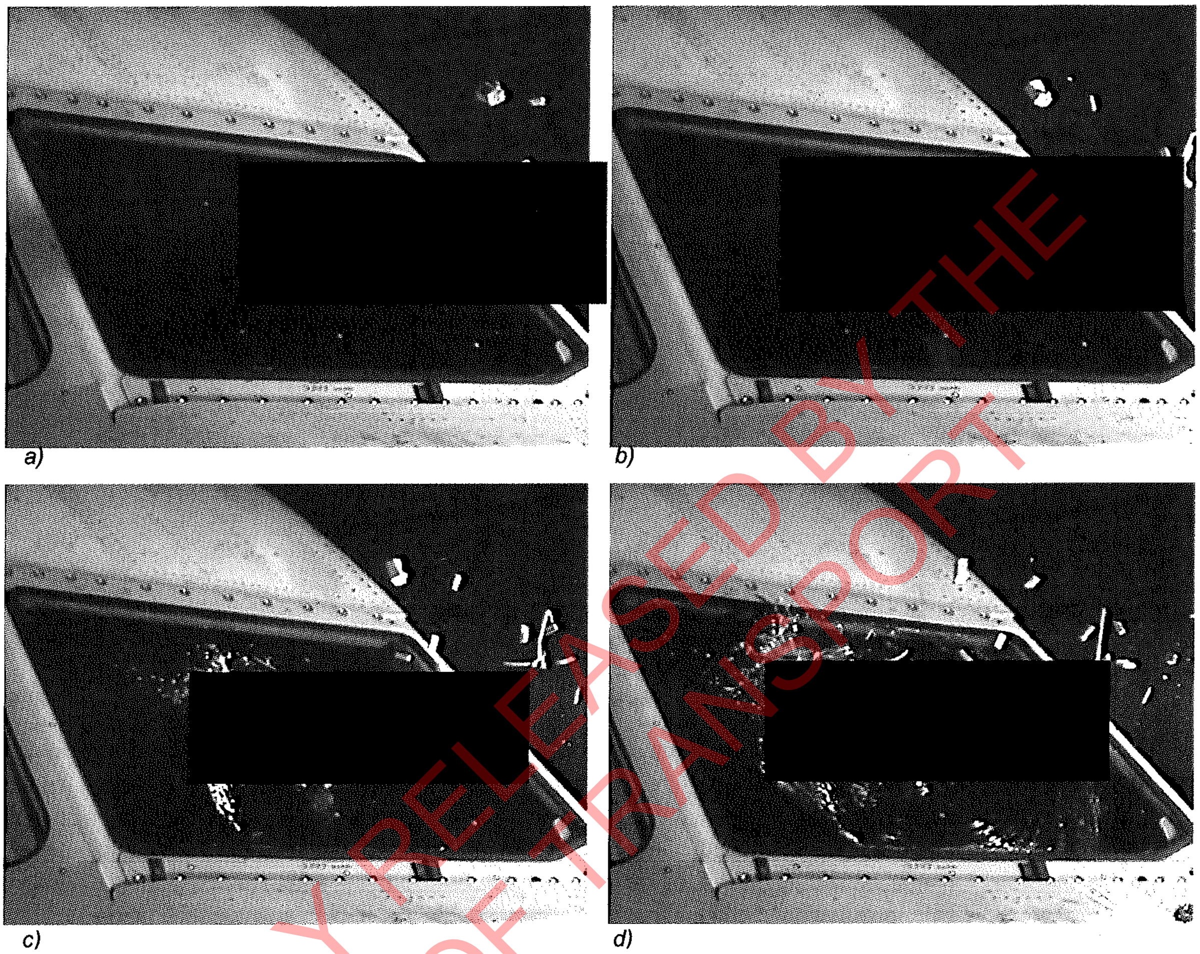


Figure 7-9: High-speed video stills of the [redacted]

7.4.1.2 Due to the steep compound raked-back angle of the windshield the first item to contact was the [redacted] (circled in Figure 7-9a). It was not until the [redacted] and started to [redacted] (Figure 7-9b). Approximately [redacted] later the [redacted] (Figure 7-9d) and did not fully load the windshield. The two main structural plies were undamaged and the damaged windshield is shown in Figure 7-10.

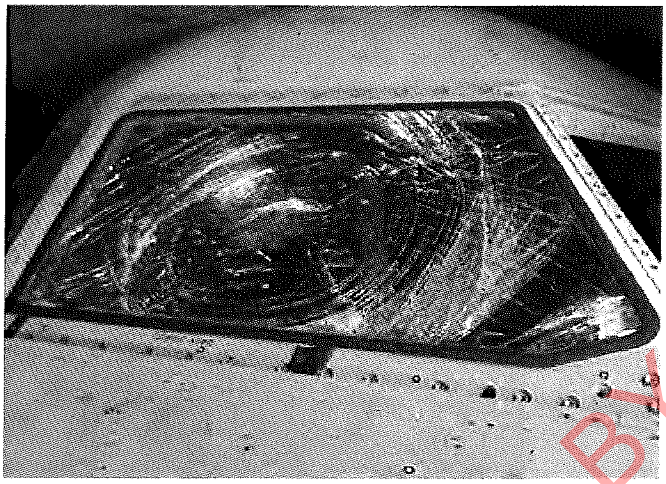


Figure 7-10: Photograph of windshield damage for [redacted]

7.4.1.3 Test 16 [redacted] was essentially a repeat of Test 15 but against a different manufactured windshield; subsequent tests were against windshields from the same manufacturer as the Test 16 windshield. Figure 7-11a and b show the point of peak damage in Test 16 from outside and inside the cockpit.

[redacted]

Figure 7-11: High-speed video stills of [redacted]

7.4.1.4 The impact sequence was virtually identical to that shown in Figure 7-9 with only the outer glass ply failing albeit slightly more than Test 15, possibly due to the higher impact velocity of [redacted] The final damage is shown in Figure 7-12.

Figure 7-12: Photograph of windshield damage [redacted]

7.4.1.5 Given the variety of [redacted], it was necessary to evaluate the impact without [redacted] seemed to occur in Test 15 and 16 from [redacted] while in the nominal attitude. To achieve this without altering any parameters, the [redacted] projectile was simply inverted allowing the [redacted] This also meant that the projectile impacted the windscreen at a less oblique angle than it did whilst in the nominal configuration (see Figure 5-1). This scenario was tested as Test 17 [redacted] and the impact sequence is shown in Figure 7-13.

[redacted]

Figure 7-13: High-speed video stills of the [redacted]

7.4.1.6 It is apparent from Figure 7-13a that the [redacted] The subsequent impact of the [redacted] (Figure 7-13b) [redacted]

7.4.1.7 The loss of [redacted] allowed the projectile to partly penetrate the layered glass structure (Figure 7-13c) and the impact caused a large amount of glass-spalling from the inside surface, resulting in shards reaching the dummy pilot, as shown in Figure 7-13d. Such a loss of integrity would mean the windshield no longer acted as a pressure seal and, coupled with ram-air, would cause catastrophic failure. Figure 7-14 shows a photograph of the failed screen.

Figure 7-14: Photograph of windshield damage for [redacted]

7.4.1.8 Test 17 showed that a [redacted] (Table 1-3), but still within the flight envelope. The subsequent tests focussed on the effect of impacts on a windshield at lower velocities.

7.4.1.9 An inverted [redacted] was launched at an Airliner-A windshield as Test 18 [redacted] Figure 7-15 shows images from the high-speed camera indicting the levels of damage.

7.4.1.10 The impact [redacted] but there was [redacted] and the [redacted]. Figure 7-16 shows the damaged screen.

[redacted]

a) Outside camera view *b) Inside camera view*

Figure 7-15: High-speed video stills of the [redacted]

Figure 7-16: Photograph of windshield damage for [redacted]

7.4.1.11 The rationale for the last test was to run a scenario similar to the velocity of the Test 18, but impacting closer to the frame where the glass ligament was shorter, and to establish if the levels of damage were similar to an impact in the centre of the screen.

7.4.1.12 Test 19 [redacted] impacted the windshield at a point 141mm up and 141mm across from the bottom inboard corner. Figure 7-17 shows images from the high-speed camera showing the levels of damage.

[redacted]

a) Outside camera view *b) Inside camera view*

Figure 7-17: High-speed video stills of the [redacted]

7.4.1.13 Both the [redacted] generating the dust shown in Figure 7-17a but neither impact damaged the main plies. Figure 7-18 shows the screen post-test.

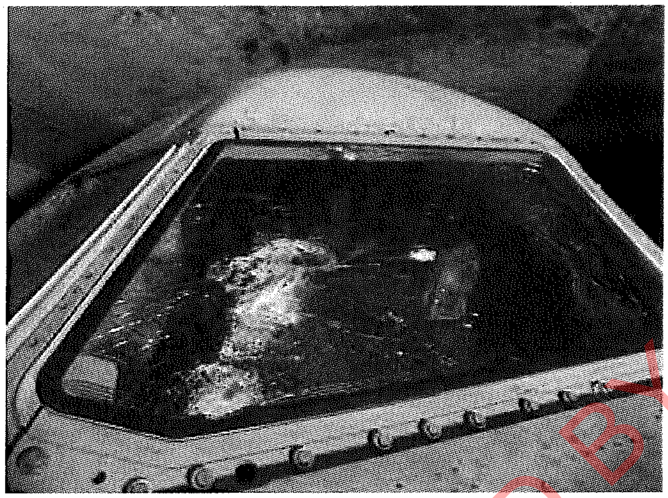


Figure 7-18: Photograph of windshield damage for [redacted]

7.5 Airliner-B windshield tests

7.5.1 In order to de-risk the selection of the [redacted] components in terms of their ability to damage a CS-25 class windshield, early in the programme, a windshield from Airliner-B was impacted by a [redacted] launched from the 6" calibre gun. A [redacted] was also launched at a second Airliner-B screen to further de-risk the launch process.

7.5.2 These tests, where the windshields were only loosely supported at the approximate correct angle, are shown in Table 7-3.

7.5.3 [redacted]

7.5.3.1 Here the projectile was a reduced version of that defined in Table 3-1, with a [redacted] Figure 7-19 shows the projectile fitted in to a 6" sabot.

[redacted]

Figure 7-19: The cut-down [redacted]

7.5.3.2 The projectile was launched as Test A1 [redacted] and images of the impact are shown in Figure 7-20. [redacted] shown in Figure 7-20b.

[redacted]

a) b)

Figure 7-20: High-speed video stills of the cut-down [redacted]

7.5.3.3 [redacted] A photograph of the post-test [redacted] is shown in Figure 7-21a, whilst the [redacted] is shown in Figure 7-21b.

[redacted]

Figure 7-21: Photograph of windshield damage for [redacted]

7.5.3.4 The [redacted] windshield from Test A1 was subjected to a second impact by a camera (Test [redacted] targeted 100mm below the first impact to account for the camera's position under the QC. Figure 7-22a shows the [redacted] with the [redacted] but the impact caused [redacted] as shown in Figure 7-22 b.

[redacted]

a) Outside camera view *b) Inside camera view*

Figure 7-22: High-speed video stills of [redacted]

7.5.4 [redacted]

7.5.4.1 A [redacted] consisting of a [redacted] was fitted in to a 6" sabot as shown in Figure 6-6 and launched as Test B [redacted]

7.5.4.2 Still images from the impact event, from the outside camera, are shown in Figure 7-23; there was no rear-facing camera used in this test. Figure 7-23a shows a [redacted]

[redacted]

Figure 7-23: High-speed video stills of the cut-down [redacted]

7.5.4.3 A post-impact photograph of the damage is shown in Figure 7-24.

[redacted]

Figure 7-24: Photograph of windshield damage for [redacted]

7.6 [redacted]

7.6.1 Some static crush and dynamic impact tests of the [redacted] were made to help characterise their behaviour for the modelling work; the testing is reported in Section 8.13.

7.6.2 [redacted] initiated through damage, [redacted]. The experimental results were analysed, considering any observed reactions.

7.6.3 For the static crush tests, the [redacted] as their behaviour was unknown and possibly hazardous. No [redacted] during these tests but [redacted] was evident during some of the crush tests. Photographs taken from the test of the [redacted] for the four classes of RPAS are shown in Figure 7-25, indicating when [redacted].

7.6.4 In most cases, for the dynamic testing of the [redacted] and during the RPAS projectile tests against the windshields, the [redacted] Despite the large amounts of deformation and damage seen, as indicated in Figure 7-26, [redacted]

[redacted]

[redacted]

7.7 Test summary

7.7.1 Techniques were developed that enabled [redacted] to be launched over the full range of potential in-service collision velocities.

7.7.2 Against Rotorcraft-A windshields

7.7.2.1 Rotorcraft-A windshields were shown to [redacted]

7.7.2.2 The [redacted]

7.7.3 Against Rotorcraft-B windshields

7.7.3.1 Rotorcraft-B windshields [redacted]

7.7.3.2 The [redacted] partially [redacted]

7.7.4 Against Airliner-A windshields

7.7.4.1 Airliner-A windshields showed [redacted]

7.7.4.2 The impact of an inverted [redacted]

7.7.4.3 Inverted projectile impacts at [redacted]

7.7.5 Against Airliner-B windshields

7.7.5.1 Airliner-B windshields were impacted [redacted]

7.7.5.2 A [redacted]

7.7.6 [redacted]

8 Material definitions

8.1 Introduction

8.1.1 Both the manned aircraft and the RPAS consist of a variety of materials which, in some cases, are specified by name and grade, but in others are more generically defined. A major part of being able to accurately model any real-world scenario, especially with damage and failure, is to have accurate mechanical properties of the materials and appropriate failure models in the FE code, along with the knowledge and expertise to be able to populate appropriate models.

8.1.2 In many cases, the exact specification of material will be unknown and some judgement has to be made based on the range of values found for a material property (e.g. yield strength), through literature surveys. In the absence of any supplied material data for the specific RPAS and target aircraft components, this was the approach taken here. Within a representative range of material property values, it was possible to calibrate model material parameters against available test data.

8.1.3 Within this programme, the material modelling of items such as [redacted] were derived from tests. These articles are themselves complex and are composed of different materials. To model such a compound item would be onerous and numerically inefficient as the desired outcome is the effect on the manned aircraft and not the state of the RPAS post-impact. For this reason, each of these parts were considered as a homogeneous material and characterised by static crush and dynamic impact tests (Sections 8.13 and 8.14).

8.1.4 This section summarises the selection of appropriate material models and the utilised material data in order to accurately model the manned aircraft and RPAS airframes. The method used to produce representative models of RPAS components is also covered along with details of the physical testing completed by Natural Impacts to support this modelling activity.

8.2 Glass

8.2.1 Glass generally behaves as a brittle material when loaded to failure. However, common (soda-lime) glass may be strengthened via thermal tempering heat treatments and chemical toughening processes. This can lead to a wide range of values for its strength and fracture toughness. Although some glass types have been defined for the manned aircraft windshields (Section 4.4), the exact properties of these materials are proprietary and not openly published. In the absence of specific data it was necessary to carry out a search of relevant literature to establish the possible range of values and the probable values for the windshield types tested in this programme.

8.2.2 A further challenge was the selection of an appropriate material model for use in the FE code Abaqus. Consideration was first made to the desired purpose of the material model. The focus of this study was to identify relative collision velocities at which a threat would either penetrate, cause extensive damage or rebound from a windshield. Therefore the use of a macroscopic brittle material model that performed elastically to failure in tension but not in compression was desired. During a literature study of method to model glass, multiple methods were investigated as to their applicability to this study; two of these showed the greatest promise and were subject to further investigation.

8.2.3 [redacted]

8.2.4 [redacted]

- [redacted]
- [redacted]

8.2.5 With a material model selected, it was necessary to define relevant material properties. Unlike other engineering materials, documents detailing the difference between the behaviour of different glasses were not readily accessible, either due to the information being proprietary or too difficult to measure reliably.

8.2.6 As the failure of glass occurs rapidly and can be altered significantly by a number of factors (for example, the variation and location of microcracks), tests to define a specific failure strength and toughness provide a wide range of values. This is highlighted in the first two rows of Table 8-1 which show the minimum and maximum values identified from a review of published experimental data [14], [15], [16], [18], [19], [20], [21], [22], [23], [24].

8.2.7 Parametric studies were carried out to determine the effect of the variation in material properties to aid with later calibration studies. The results from these studies, coupled with some initial tests on Rotorcraft-A windshields (Section 9.3), allowed the selection of data deemed appropriate for airframe windshields. The values identified via this exercise were used in modelling of the RPAS impact with Rotorcraft-A and Rotorcraft-B windshields (Section 10) without further calibration. Whilst the outside layer of the Airliner-A windshield used these same properties, the two main thicker layers were treated as having the maximum identified strength and fracture toughness; Table 8-1 details the material property values used for each windshield.

[redacted]

Table 8-1: Glass material properties: range and selected data

8.3 Polyvinyl Butyral (PVB)

8.3.1 Polyvinyl Butyral (PVB) is a 'rubbery' material used to bond layers of glass into a laminate and provides the ability to make such laminates 'shatter-proof' when impact by foreign objects. This bond layer acts as a membrane and has no appreciable bending stiffness.

8.3.2 Many different methods are available to model PVB, each tailored towards different problems. The driving factors of the selection process were for a model which would be simple to calibrate and allow easy implementation of failure behaviour, whilst still being representative of the material at high strain rates.

8.3.3 Several PVB material models were identified in the literature review and considered for use within this study:

- [redacted]
- [redacted]
- [redacted]

8.3.4 [redacted]

8.3.5 [redacted]

[redacted]

8.4 Thermoplastic Polyurethane (TPU)

8.4.1 For the Airliner-A windshield, it was understood from the manufacturer's website [12] that the thick interlayer between the outer glass ply and the middle glass plies was a Thermoplastic Polyurethane (TPU). Data for this was taken from a website [29] and detailed in Table 8-3.

[redacted]

Table 8-3: Thermoplastic Polyurethane material properties

8.5 Acrylic

8.5.1 Acrylic forms the inner layer of the Rotorcraft-B windshield laminate. [redacted]

[redacted]

Table 8-4: Acrylic material properties

8.6 Acrylonitrile Butadiene Styrene (ABS)

8.6.1 ABS was selected as a representative material for the [redacted]RPAS frame. Table 8-5 details the mechanical data implemented for this material.

[redacted]

Table 8-5: ABS Material Data [33, 34]

8.7 Nylon 66, 30% Glass Fibre

8.7.1 [redacted]

[redacted]

[redacted]

Table 8-6: Nylon 66, 30% Glass Fibre Material Data [31, 35, 36]

8.8 Aluminium alloy

8.8.1 Aluminium alloy was a prevalent material amongst the manned aircraft models. Generic elastic data was applied to appropriate airframe components. However, [redacted] RPAS was constructed with Al-6082 plates, for which the material data (Table 8-7) was obtained from the Engineering Sciences Data Unit (ESDU) website [37].

[redacted]

Table 8-7: Al-6082 Material Data [37]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted] [redacted]

[redacted] [redacted]

[redacted]

[redacted] [redacted]

[redacted] [redacted]

[redacted]

[redacted]

[redacted]

[redacted]

8.13 Testing of individual RPAS components

8.13.1 The complexity of RPAS components, such as the [redacted] made it infeasible to model the full assembly in detail, and it hence the approach used here was to represent these components as homogenous isotropic materials. This was achieved by characterising the material through static crash and dynamic impact testing. This would then provide confidence in the behaviour of the assembled RPAS models being representative of their physical counterparts

8.13.2 Crush tests were initially carried out to classify the compressive behaviour of the components; force-displacement curves were obtained. All component types were crushed, except for the [redacted] due to extended lead times on the procurement of these items; Table 8-15 shows the items tested.

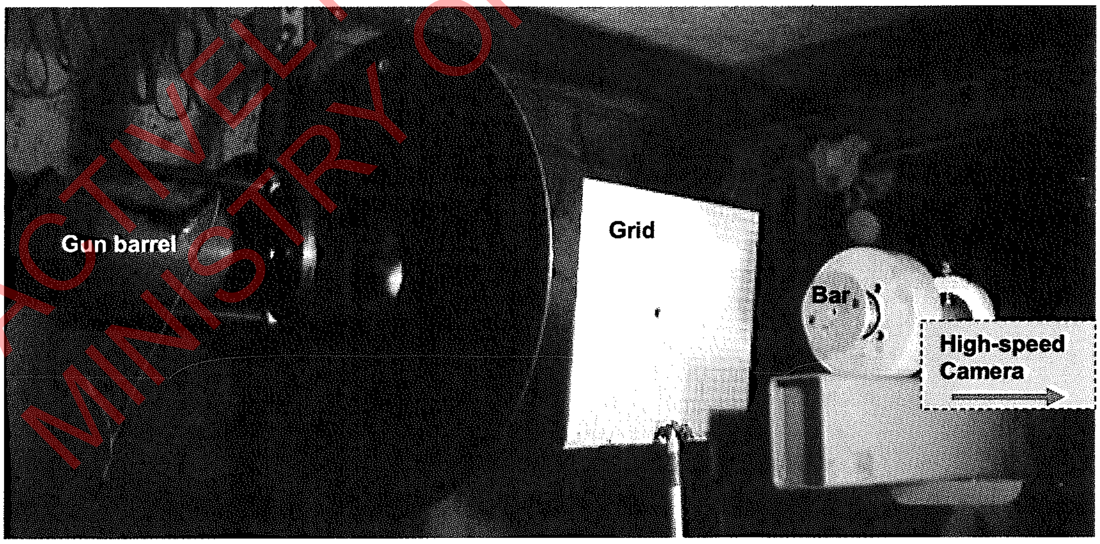


Figure 8-1: Natural Impacts' large Hopkinson bar test setup

8.13.3 Following this, impact tests against a Hopkinson bar (Figure 8-1) documented the dynamic response of the component; force-time histories were obtained. These were impacted along the same axis as the static crush tests, with the exception of the [redacted]

[redacted] which was impacted longitudinally. An example of a crush and impact test on a [redacted] motor within its frame is shown in Figure 8-2.

[redacted]

Table 8-15: Natural Impacts RPAS component testing matrix

[redacted]

2 The crush direction was aligned with the anticipated direction of impact during collision testing. The exception to this was the [redacted] which was tested laterally to avoid premature on-set of localised [redacted]. Note that this restriction did not apply to the impact tests, where the true behaviour of the [redacted] in the longitudinal direction was successfully characterised. The subsequently derived material properties were considered to homogeneous isotropic since there was only test data in one direction.

8.14 Material characterisation of RPAS components

8.14.1 An approach was developed by QinetiQ to produce representative material models of the supplied RPAS components using test data (Section 8.13). The force-displacement data from the crush tests was converted to elastic-plastic stress-strain data, which was then used in Abaqus to simulate the crush test to validate the stress-strain data.

8.14.2 This material model was then used to model the impact event of the same component at the same velocity as the physical test; the predicted force-time response was compared to that of the test.

8.14.3 [redacted]

[redacted]

[redacted]

8.14.4 [redacted]

9 Model development and validation

9.1 Introduction

9.1.1 This Section describes the approach taken to the development and incremental validation of the modelling work.

In addition to the RPAS component model calibration described in Sections 8.13 and 8.14, various additional studies and test activities were undertaken to inform and de-risk the development of methods prior to the final modelling runs against the threat matrix shown in Table 1-3.

9.1.2 These activities included:

1. Modelling studies to develop the analysis approach (Section 9.2);
2. Preliminary tests to provide early validation data of the models (Section 9.3), and;
3. Validation against the full-scale collision test results (Section 9.4).

9.2 Modelling studies to develop the analysis approach

9.2.1 As described in Section 8.1, the requirement to predict the failure of laminated glass structures introduced a great number of challenges to the modelling exercise. In addition to investigating suitable material models, it was necessary to determine an appropriate 'meshing scheme' for the windshields.

9.2.2 Preliminary studies included tens of thousands of simulations, run as parameter studies with a simple windshield being impacted with a simple projectile. These studies provided useful information that enabled decisions to be made on the setup of the model, element type, mesh density and contact properties.

9.2.3 Observations and conclusions from these early modelling studies included:

- [redacted]
- [redacted]
- [redacted]
- [redacted]

[redacted] [redacted]

[redacted] [redacted]

[redacted]

9.2.6 [redacted]

9.2.7 [redacted]

9.2.8 [redacted]

9.3 Preliminary tests to provide early validation data for model setup

9.3.1 To aid model development, in terms of approach and material models, additional impact tests were carried out using various components, fired against spare/damaged Rotorcraft-A windshields that were clamped to a test bench (not installed in the airframe). As the windshield material models and overall modelling approach had not been validated against experimental data, this was a significant step towards de-risking the technical delivery of the programme.

[redacted]

Table 9-1: Test matrix detailing early validation shots vs Rotorcraft-A windshields

9.3.2 The additional impact tests conducted against Rotorcraft-A screens are summarised in Table 9-1. Note that in order to maximise the benefits of the data being generated, these tests were carried out at velocities in the same velocity range as the planned full-scale collision tests.

9.3.3 These tests were very valuable, not just for early calibration efforts, but they also provided confidence in the material models and modelling method at the time. [redacted]

9.4 Validation against full-scale collision test results

9.4.1 The complete schedule of full-scale collision tests have been completed using the developed RPAS projectiles against windshields installed in the acquired manned aircraft structures. These tests are reported Section 7 and a summary of the test matrix with the measured impact velocities are presented in Table 7-1.

9.4.2 Rotorcraft-A results

9.4.2.1 Tests were carried out against the Rotorcraft-A windshield using the [redacted] and the [redacted] The Rotorcraft-A windshield is a [redacted] Early tests on loosely-held screens (Section 9.3) demonstrated that [redacted]

9.4.2.2 The Finite Element Model (FEM) of the Rotorcraft-A cockpit and windshield, which consisted of around [redacted] elements [redacted] degrees of freedom), was run using the same velocities at the tests[3].

9.4.2.3 The material models were calibrated using the test results, as follows:

- No changes to the glass properties
- Simplification of the PVB model to prevent excessive failure strengths due to high strain rates, as described in Section 8.3.

9.4.2.4 Figures in Appendix A.1 and A.2 provide a visual comparison of the test and predicted windshield condition post-impact; the comparison is excellent in terms of the extent of damage caused. Furthermore, comparisons of predicted damage and penetration thresholds against test results are illustrated in Section 10.

[3] The explicit dynamic time-stepping simulations of the RPAS projectiles vs manned aircraft scenarios (of Rotorcraft-A, Rotorcraft-B, Airliner-A and [redacted]) typically have to be run to a simulation time of greater than [redacted] (depending on the initial impact velocity) in order to progress the damage (should there be any). This would typically take between 50 and 150 CPU hours with an average of 90 CPU hours on 64-bit Dell workstations with 128GB RAM using Intel® Xeon® CPUE5-2697v3 2.6GHz processors.

9.4.3 Rotorcraft-B results

9.4.3.1 Tests were carried out against the Rotorcraft-B windshield using the [redacted]. The windshield is a [redacted]

9.4.3.2 The FEM of the Rotorcraft-B cockpit and windshield, which consisted of around [redacted] elements [redacted] degrees of freedom), was run for the same velocities as the tests.

9.4.3.3 The material models were calibrated using the test results, as follows:

- No changes to the glass properties
- 10% increase to the acrylic strength from the values that were originally assumed. Note that this increase is relatively modest and the strength remains within the range of values identified within QinetiQ's literature review.

9.4.3.4 Figures in Appendix A.3 and A.4 provide a visual comparison of the test and predicted windshield condition post-impact; the comparison is excellent in terms of the extent of damage caused. Furthermore, comparisons of predicted damage and penetration thresholds against test results are illustrated in Section 10.

9.4.4 Airliner-A results

9.4.4.1 Tests were carried out against the Airliner-A windshield using the [redacted] The windshield is a [redacted]

9.4.4.2 The FEM of the Airliner-A cockpit and windshield, which consisted of around [redacted] elements [redacted] degrees of freedom), was run at the same velocities as the tests. This included impacts with the [redacted] (nominal configuration) for the first two tests and also the inverted case, which was used for the remaining three impact tests. To better reflect the test conditions, the nominal configuration was run with 10° pitch up and the inverted configuration was run with 10° of downward pitch.

9.4.4.3 The first two collision tests on the Airliner-A windshields were conducted with the [redacted] projectile in its nominal orientation (see Figure 5-1) and at a velocity of [redacted]

9.4.4.4 Inspection of the high-speed video footage showed that the windshield, with its toughened outer glass ply, [redacted]. Furthermore, from inspection of the [redacted], it was observed that the [redacted] was not consistent with that of the rotorcraft screens. For example, [redacted] from around the [redacted], and the [redacted] The appearance of the [redacted]

---

4 It was judged that the [redacted] and associated sabot were very close to the limit of what they could withstand during launch. Given that there were [redacted], it was not considered to be a good use of the available shots to attempt to increase the launch velocity to [redacted]

9.4.4.5 The initial modelling results suggested [redacted] of the Airliner-A screen, when compared with the available test results. A range of steps were therefore taken to try to refine the models and calibrate the material properties[5] to better-capture the subtle interactions that were revealed in the high-speed video footage. In particular, the following changes were made to the models:

- [redacted]
- [redacted]
- [redacted]
- [redacted]

9.4.4.6 The above changes did improve the response but were not sufficient to achieve the excellent correlation observed for the other four collision test combinations. Key differences between the predicted and tested response include:

- Analysis cases where the [redacted] directly impacts the windshield (i.e. [redacted] do not capture the failure response of the [redacted] correctly and are likely to significantly over-estimate the contact forces. *This is because the [redacted] material was only calibrated against crush test data and so the resulting model cannot [redacted] in the manner observed during test. Inspection of the high-speed video footage suggested the [redacted] the impact of the [redacted] so this might lead to conservative estimates of failure velocities.*
- The model predicts [redacted] during the initial contact with the [redacted] whereas the [redacted] *This could be due to many factors including (but not limited to) the material degradation and erosion laws utilised within the analysis code, or differences in support provided by the interlayer.*
- [redacted] *This implies that the impact forces are being over-predicted, the load transfer within the laminate not being correctly modelled, and/or the strength of the laminate is greater than expected, possibly due to the applied toughening treatments.*
- The [redacted] was tested statically in the [redacted] rather than the [redacted] in which it [redacted] *However, this is unlikely to be significant as the material model was developed from this data and the [redacted] test data.* [redacted]

9.4.4.7 The subsequent models which employed the inverted projectile configuration (C4.0QC-I), had the [redacted] from the projectile model as it was considered that the material behaviour of the [redacted] was not representative of the [redacted] seen in the tests.

5 Whilst it might be possible to adjust the model by simply increasing the strength of the glass without consideration of physical limits, this would not be good practice. Instead, modifications have been limited to those that are compatible with available evidence and have a clear physical justification.

9.4.4.8 Figures in Appendix A.5 and A.6 provide a visual comparison of the test and predicted windshield condition post-impact. Furthermore, comparisons of predicted damage and penetration thresholds against test results are illustrated in Section 10.

9.4.4.9 It can be seen from these results that:

a. The current Airliner-A model gives conservative results.
b. The extent of damage predicted in the outer ply is broadly comparable with that observed in test, but the model fails in a less complex manner.
c. [redacted] is consistent with the inverted RPAS test results[6], even if the models [redacted]

9.4.4.10 Further possible refinements to the models have been identified but are not within the scope or available timescales of this programme. Recommendations for future work on this topic are included in Section 12.

9.4.5 [redacted]

[redacted]

6 No collapse result was recorded for the nominal configuration.

7 A continuum shell behaves largely like a conventional shell element, but it is a three-dimensional cell with its thickness being defined by geometry and a surface normal.

10 Collision modelling results

10.1 Introduction

10.1.1 Previous sections of this report have documented the development and validation of modelling methods to predict the effect of impacts between small RPAS and manned aircraft. The final part in this programme was to exercise these methods against the full analysis matrix defined in Table 1-3.

10.1.2 There is a high level of confidence in the results of the Rotorcraft-A and Rotorcraft-B windshield analyses due to the predictions showing good comparison with the testing (Section 9.4). However, the comparison of the Airliner-A predictions with the limited tests has been less favourable, with a trend towards more conservative predictions of impact velocities causing damage.

10.1.3 Generation of analysis results to determine damage and failure thresholds for each of the collision scenarios was carried out by running each case at different initial impact velocities and making an assessment of the predicted outcome. This required approximately 100 model simulations, totalling approximately 9,000 CPU hours of computational effort. The result have been plotted on bar charts (shown in later figures) using the green-amber-red colour damage level definitions defined in Table 7-2.

10.1.4 The collision test results are also marked on the bar-charts[8]. These are displayed as discrete points and are also coloured in accordance with the damage level definitions in Table 7-2. Further, for comparison, photographs of the resulting damage of the test windshields are shown against the predicted damage of the modelling in Appendix A.

10.1.5 [redacted]

8 Charts for Airliner-B have not been produced because no modelling activity was undertaken for this configuration. Note that the test activities on Airliner-B, presented within this report, were not planned within the contract. Furthermore, it should be noted that these tests were conducted with the screens not installed in their parent airframe.

10.2 Rotorcraft-A windshield impacts

10.2.1 Frames from an example impact analysis against Rotorcraft-A are shown below in Figure 10-1. Results for all collision scenarios are shown in Figure 10-2.

[redacted]

[redacted]

10.3 Rotorcraft-B windshield impacts

10.3.1 Frames from an example impact analysis against Rotorcraft-B are shown below in Figure 10-3. Results for all collision scenarios are shown in Figure 10-4.

[redacted]

[redacted]

10.4 [redacted]

[redacted]

[redacted]

10.5 [redacted]

[redacted]

[redacted]

10.5.2 [redacted]

[redacted]

[redacted]

10.6 Summary of collision modelling results

10.6.1 Table 10-1 provided a summary of the [redacted] collisions against the different manned aircraft.

[redacted]

[redacted]

[redacted]

11 Conclusions

11.1 Aircraft vulnerability to RPAS threat

11.1.1 Prior to this study, the effect of small RPAS colliding with manned aircraft structures was subject to much speculation and opinion, but very little evidence. The results of this study provide a step change in knowledge and will support the Stakeholders in making informed and balanced decisions or recommendations on future legislation, aircraft operations, operational airspace management, design standards and research requirements.

11.1.2 [redacted]

11.1.3 Table 11-1 shows the predicted damage [redacted]

[redacted]

Table 11-1: Predicted damage and [redacted]

11.1.4 [redacted]

11.1.5 It is worthy of note that the Rotorcraft-B windshield is certified against bird strike requirements, whereas the Rotorcraft-A screen is not; [redacted]

11.1.6 The Airliner-A windshield is significantly more substantial than that of the rotorcraft windshields, and comprises multiple layers of glass and interlayer materials up to a thickness of approximate [redacted]

11.1.7 [redacted]

11.1.8 [redacted]

11.2 Development and validation of analysis methods

11.2.1 Despite the technical challenges associated with modelling the failure response of glass structures, the complexity of the RPAS configurations and the dearth of information that was initially available, the modelling activities generally produced accurate predictions, particularly against the rotorcraft tests.

11.2.2 A key factor in the success of this activity was the incremental validation approach, making best use of available testing facilities and aircraft/RPAS hardware assets, to progressively de-risk and guide the model development.

11.2.3 The modelling results for Rotorcraft-A and Rotorcraft-B proved to be accurate [redacted] This is evident from the comparison of test and modelling results presented in Section 10 and Appendix A. The predictions for the more-complex Airliner-A windshields did not achieve the same level of accuracy but this can, in part, but attributed to known simplifications to the RPAS material models and suspected differences in the construction of the screens from the supplied data. Attempts were made to refine and calibrate the Airliner-A windshield model [redacted] but there remains a discrepancy that appears to result in overly-conservative failure predictions. This is an area that is worthy of further exploration, to determine whether the existing analysis methods can be legitimately calibrated for this thicker, more-complex screen or whether alternative material models might be required for this class of structural transparency.

11.2.4 The modelling work has created a capability that can be used to explore additional impact scenarios and possible mitigation measures for embodiment in future design guidelines.

12 Recommendations

12.1 The test evidence and methods developed and validated within this programme provide a high-value and unique capability that can be exploited in many ways. The application and development of the information and capability will depend upon Stakeholder, industry and wider government requirements, but the following section provides QinetiQ's summary of recommendations from the work. This includes aspects where QinetiQ feel development should continue, and ideas and recommendations for further exploitation of the work completed to date.

12.2 Exploitation of the modelling capability

12.2.1 The modelling work has created a capability that can be used to explore additional impact scenarios and possible mitigation measures for embodiment in future design guidelines. In particular, further activities could include:

- [redacted]
- Assessing the effect of impacts against other areas of the aircraft, including leading edges, nose cones, main rotors and control surfaces.
- Assessing alternative platforms e.g. Fast Jets, or alternative RPAS representations.
- Assessing the effect of glancing impacts and different impact scenarios/locations to provide data that could be used when quantifying the risk, as well as the severity of impact.
- [redacted]

12.3 Development and refinement of the modelling

12.3.1 The analysis activity developed methods that produced accurate results for the majority of the collision scenarios. However further development of the Airliner-A windshield impact cases is recommended in order to improve the level of confidence in the screen configuration/materials and the accuracy of the modelling predictions. Initial modifications to the Airliner-A windshield and [redacted]representation during the post-test calibration activity improved the correlation with test (including behaviour at different stages of the impact as well as the headline red-amber-green criteria) but it was not possible to explore all of the identified options. There are many activities that could be undertaken to support this including small experimental studies, forensic evaluation of the screens and pure model development. Examples include:

- Development/application of a [redacted] to better reflect its response under impact, including the [redacted] that it was observed to have on the nominal configuration [redacted] tests.
- Inspection/test of the Airliner-A windshield interlayer to determine its material type and generate better material property data.
- Testing of Airliner-A glass samples to determine realistic performance data for the material.
- Investigation of alternative material models for thick glass structures, such as the Airliner-A screens.

- Additional testing against Airliner-A screens, using well-defined projectiles such as ball bearings or individual components.
- [redacted]
- Component testing against instrumented wedges to improve failure models [redacted]
- [redacted]
- Consideration of secondary impacts between RPAS debris and [redacted].

12.4 Extension of proven modelling approach

12.4.1 The methodology developed by QinetiQ to deliver this programme of work could be applied to other complex impact modelling problems. This might include development of test evidence and modelling capability to assess the consequences of RPAS impacting other critical structures such as fan blades.

13 References

1. Brooks, M. *Small RPAS Collision Study - Request for Quotation.* UASCDC/TR47/RFQ/2.0, 24 Jun 2016

[redacted]

5. *Autonomous Systems Underpinning Research (ASUR).* http://www.asur-programme.co.uk, Oct 2016.

6. *Alliance for Systems Safety of UAS through Research Excellence (ASSURE).* http://www.assureuas.org, Oct 2016.

7. Radi, A., *Potential damage assessment of a mid-air collision with a small UAV*, Monash University, V1.0, 2013.

8. [redacted]

[redacted]

12. [redacted]

13. [redacted]mail to William Austen, QinetiQ, dst[redacted]

14. [redacted]

15. [redacted]

16. [redacted]

17. *Abaqus 6.14 Online Documentation*, Dassault Systèmes, Abaqus version 6.14, Apr 2014.
18. [redacted]
19. [redacted]
20. [redacted]
21. [redacted]
22. [redacted]
23. [redacted]
24. [redacted]
25. [redacted]
26. [redacted]
27. [redacted]
28. [redacted]
29. [redacted]
30. [redacted]
31. *Matweb* www.matweb.com, Oct 2016.
32. [redacted]
33. *Matbase* www.matbase.com, Oct 2016.
34. *Plastics International* www.plasicsintl.com, Oct 2016.

35. [redacted]

36. [redacted]

37. [redacted]

38. [redacted]

39. [redacted]

40. [redacted]

41. [redacted]

14 List of Abbreviations

ABS	Acrylonitrile Butadiene Styrene
BALPA	British Airline Pilots Association
CAA	Civil Aviation Authority
CAD	Computer-Aided-Design
COTS	Commercial Off-The-Shelf
DfT	Department for Transport
Def Stan	Defence Standard (UK)
FEA	Finite Element Analysis
FEM	Finite Element Model
fps	Frames per second
FW	Fixed-Wing
GFX	Government Furnished Supplies
HDPE	High-density polyethylene
IR	Infra-Red
Li-Fe	Lithium-iron
Li-Po	Lithium-polymer
MAA	Military Aviation Authority
MTOW	Maximum Take-Off Weight
NI	Natural Impacts
PVB	Polyvinyl Butyral
QC	Quadcopter
RPAS	Remotely Piloted Air System
S&L	Straight and Level
TPU	Thermoplastic Polyurethane
UK	United Kingdom
UAS	Unmanned Air System
UASCDC	Unmanned Air Systems Capability Development Centre

15 List of units

”	inch
g	gram
kg	kilogram
m	metre
mm	millimetre
ms	millisecond
ms^{-1}	metre per second

A Pictorial comparison of windshield damage

A.1 Rotorcraft-A vs [redacted]

[redacted]

[redacted]

[redacted]

[redacted]

A.2 Rotorcraft-A vs [redacted]

[redacted]

[redacted]

[redacted]

A.3 Rotorcraft-B vs [redacted]

[redacted]

[redacted]

[redacted]

A.4 Rotorcraft-B vs [redacted]

[redacted]

[redacted]

[redacted]

A.5 Airliner-A vs [redacted]

[redacted]

[redacted]

A.6 [redacted]

[redacted]

[redacted]

A.7 Airliner-B vs [redacted]

[redacted]

A.8 Airliner-B vs [redacted]

[redacted]

[redacted]

[redacted]

Initial Distribution List

External		
Major (RCAF) Roderick Short, MAA	Soft copy (pdf):	Copy 1 of 5
Mr Carl Davies SDM UAS CDC	Soft copy (pdf):	Copy 2 of 5
Mr Tim Pottage, BALPA	Soft copy (pdf):	Copy 3 of 5
Dr Daniel Jones, DfT	Soft copy (pdf):	Copy 4 of 5

QinetiQ		
Authors	Soft copy (pdf):	Copy 5 of 5
Information Warehouse	Soft copy (pdf):	As authors

Blank page

Report Documentation Page

Originator's Report Number	QINETIQ/17/01224/1.0
Originator's Name and Location	Bill Austen, Dr Steven Lord, Dr Roger White*, Richard Purver*, Simon Bridges & Kieran Wood, G069-A7, Cody Technology Park, GU14 0LX, UK
Customer Contract Number	MAA Contract HOCS1c/0024 and BALPA Purchase Order No 6155G
Customer Sponsor's Post/Name and Location	Kevin Griffith, UAS Capability Development Centre

Report Protective Marking and any other markings	Date of issue	Pagination	No. of references
OFFICIAL SENSITIVE - HANDLING INSTRUCTION: NOT TO BE DISTRIBUTED OUTSIDE THE ORGANISATIONS LISTED IN THE ADDITIONAL RELEASE CONDITIONS SECTION OF THIS REPORT QinetiQ Proprietary	10 April 2017	127 + Covers	41

Report Title
Small RPAS Collision Study - Final Report

Translation / Conference details: N/A

Title Protective Marking	OFFICIAL
Authors	Bill Austen, Dr Steven Lord, Dr Roger White*, Richard Purver*, Simon Bridges & Kieran Wood *(*Natural Impacts Ltd)*
Downgrading Statement	N/A
Secondary Release Limitations	N/A
Announcement Limitations	T047 - Small Remotely Piloted Aircraft System Collision Study External Communication Plan Ref: UASCDC/T047/ECP
Keywords / Descriptors	RPAS, Drone, Collision, Impact, Finite Element Modelling, Testing, Manned Aircraft, Windshields, Tail rotor

Abstract
A programme of work has been successfully completed to evaluate, via state-of-the-art analysis and full-scale testing, the impact threat posed by various small Remotely Piloted Air Systems (RPAS) to different classes of manned aircraft. Results have demonstrated that [redacted]. The output from this study provides a step change in knowledge and capability that will support the UK military and aviation authorities in making informed and balanced decisions/recommendations on future legislation, aircraft operations, operational airspace management, design standards and research requirements.

Abstract Protective Marking:	OFFICIAL SENSITIVE - HANDLING INSTRUCTION: NOT TO BE DISTRIBUTED OUTSIDE THE ORGANISATIONS LISTED IN THE ADDITIONAL RELEASE CONDITIONS SECTION OF THIS REPORT QinetiQ Proprietary

Last page

[redacted]

From: K S Webby [redacted]
Sent: Friday, 28 May 2021 10:44 AM
To: Enabling Drone Integration
Subject: Submission by Kim and Tawhai Webby to the Enabling Drone Integration-Consultation document
Attachments: Enabling Drone Integration-Consultation Submission.docx

Enabling Drone Integration-Consultation
Ministry of Transport
PO Box 3175
Wellington 6140

[redacted]

28 May 2021

Dear Sir/Madam,
Thank you for the opportunity to comment on your consultation document.

Although we are supportive of the efforts to improve the integration and safety of drone use in New Zealand, we are concerned that Control Line model aircraft are included in your proposed legislation.

My son, Tawhai and I are active Control Line model aircraft fliers (along with a group of enthusiasts around the world) who enjoy this sport for recreation and competition at a national level. Internationally I have represented New Zealand five times including two World Championships.

Our Submission is that the consultation document incorrectly identifies Control Line model aircraft flying as either remotely piloted aircraft (RPA) or as unmanned aircraft (UA).

Control Line model aircraft are tethered by cables with a maximum line length of 22m depending on the event class governed by Model Flying New Zealand or international FAI rules. Control Line models fly in a half hemisphere and are controlled by the pilot in the centre circle. The maximum airspace used would be within a 50m diameter circle and altitude of 24m allowing for the pilot. The models are controlled directly through the control cables and are not remotely piloted. The models would rarely weigh over 2kg with most being under 1800g.

We suggest that a simple exemption be given to Control Line model aircraft that are physically constrained by control lines less than 25 metres length. United Kingdom has an exemption for Control Line model aircraft.

Thank you for your consideration of our suggestion.

Yours faithfully
Kim and Tawhai Webby

[redacted]

From: Bryan Lintott [redacted]
Sent: Friday, 4 June 2021 3:49 PM
To: Enabling Drone Integration
Subject: Enabling Drone Integration consultation. B. Lintott
Attachments: ATCM41_ Environmental Guidelines for Operation of RPAS in Antarctica .pdf; ATCM41 _Resolution 4. Environmental Guidelines for operation of Remotely Piloted Aircraft Systems.docx; ATCM38_ip082_USAP Safe Operations.doc; ATCM38_ip082 UAS Risk Assessment Form .pdf; ATCM37_wp051_UAS for research, monitoring and observation.doc

Uninhabited Aerial Vehicles (UAV) and Urban Air Mobility (UAM)
'Drone' Consultation 2021

Tēnā koutou,

I offer this contribution to the consultation on the enhanced integration of Uninhabited Aerial Vehicles (UAVs) and Urban Air Mobility (UAM) in the Aotearoa New Zealand national air space. It is based on my professional heritage experience in Aotearoa New Zealand, [redacted] general interest in aviation, and international heritage advocacy through two International Council on Monuments and Sites (ICOMOS) international scientific committees: polar, and risk preparedness. The views expressed are my own.

The term 'Uninhabited Aerial Vehicles (UAVs), already in use in the United Kingdom, is one option to consider as it is aligned with contemporary degenderising of all aerospace terminology and nomenclature. In addition, urban Air Mobility (UAM) allows for the 'habitation' of robotic aviation platforms.

There is the risk of physical impact damage or destruction that unrestricted use of UAVs and UAM may cause to historic sites, structures and monuments and secondarily, damage or destruction through incorrect removal of crash debris and the possibility of fire caused by battery/circuitry/motor malfunction. If a UAV or UAM impacts a historic site, structure or monument, the historic site, structure and monument custodian/s should be approached by the first responders and operators of the UAV or UAM. The custodians can advise on additional risks to remove the UAV or UAM and confirm the response plan to limit or prevent further damage. In the event that the custodians are not contactable, first responders should have been provided with general and site-specific advice on responding to UAV and UAM impact events,

There is the risk that the visual, aural aspects, or awareness of observation/surveillance by UAVs and UAMs will diminish, disrupt or destroy intangible heritage experiences and values, ranging from spatial appreciation and temporal association to cultural and spiritual values. For example, visiting a site related to 19th-century events and reflecting upon the past is an encounter that is best experienced when there are no modern distractions, *e.g.* not having to 'filter' the 'angry techno swarm' noise of a UAV or UAM. In addition, many cultural and spiritual events are profound encounters deserving of the individual's or group's privacy.

In response to these cultural and spiritual concerns, heritage UAV and UAM exclusion zones - permanent and temporary - should be established through consultation and regulation. Aotearoa New Zealand is fortunate in having a range of heritage organisations, groups, communities, and advocates who can provide expert advice on places of cultural, spiritual, and historical significance that should be excluded from unpermitted UAVs and UAM activity. These include Te Arawhiti Office for Māori Crown Relations, the Ministry for the Environment Mahi mō te Taiao, the Ministry for Culture and Heritage Manatū Taonga, Heritage New Zealand Pouhere Taonga; rūnanga, iwi, hapū and whanau; ICOMOS New Zealand Te Mana o Nga Pouwhenua o Te Ao and regional, local and community entities. The above should also have an ongoing role in monitoring and informing responses to UAV and UAM activity.

When considering how to permit UAVs to record imagery to promote historic sites, structures, monuments, and associated events and ceremonies, there is merit in assessing the guidelines established by English Heritage:

- 'To ensure the safety and security of English Heritage sites, any drone flying must take place when the site is closed to the public. All operators must hold the following:
- A current and valid Permit for Commercial Operation (PfCo) from the CAA;
- evidence of valid drone and public liability insurance;
- a risk assessment for the proposed drone flight;
- a flight plan for the proposed drone flight;
- a technical specification for the make / model of drone to be used.[1]'

Consideration should be given as to how UAVs and UAM laws and regulations in the home islands relate to the operation of these technologies within the Ross Dependency, Antarctica. The current guidelines, and some related documents, for Antarctic RPAS and other robotic platforms are attached.

UAVs and UAM are being incorporated into the Aotearoa New Zealand national air space as a domestic undertaking, and by a range of international actors as an experimental environment. Accordingly, developments here will influence and impact internationally; therefore, consideration should be given to the potential global aspects of what is being developed and deployed in Aotearoa New Zealand.

Nāku, nā

B. Lintott

[redacted]

[1] https://www.english-heritage.org.uk/about-us/filming-and-tv-locations/drone-filming/. Accessed: 4 June 2021.

WP 51

XXXVII ANTARCTIC TREATY CONSULTATIVE MEETING
BRASILIA 2014

Agenda Item:	ATCM 10, CEP 8b
Presented by:	United States
Original:	English
Submitted:	14/03/2014

Considerations for the use of unmanned aircraft systems (UAS) for research, monitoring, and observation in Antarctica

Considerations for the use of unmanned aircraft systems (UAS) for research, monitoring, and observation in Antarctica

Working Paper submitted by the United States

Summary

Unmanned aircraft systems are being used worldwide as tools for scientific data collection and environmental monitoring. This paper invites the CEP and ATCM to consider the potential for expanded use of unmanned aircraft in Antarctica and how best to ensure the safety of personnel, infrastructure, wildlife, and the environment.

Introduction

The use of unmanned aircraft systems (UAS), some of which are known as remotely-piloted aircraft systems (RPAS), has expanded worldwide over the past few decades. Recent advances in the technology, decreasing cost, and advantages over manned aircraft have resulted in increased UAS use in scientific research. UAS utilization by scientists, national programs, and visitors in Antarctica is currently limited, but expected to increase in the near future. This paper includes a description of UAS, their applications, the potential impacts of their use in Antarctica, and measures to mitigate those impacts.

Description and classification

Unmanned aircraft systems used in research consist of an unmanned aircraft, a ground control system, a control link, and a sensor payload. Some UAS are also known as RPAS. The aircraft component of the UAS can be referred to as an unmanned aerial vehicle (UAV), a remotely piloted vehicle (RPV), a remotely operated aircraft (ROA) or a drone.

UAS vary widely in size and application and, as an emerging technology, continue to evolve. UAS can generally be classified according to their size, the altitudes at which they operate, and their endurance. UAS weighing 25 kg or less are often classified as small (sUAS), generally operate at low altitudes (≤ 1 km) for a few minutes to hours, and are usually battery-operated. Larger UAS operate at medium (up to 10 km) to high altitudes (20 km or more) for longer periods of time (many hours to days) and may use battery packs, petroleum fuels, and/or solar panels.

Vertical take off and landing (VTOL) UAS have the ability to operate in limited or uneven terrain and are highly portable. These systems generally operate at low altitudes and for limited durations, as their ability to hover can strain their batteries. Certain VTOL UAS are referred to as copters, with some designation of the number of rotors (e.g. "quadcopter" for a 4-rotor aircraft).

A UAS crew includes a remote pilot and usually at least one observer. The observer can assist in maintaining the visual line-of-sight (VLOS) with the aircraft and monitor the airspace for potential collisions. The pilot and the observer(s) should maintain a constant communications link.

Advantages and considerations

As an alternative for Antarctic research and monitoring, UAS can offer some advantages over manned aircraft missions and satellites including lower initial investment and operating costs, logistical flexibility, and, as compared to manned aircraft missions, increased personnel safety and reduced fossil fuel use. sUAS are also very quiet and could fly over animal colonies with minimal disturbance.

UAS used in polar environments should be capable of operating in extreme cold temperatures and under icing conditions. Weather restrictions, including wind speed and cloud cover limitations, should be carefully considered. The size and terrain of the area required for take off and landing merit consideration, as do options for launch methods. Bandwidth requirements and the degree of automation of UAS are important in light of the limited communications infrastructure in Antarctica.

Current and emerging Antarctic applications

Current Antarctic UAS applications include wildlife monitoring, remote sensing, and aerial filming. The U.S. National Oceanographic and Atmospheric Administration (NOAA) estimated abundances of krill-dependent predators with VTOL sUAS and camera payloads to help fulfill CCAMLR monitoring obligations. The Center for the Remote Sensing of Ice Sheets (CRESIS) at the University of Kansas, with U.S. National Science Foundation (NSF) funding, used a mid-sized UAS to perform radar soundings and collect images of the ice sheet in the Whillans Ice Stream area. Tour operators are using radio-controlled VTOL sUAS to film Antarctic landscape features inaccessible by other means to expand the experience for visitors.

Expansion of UAS utilization in Antarctica should be expected as these systems offer advantages over manned flights and ground-based observations for monitoring environmental conditions and wildlife. National programs and visitors could employ UAS for way-finding and obstruction detection and UAS have the potential for use in search and rescue. Tour operators and visitors will likely seek to expand their use of UAS for filming and photography.

Risk to operations and ecosystems

UAS, though small and remotely-piloted, are still aircraft. Therefore, risks should be assessed as for any airborne object and UAS should be operated as safely as manned aircraft. Risks to science and support operations include collisions with other aircraft and vital infrastructure; radio signal and electromagnetic interference; and injury of personnel. UAS use in Antarctica also puts wildlife, especially birds, at risk for disturbance and, in the case of collision or crash, injury or death. Crashes or collisions involving UAS risk damaging or destroying the Antarctica's wilderness and sensitive areas including Antarctic Specially Protected Areas (ASPAs) and Historic Sites and Monuments (HSMs).

Mitigation of risks

Mitigation measures should be implemented to ensure that the advantages of operating UAS in Antarctica outweigh the risks to personnel, science, ecosystems, and infrastructure. Thorough analyses of the aforementioned risks, as well as the potential for waste generation, should be performed for each application of UAS.

Guidelines and best practices for UAS utilization in Antarctica should be established to ensure safety and to minimize risk to people, wildlife, the environment, and property in the air and on the ground. Notification of airspace coordinators and station operators of intended UAS use will help to separate UAS from other aircraft and minimize interference with research and science support operations. Mitigating the risks of harmful interference to Antarctic fauna and flora (Annex II to the Protocol on Environmental Protection to the Antarctic Treaty) could be accomplished via implementation of the Guidelines for the Operation of Aircraft Near Concentrations of Birds in Antarctica (Resolution 2 (2004)) with modifications for UAS. Restricting the use of UAS within ASPAs and near HSMs will help to ensure the preservation of these sensitive areas.

Best practices for operating UAS should include essential design features, training regimes, and operating conditions. All UAS should have safety features that minimize the risk of failure, crashes, and collisions including, but not limited to: automated return-to-home and landing modes should the system experience a loss of control link; pairing of aircraft to ground control to avoid loss of control due to signal interference; and, as available, sense-and-avoid technology. Safe operations can also be supported through training of

UAS pilots and observers including, but not limited to, simulations, test flights indoors or in restricted airspace, and field test flights.

Attention to operating parameters and conditions including altitude and range limitations of the device; guidelines for proximity to personnel, wildlife, and infrastructure; and weather limits such as wind and cloud cover is critical. Maintaining VLOS is an important practice to avoid collisions with other aircraft and to minimize harmful interference of wildlife (maintenance of VLOS and use of observers may vary with UAS platforms and applications). Airworthiness maintenance is critical to avoid failure – factors such as remaining battery charge and integrity of the aircraft and payload should be considered, amongst others. Plans should be in place for landing the aircraft away from personnel, structures, wildlife, and APSAs if an in-flight emergency occurs.

Including UAS activities in environmental evaluations and permit issuance could also help to ensure safety and mitigation of risk. To ensure safety for all aircraft and to minimize injury and loss of life, many national civilian aviation authorities have issued and/or are developing standards and regulations for UAS use within their airspace including certifications of airworthiness and crews (Resources Annex). Consideration of guidelines and best practices that are compatible between National Antarctic Programs is merited.

Recommendations

Expanded UAS use has the potential to contribute substantially to the study and monitoring of the Antarctic environment and to other scientific research. UAS have distinct advantages over manned aircraft and other monitoring techniques. However, there are inherent risks to UAS operations that should be considered and efforts should be made to mitigate those risks. The CEP and ATCM are recommended to:

1) note the potential for UAS to contribute to scientific research and environmental monitoring in Antarctica and acknowledge that use of UAS in the Antarctic is likely to expand in the near future;
2) consider requesting that SCAR review the risks of UAS operations on the safety of wildlife and the environment;
3) consider requesting that COMNAP review the risks of UAS operations on the safety of other aircraft and on station operations; and,
4) after reviewing the results of the risk analyses, invite COMNAP, in consultation with SCAR and external experts in the safe operations of UAS, to discuss establishing guidelines for the environmentally- and operationally-safe use of UAS in Antarctica that are compatible across National Antarctic Programs.

Annex: Resources

UAS use in scientific research

Arctic Monitoring and Assessment Programme. 2012. Enabling Science Use of Unmanned Aircraft Systems for Arctic Environmental Monitoring. By: Crowe, W., Davis, K.D., la Cour-Harbo, A., Vihma, T., Lesenkov, S., Eppi, R., Weatherhead, E.C., Liu, P., raustein, M., Abrahamsson, M., Johansen, K-S., Marshall, D., Storvold, R., Mulac, B. Oslo, 30 pp. (http://www.amap.no/documents/doc/enabling-science-use-of-unmanned-aircraft-systems-for-arctic-environmental-monitoring/716)

Arctic Monitoring and Assessment Programme. *In preparation*. Handbook for Scientific UAS Operation in the Arctic. (http://www.amap.no/documents)

Perryman, W., Goebel, M.E., Ash, N., LeRoi, D., and Gardner, S. 2014. Small unmanned aerial systems for estimating abundance of frill-dependent predators: a feasibility study with preliminary results. In: Walsh, J.G., ed. *AMLR 2010-2011 Field Season Report*. NOAA National Marine Fisheries Services. Technical Memorandum: NOAA-TM-NMFS-SWFSC-524, pp. 64-72. (http://swfsc.noaa.gov/uploadedFiles/Divisions/AERD/Publications/FSR2011_AMLR_FINAL.pdf?n=9809)

Watts, A.C., Ambrosia, V.G., and Hinkley, E.A. 2012. Unmanned aircraft systems in remote sensing and scientific research: classification and considerations of use. Remote Sensing. 4 (6), 1671-1692; doi: 10.3390/rs4061671 (http://www.mdpi.com/2072-4292/4/6/1671)

Relevant frameworks, guidelines, and policies

Antarctic Treaty Secretariat. 2004. Guidelines for the Operation of Aircraft Near Concentrations of Birds in Antarctica. Resolution 2, Annex II to the Protocol on Environmental Protection to the Antarctic Treaty. (http://www.ats.aq/documents/cep/Guidelines_aircraft_e.pdf)

European Aviation Safety Agency. 2009. Policy Statement – Airworthiness Certification of Unmanned Aircraft Systems (UAS). Doc # E.Y013-01. (http://www.easa.europa.eu/certification/docs/policy-statements/E.Y013-01_%20UAS_%20Policy.pdf)

European RPAS Steering Group. 2013. Roadmap for the Integration of Civil Remotely-piloted Aircraft Systems into the European Aviation System. Final Report. (http://ec.europa.eu/enterprise/sectors/aerospace/files/rpas-roadmap_en.pdf)

Federal Aviation Administration. 1981. Model Aircraft Operating Standards. Advisory Circular: AC 91-57. (http://www.faa.gov/documentLibrary/media/Advisory_Circular/91-57.pdf)

Federal Aviation Administration. 2007. Unmanned Aircraft Operations in the National Airspace System. Federal Register Notice: Docket No. FAA-2006-25714. (http://www.faa.gov/about/initiatives/uas/reg/media/frnotice_uas.pdf)

Federal Aviation Administration. 2012. Expanding Use of Small Unmanned Aircraft Systems in the Arctic: Implementation Plan. (http://www.faa.gov/about/initiatives/uas/media/sUAS_Arctic_Plan.pdf)

Federal Aviation Administration. 2013. Integration of Civil Unmanned Aircraft Systems in the National Airspace System Roadmap. (http://www.faa.gov/about/initiatives/uas/media/UAS_Roadmap_2013.pdf)

International Civil Aviation Organization. 2012. Unmanned Aircraft System (UAS). Circular: Cir 328, AN/190. (http://www.icao.int/Meetings/UAS/Documents/Circular%20328_en.pdf)

Websites

Center for the Remote Sensing of Ice Sheets (CRESIS), University of Kansas https://www.cresis.ku.edu

European Aviation Safety Agency: Unmanned Aircraft System (UAS) and Remotely Piloted Aircraft Systems (RPAS) http://www.easa.europa.eu/rulemaking/Unmanned-Aircraft-Systems-(UAS)-and-Remotely-Piloted-Aircraft-Systems-(RPAS).php

European Commission: Remotely Piloted Aircraft Systems (RPAS) http://ec.europa.eu/enterprise/sectors/aerospace/uas/index_en.htm

Federal Aviation Administration: Unmanned Aircraft Systems (UAS) http://www.faa.gov/about/initiatives/uas/

International Civil Aviation Organization: UAS http://www.icao.int/Meetings/UAS/Pages/default.aspx

National Oceanographic and Atmospheric Administration: Antarctic Ecosystem Research Division (NOAA Fisheries, U.S. AMLR) http://swfsc.noaa.gov/aerd/

National Oceanographic and Atmospheric Administration: Unmanned Aircraft System Program http://uas.noaa.gov

UAS RISK ASSESSMENT FOR AIRFRAMES WEIGHING GREATER THAN 330 U.S. POUNDS (150 Kg) OR MAXIMUM AIRSPEED GREATER THAN 200 KTS (370 Km/hr)

Hazard	Event	Without Controls			Recommended Controls	Residual with Controls In Place		
		Prob	Sev	Risk		Prob	Sev	Risk
Loss of control (pilot error)	Collision with manned aircraft	IV	A	3	Crew qualifications and currency as described below and in accordance with USAP Air Operations Manual (AOM), Chapter 4	IV	A	3
	Collision with another UAS	IV	B	5	Crew qualifications and currency as described below and in accordance with USAP AOM, Chapter 4	IV	B	5
	Injury to person(s) on ground	IV	A	3	Crew qualifications and currency as described below and in accordance with USAP AOM, Chapter 4	IV	A	3
	Damage to property on ground	III	B	3	Crew qualifications and currency as described below and in accordance with USAP AOM, Chapter 4	IV	B	5
	Environmental incident	II	C	3	Crew qualifications and currency as described below and in accordance with USAP AOM, Chapter 4	III	C	4
	Crash obstructing runway	II	C	3	Crew qualifications and currency as described below and in accordance with USAP AOM, Chapter 4	III	C	4
Loss of control (technical)	Collision with manned aircraft	IV	A	3	System airworthiness, flight safety review, and maintenance as described below and in accordance with USAP AOM, Chap 4	IV	A	3
	Collision with another UAS	IV	B	5	System airworthiness, flight safety review, and maintenance as described below and in accordance with USAP AOM, Chap 4	IV	B	5
	Injury to person(s) on ground	IV	A	3	System airworthiness, flight safety review, and maintenance as described below and in accordance with USAP AOM, Chap 4	IV	A	3
Loss of control (technical) (continued)	Damage to property on ground	III	B	3	System airworthiness, flight safety review, and maintenance as described below and in accordance with USAP AOM, Chap 4	IV	B	5
	Environmental incident	II	C	3	System airworthiness, flight safety review, and maintenance as described below and in accordance with USAP AOM, Chap 4	III	C	4

Hazard	Event	Without Controls			Recommended Controls	Residual with Controls In Place		
		Prob	Sev	Risk		Prob	Sev	Risk
	Crash obstructing runway	II	C	3	System airworthiness, flight safety review, and maintenance as described below and in accordance with USAP AOM, Chap 4	III	C	4
Loss of control (weather)	Collision with manned aircraft	IV	A	3	Flight planning as described below and in accordance with the USAP AOM, Chap 4	IV	A	3
	Collision with another UAS	IV	B	5	Flight planning as described below and in accordance with the USAP AOM, Chap 4	IV	B	5
	Injury to person(s) on ground	IV	A	3	Flight planning as described below and in accordance with the USAP AOM, Chap 4	IV	A	3
	Damage to property on ground	IV	B	5	Flight planning as described below and in accordance with the USAP AOM, Chap 4	IV	B	5
	Environmental incident	III	C	4	Flight planning as described below and in accordance with the USAP AOM, Chap 4	IV	C	5
	Crash obstructing runway	III	C	4	Flight planning as described below and in accordance with the USAP AOM, Chap 4	IV	C	5
Failure to follow air traffic control rules and local operational procedures	Collision with manned aircraft	III	A	2	Publish local air traffic procedures, train pilots, and test pilots on knowledge; flight briefing as described below and in accordance with USAP AOM, Chap 4	IV	A	3
	Collision with another UAS	IV	B	5	Publish local air traffic procedures, train pilots, and test pilots on knowledge; flight briefing as described below and in accordance with USAP AOM, Chap 4	IV	B	5
Failure of airframe or propulsion	Injury to person(s) on ground	IV	A	3	System airworthiness, flight safety review, and maintenance as described below and in accordance with the USAP AOM, Chap 4	IV	A	3
	Damage to property on ground	III	B	3	System airworthiness, flight safety review, and maintenance as described below and in accordance with the USAP AOM, Chap 4	IV	B	5
	Environmental incident	II	C	3	System airworthiness, flight safety review, and maintenance as described below and in accordance with the USAP AOM, Chap 4	III	C	4

Hazard	Event	Without Controls			Recommended Controls	Residual with Controls In Place		
		Prob	Sev	Risk		Prob	Sev	Risk
	Crash obstructing runway	III	C	4	System airworthiness, flight safety review, and maintenance as described below and in accordance with the USAP AOM, Chap 4	IV	C	5
Failure to respect frequency assignments	Interference with critical aviation communications	III	C	4	Flight briefing and spectrum management as described below and in accordance with the USAP AOM, Chap 4	IV	C	5
	Interference with administrative or scientific communications	II	C	3	Flight briefing and spectrum management as described below and in accordance with the USAP AOM, Chap 4	III	C	4
	Interference with other communications	IV	D	5	Flight briefing and spectrum management as described below and in accordance with the USAP AOM, Chap 4	IV	D	5

Crew qualifications and currency: Second Class Pilot medical certificate, certificate of completion of agency-developed, company or military flight training course for the system to be operated. Minimum of three qualifying flights in previous 90 days. Pilots that operate UAS's from a ground station by remotely manipulating controls for flight control surfaces shall hold a US Federal Aviation Administration Private Pilot's License or foreign equivalent.

System airworthiness, flight safety review and maintenance: Air worthiness, flight safety and flight readiness reviews by Office of Aviation Services are required for flight in USAP airspace. Aircraft maintenance in accordance with U.S. Federal Aviation Regulations or foreign equivalent and applicable maintenance manual guidance. Except for commercial remote controllers and systems with proven lost link reliability, all systems require a flight termination capability.

Flight planning: Flight routing and scheduling must be approved by the air traffic manager.

Flight briefing: A flight briefing covering weather, systems, communications, emergency procedures and landing sites, and mission profile will be conducted before each flight.

Spectrum management: All electromagnetic emissions must be approved by the program spectrum manager or other appropriate program authority.

UAS RISK ASSESSMENT FOR AIRFRAMES WEIGHING LESS THAN OR EQUAL TO 330 U.S. POUNDS (150 Kg) BUT GREATER THAN OR EQUAL TO 55 U.S. POUNDS (25 Kg) OR MAXIMUM AIRSPEED LESS THAN 200 KTS (370 Km/hr) BUT GREATER THAN 70 KNOTS (130 Km/hr)

Hazard	Event	Without Controls			Recommended Controls	Residual with Controls In Place		
		Prob	Sev	Risk		Prob	Sev	Risk
Loss of control (pilot error)	Collision with manned aircraft	IV	A	3	Crew qualifications and currency as described below and in accordance with USAP Air Operations Manual (AOM), Chapter 4	IV	A	3
	Collision with another UAS	IV	B	5	Crew qualifications and currency as described below and in accordance with USAP AOM, Chapter 4	IV	B	5
	Injury to person(s) on ground	IV	A	3	Crew qualifications and currency as described below and in accordance with USAP AOM, Chapter 4	IV	A	3
	Damage to property on ground	III	C	4	Crew qualifications and currency as described below and in accordance with USAP AOM, Chapter 4	IV	C	5
	Environmental incident	II	C	3	Crew qualifications and currency as described below and in accordance with USAP AOM, Chapter 4	III	C	4
	Crash obstructing runway	II	C	3	Crew qualifications and currency as described below and in accordance with USAP AOM, Chapter 4	III	C	4
Loss of control (technical)	Collision with manned aircraft	IV	A	3	System airworthiness, flight safety review, and maintenance as described below and in accordance with USAP AOM, Chap 4	IV	A	3
	Collision with another UAS	IV	B	5	System airworthiness, flight safety review, and maintenance as described below and in accordance with USAP AOM, Chap 4	IV	B	5
	Injury to person(s) on ground	IV	A	3	System airworthiness, flight safety review, and maintenance as described below and in accordance with USAP AOM, Chap 4	IV	A	3
Loss of control (technical) (continued)	Damage to property on ground	III	C	4	System airworthiness, flight safety review, and maintenance as described below and in accordance with USAP AOM, Chap 4	IV	C	5

Hazard	Event	Without Controls			Recommended Controls	Residual with Controls In Place		
		Prob	Sev	Risk		Prob	Sev	Risk
	Environmental incident	II	C	3	System airworthiness, flight safety review, and maintenance as described below and in accordance with USAP AOM, Chap 4	III	C	4
	Crash obstructing runway	II	C	3	System airworthiness, flight safety review, and maintenance as described below and in accordance with USAP AOM, Chap 4	III	C	4
Loss of control (weather)	Collision with manned aircraft	IV	A	3	Flight planning as described below and in accordance with the USAP AOM, Chap 4	IV	A	3
	Collision with another UAS	IV	B	5	Flight planning as described below and in accordance with the USAP AOM, Chap 4	IV	B	5
	Injury to person(s) on ground	IV	A	3	Flight planning as described below and in accordance with the USAP AOM, Chap 4	IV	A	3
	Damage to property on ground	IV	C	5	Flight planning as described below and in accordance with the USAP AOM, Chap 4	IV	B	5
	Environmental incident	III	C	4	Flight planning as described below and in accordance with the USAP AOM, Chap 4	IV	C	5
	Crash obstructing runway	III	C	4	Flight planning as described below and in accordance with the USAP AOM, Chap 4	IV	C	5
Failure to follow air traffic control rules and local operational procedures	Collision with manned aircraft	III	A	2	Publish local air traffic procedures, train pilots, and test pilots on knowledge; flight briefing as described below and in accordance with USAP AOM, Chap 4	IV	A	3
	Collision with another UAS	IV	C	5	Publish local air traffic procedures, train pilots, and test pilots on knowledge; flight briefing as described below and in accordance with USAP AOM, Chap 4	IV	C	5
Failure of airframe or propulsion	Injury to person(s) on ground	IV	A	3	System airworthiness, flight safety review, and maintenance as described below and in accordance with the USAP AOM, Chap 4	IV	A	3
	Damage to property on ground	III	B	3	System airworthiness, flight safety review, and maintenance as described below and in accordance with the USAP AOM, Chap 4	IV	C	5

Hazard	Event	Without Controls			Recommended Controls	Residual with Controls In Place		
		Prob	Sev	Risk		Prob	Sev	Risk
	Environmental incident	II	C	3	System airworthiness, flight safety review, and maintenance as described below and in accordance with the USAP AOM, Chap 4	III	C	4
	Crash obstructing runway	III	C	4	System airworthiness, flight safety review, and maintenance as described below and in accordance with the USAP AOM, Chap 4	IV	C	5
Failure to respect frequency assignments	Interference with critical aviation communications	III	C	4	Flight briefing and spectrum management as described below and in accordance with the USAP AOM, Chap 4	IV	C	5
	Interference with administrative or scientific communications	II	C	3	Flight briefing and spectrum management as described below and in accordance with the USAP AOM, Chap 4	III	C	4
	Interference with other communications	IV	D	5	Flight briefing and spectrum management as described below and in accordance with the USAP AOM, Chap 4	IV	D	5

Crew qualifications and currency: Second Class Pilot medical certificate, certificate of completion of agency-developed, company or military flight training course for the system to be operated. Minimum of three qualifying flights in previous 90 days. Pilots that operate UAS's from a ground station by remotely manipulating controls for flight control surfaces shall hold a US Federal Aviation Administration Private Pilot's License or foreign equivalent.

System airworthiness, flight safety review and maintenance: Commercial off-the-shelf models must be approved by USAP Airworthiness and Flight Safety Review Board (AFSRB). Air worthiness, flight safety and flight readiness reviews by Office of Aviation Services are required for flight in USAP airspace by Non-COTS aircraft. Flight critical components shall be inspected at least once before flight each day and an appropriate maintenance inspection schedule will be developed for critical components. Except for commercial remote controllers and systems with proven lost link reliability, all systems require a flight termination capability.

Flight planning: Flight routing and scheduling must be approved by the program air traffic manager.

Flight briefing: A flight briefing covering weather, systems, communications, emergency procedures and landing sites, and mission profile will be conducted before each flight.

Spectrum management: All electromagnetic emissions must be approved by the program spectrum manager or other appropriate program authority.

UAS RISK ASSESSMENT FOR AIRFRAMES WEIGHING LESS THAN OR EQUAL TO 55 U.S. POUNDS (25 Kg) AND MAXIMUM AIRSPEED LESS THAN OR EQUAL TO 70 KNOTS (130 Km/hr)
(Note special risk assessment for quadcopter-like UAS's, below)

Hazard	Event	Without Controls			Recommended Controls	Residual With Controls In Place		
		Prob	Sev	Risk		Prob	Sev	Risk
Loss of control (pilot error)	Collision with manned aircraft	IV	A	3	Crew qualifications and currency as described below and in accordance with USAP Air Operations Manual (AOM), Chapter 4	IV	A	3
	Collision with another UAS	IV	C	5	Crew qualifications and currency as described below and in accordance with USAP AOM, Chapter 4	IV	C	5
	Injury to person(s) on ground	IV	A	3	Crew qualifications and currency as described below and in accordance with USAP AOM, Chapter 4	IV	A	3
	Damage to property on ground	III	C	4	Crew qualifications and currency as described below and in accordance with USAP AOM, Chapter 4	IV	C	5
	Environmental incident	II	C	3	Crew qualifications and currency as described below and in accordance with USAP AOM, Chapter 4	III	C	4
	Crash obstructing runway	II	D	4	Crew qualifications and currency as described below and in accordance with USAP AOM, Chapter 4	III	D	5
Loss of control (technical)	Collision with manned aircraft	IV	A	3	System airworthiness, flight safety review, and maintenance as described below and in accordance with USAP AOM, Chap 4	IV	A	3
	Collision with another UAS	IV	C	5	System airworthiness, flight safety review, and maintenance as described below and in accordance with USAP AOM, Chap 4	IV	C	5
	Injury to person(s) on ground	IV	A	3	System airworthiness, flight safety review, and maintenance as described below and in accordance with USAP AOM, Chap 4	IV	A	3
	Damage to property on ground	III	C	4	System airworthiness, flight safety review, and maintenance as described below and in accordance with USAP AOM, Chap 4	IV	C	5
Loss of control (technical) (continued)	Environmental incident	II	C	3	System airworthiness, flight safety review, and maintenance as described below and in accordance with USAP AOM, Chap 4	III	C	4
	Crash obstructing runway	II	D	4	System airworthiness, flight safety review, and maintenance as described below and in accordance with USAP AOM, Chap 4	III	D	5
Loss of control (weather)	Collision with manned aircraft	IV	A	3	Flight planning as described below and in accordance with the USAP AOM, Chap 4	IV	A	3

Hazard	Event	Without Controls			Recommended Controls	Residual With Controls In Place		
		Prob	Sev	Risk		Prob	Sev	Risk
	Collision with another UAS	IV	C	5	Flight planning as described below and in accordance with the USAP AOM, Chap 4	IV	C	5
	Injury to person(s) on ground	IV	A	3	Flight planning as described below and in accordance with the USAP AOM, Chap 4	IV	A	3
	Damage to property on ground	IV	C	5	Flight planning as described below and in accordance with the USAP AOM, Chap 4	IV	C	5
	Environmental incident	III	C	4	Flight planning as described below and in accordance with the USAP AOM, Chap 4	IV	C	5
	Crash obstructing runway	III	D	5	Flight planning as described below and in accordance with the USAP AOM, Chap 4	IV	D	5
Failure to follow air traffic control rules and local operational procedures	Collision with manned aircraft	III	A	2	Publish local air traffic procedures, train pilots, and test pilots on knowledge; flight briefing as described below and in accordance with USAP AOM, Chap 4	IV	A	3
	Collision with another UAS	IV	C	5	Publish local air traffic procedures, train pilots, and test pilots on knowledge; flight briefing as described below and in accordance with USAP AOM, Chap 4	IV	C	5
Failure of airframe or propulsion	Injury to person(s) on ground	IV	A	3	System airworthiness, flight safety review, and maintenance as described below and in accordance with the USAP AOM, Chap 4	IV	A	3
Failure of airframe or propulsion (continued)	Damage to property on ground	III	C	4	System airworthiness, flight safety review, and maintenance as described below and in accordance with the USAP AOM, Chap 4	IV	C	5
	Environmental incident	II	C	3	System airworthiness, flight safety review, and maintenance as described below and in accordance with the USAP AOM, Chap 4	III	C	4
	Crash obstructing runway	III	D	5	System airworthiness, flight safety review, and maintenance as described below and in accordance with the USAP AOM, Chap 4	IV	D	5
Failure to respect frequency assignments	Interference with critical aviation communications	III	C	4	Flight briefing and spectrum management as described below and in accordance with the USAP AOM, Chap 4	IV	C	5
	Interference with administrative or scientific communications	II	C	3	Flight briefing and spectrum management as described below and in accordance with the USAP AOM, Chap 4	III	C	4

Hazard	Event	Without Controls			Recommended Controls	Residual With Controls In Place		
		Prob	Sev	Risk		Prob	Sev	Risk
	Interference with other communications	IV	D	5	Flight briefing and spectrum management as described below and in accordance with the USAP AOM, Chap 4	IV	D	5

Crew qualifications and currency: Second Class Pilot medical certificate, certificate of completion of agency-developed, company or military flight training course for the system to be operated. Minimum of three qualifying flights in previous 90 days. Pilots that operate UAS's from a ground station by remotely manipulating controls for flight control surfaces shall hold a US Federal Aviation Administration Private Pilot's License or foreign equivalent.

System airworthiness, flight safety review and maintenance: Commercial off-the-shelf models must be approved by USAP Airworthiness and Flight Safety Review Board (AFSRB). Air worthiness, flight safety and flight readiness reviews by Office of Aviation Services are required for flight in USAP airspace by Non-COTS aircraft. Only maintenance requirements specified by AFSRB shall be required. Except for commercial remote controllers, all systems require a flight termination capability.

Flight planning: Flight routing and scheduling must be approved by the program air traffic manager.

Flight briefing: A flight briefing covering weather, systems, communications, emergency procedures and landing sites, and mission profile will be conducted before each flight.

Spectrum management: All electromagnetic emissions must be approved by the program spectrum manager or other appropriate program authority.

GENERAL RISK ASSESSMENT FOR QUADCOPTER-LIKE UNMANNED AERIAL SYSTEMS

Assumptions: Commercial off-the-shelf airframe and control system with automatic pilot, automatic takeoff and automatic return home features. Total weight less than 5 U.S. pounds (2.3 Kg), maximum range less than 1.25 miles (2 Km), maximum horizontal speed less than 15 m/sec, maximum flight time less than 15 minutes

Hazard	Event	No Risk Controls			Recommended Controls	Residual Risk With Controls in Place		
		Prob	Sev	Risk		Prob	Sev	Risk
Loss of control due to pilot error	Collision with manned aircraft	IV	C	5	Crew qualifications and currency in accordance with crew risk controls, below. Airframe painted at least 50% with high visibility paint or equipped with operating strobe lights.	IV	C	5
	Collision with another UAS	IV	D	5	Crew qualifications and currency in accordance with crew risk controls, below	IV	D	5
	Injury to person(s) on ground, sea or vessel	IV	D	5	Crew qualifications and currency in accordance with crew risk controls, below. Install blade guards on all propellers and rotors, airframe painted at least 50% with high visibility paint or equipped with operating strobe lights.	IV	D	5
	Damage to property on ground, sea or vessel	II	D	5	Crew qualifications and currency in accordance with crew risk controls, below	IV	D	5
	Environmental incident	II	D	4	Crew qualifications and currency in accordance with crew risk controls, below	III	D	5
	Crash obstructing a landing area used by other aircraft	II	D	4	Crew qualifications and currency in accordance with crew risk controls, below	III	D	5
Loss of control on account of technical failures	Collision with manned aircraft	IV	C	5	Software and firmware updates recommended by the manufacturer must be installed. Electromagnetic emissions shall be cleared with appropriate program authorities to prevent interference with or from known electromagnetic sources.	IV	C	5
Loss of control on account of technical failures (continued)	Collision with another UAS	IV	D	5	Software and firmware updates recommended by the manufacturer must be installed. Electromagnetic emissions shall be cleared with appropriate program authorities to prevent interference with or from known electromagnetic sources.	IV	D	5

Hazard	Event	No Risk Controls			Recommended Controls	Residual Risk With Controls in Place		
		Prob	Sev	Risk		Prob	Sev	Risk
	Injury to person(s) on ground, sea or vessel	IV	D	5	Install blade guards on all propellers and rotors, airframe painted at least 50% with high visibility paint or equipped with operating strobe lights. Software and firmware updates recommended by the manufacturer must be installed. Electromagnetic emissions shall be cleared with appropriate program authorities to prevent interference with or from known electromagnetic sources.	IV	D	5
	Damage to property on ground, sea or vessel	II	D	5	Software and firmware updates recommended by the manufacturer must be installed. Electromagnetic emissions shall be cleared with appropriate program authorities to prevent interference with or from known electromagnetic sources.	IV	D	5
	Environmental incident	II	D	4	Software and firmware updates recommended by the manufacturer must be installed. Electromagnetic emissions shall be cleared with appropriate program authorities to prevent interference with or from known electromagnetic sources.	III	D	5
	Crash obstructing a landing area used by other aircraft	II	D	4	Software and firmware updates recommended by the manufacturer must be installed. Electromagnetic emissions shall be cleared with appropriate program authorities to prevent interference with or from known electromagnetic sources.	III	D	5
Loss of control due to weather	Collision with manned aircraft	IV	C	5	The pilot/operator must obtain a weather briefing, if available, or otherwise reasonably ensure that weather forecast during planned UAS flights will be VMC and winds will not exceed the capabilities of the aircraft. Flights will be terminated if VMC and visual contact with the UAS cannot be maintained or if winds exceed the ability to safely control the aircraft.	IV	C	5
	Collision with another UAS	IV	D	5	The pilot/operator must obtain a weather briefing, if available, or otherwise reasonably ensure that weather forecast during planned UAS flights will be VMC and winds will not exceed the capabilities of the aircraft. Flights will be terminated if VMC and visual contact with the UAS cannot be maintained or if winds exceed the ability to safely control the aircraft.	IV	D	5

Hazard	Event	No Risk Controls			Recommended Controls	Residual Risk With Controls in Place		
		Prob	Sev	Risk		Prob	Sev	Risk
	Injury to person(s) on ground, sea or vessel	IV	D	5	The pilot/operator must obtain a weather briefing, if available, or otherwise reasonably ensure that weather forecast during planned UAS flights will be VMC and winds will not exceed the capabilities of the aircraft. Flights will be terminated if VMC and visual contact with the UAS cannot be maintained or if winds exceed the ability to safely control the aircraft. Install blade guards on all propellers and rotors, airframe painted at least 50% with high visibility paint or equipped with operating strobe lights.	IV	D	5
	Damage to property on ground, sea or vessel	IV	D	5	The pilot/operator must obtain a weather briefing, if available, or otherwise reasonably ensure that weather forecast during planned UAS flights will be VMC and winds will not exceed the capabilities of the aircraft. Flights will be terminated if VMC and visual contact with the UAS cannot be maintained or if winds exceed the ability to safely control the aircraft.	IV	D	5
Loss of control due to weather (continued)	Environmental incident	III	D	5	The pilot/operator must obtain a weather briefing, if available, or otherwise reasonably ensure that weather forecast during planned UAS flights will be VMC and winds will not exceed the capabilities of the aircraft. Flights will be terminated if VMC and visual contact with the UAS cannot be maintained or if winds exceed the ability to safely control the aircraft.	IV	D	5
	Crash obstructing a landing area used by other aircraft	III	D	5	The pilot/operator must obtain a weather briefing, if available, or otherwise reasonably ensure that weather forecast during planned UAS flights will be VMC and winds will not exceed the capabilities of the aircraft. Flights will be terminated if VMC and visual contact with the UAS cannot be maintained or if winds exceed the ability to safely control the aircraft.	IV	D	5
Failure to follow aircraft control rules and operational procedures	Collision with manned aircraft	IV	C	5	Pilot/operators shall be trained in applicable local air traffic control rules, if any, and shall be tested on their knowledge by appropriate program officials.	IV	C	5

Hazard	Event	No Risk Controls			Recommended Controls	Residual Risk With Controls in Place		
		Prob	Sev	Risk		Prob	Sev	Risk
	Collision with another UAS	IV	D	5	Pilot/operators shall be trained in applicable local air traffic control rules, if any, and shall be tested on their knowledge by appropriate program officials.	IV	D	5
Failure of airframe or propulsion	Injury to person(s) on ground, sea or vessel	IV	C	5	Comply with system risk controls, below. Install blade guards on all propellers and rotors, airframe painted at least 50% with high visibility paint or equipped with operating strobe lights.	IV	C	5
	Damage to property on ground, sea or vessel	III	D	5	Comply with system risk controls, below.	IV	D	5
	Environmental incident	II	D	4	Comply with system risk controls, below.	III	D	5
	Crash obstructing landing area used by other aircraft	III	D	5	Comply with system risk controls, below.	IV	D	5
Electromagnetic interference	Interference with safety of flight communications	III	D	5	Electromagnetic emissions shall be cleared with appropriate program authorities to prevent interference with or from known electromagnetic sources. Comply with applicable local air traffic control rules, including communications when required between the UAS pilot/operator and air traffic control and other aircraft.	IV	D	5
	Interference with national program administrative or scientific communications	II	D	4	Electromagnetic emissions shall be cleared with appropriate program authorities to prevent interference with or from known electromagnetic sources.	III	D	5
	Interference with other communications	II	D	4	Electromagnetic emissions shall be cleared with appropriate program authorities to prevent interference with or from known electromagnetic sources.	III	D	5
Recovery by grabbing UAS out of air with hands	Injury to flight crew	II	D	4	Prohibit manual recovery of UAS in flight. Install blade guards on all propellers and rotors	IV	D	5
Recharging LiPO batteries	Fire	II	C	3	Charge batteries in accordance with manufacturer's instructions and within a fireproof container. Do not leave charging batteries unattended.	II	D	4

Operational risk controls: Flight must remain within sight of the pilot/operator, within Visual Meteorological Conditions (VMC), within 300 meters of pilot/operator, and below 125 meters above ground level (AGL), and comply with applicable local air traffic control rules, including communications when required between the UAS pilot/operator and air traffic control and other aircraft. The pilot/operator must obtain a weather briefing, if available, or otherwise reasonably ensure that weather forecast during planned UAS flights will be VMC and winds will not exceed the capabilities of the aircraft. The final authority to conduct each UAS flight or series of flights on a specific day shall be granted by the appropriate program air traffic control official or station manager when no air traffic control official is present.

System risk controls: Blade guards installed on all propellers and rotors, airframe painted at least 50% with high visibility paint or equipped with operating strobe lights. Software and firmware updates recommended by the manufacturer must be installed. Electromagnetic emissions shall be cleared with appropriate program authorities to prevent interference with or from known electromagnetic sources.

Crew risk controls: Each pilot/operator shall have at least 10 hours of logged flight time in the make and model of UAS to be flown and at least three flights of at least 15 minutes duration each in the make and model in the preceding 90 days. Pilot/operators shall be trained in applicable local air traffic control rules, if any, and shall be tested on their knowledge by appropriate program officials.

SAFETY or ENVIRONMENTAL HEALTH MISHAP <u>PROBABILITY</u>

I	**Frequent**	One or more events expected in a year.
II	**Likely**	Several events expected during a twenty year span.
III	**Infrequent**	One event expected during a twenty year span.
IV	**Unlikely**	Not expected to happen during a 20 year span.

<u>SEVERITY</u>

		People	Property	Project or Mission
A	**Grave**	Injury or illness resulting in death or a permanent total disability	Cost of damage is $1,000,000 or greater	Inability to accomplish a critical project
B	**Serious**	Injury or illness resulting in permanent partial disability	Cost of damage is greater than $200,000 but less than $1,000,000.	Major impact on ability to accomplish a critical project. Significant adverse media attention.
C	**Moderate**	Injury or temporary reversible illness resulting in loss of time from work beyond the day on which it occurred	Cost of damage is greater than $20,000 but less than $200,000.	Moderate impact on ability to accomplish a critical project.
D	**Minor**	Injury or temporary reversible illness requiring more than simple first aid treatment (Illnesses include: eye irritation, sore throat, dermatitis, etc.)	Cost of damage is greater than $1000 but less than $20,000.	Minor impact on ability to accomplish a critical project. Operational nuisance.

RISK ASSESSMENT CODE

		PROBABILITY			
SEVERITY		I	II	III	IV
	A	1	1	2	3
	B	1	2	3	5
	C	2	3	4	5
	D	3	4	5	5

RAC 1 Extreme risk
RAC 2 High risk
RAC 3 Medium risk
RAC 4 Low risk
RAC 5 Very low risk

IP 82

Agenda Item:	ATCM 10, CEP 8b
Presented by:	United States
Original:	English
Submitted:	30/04/2015

A risk-based approach to safe operations of unmanned aircraft systems in the United States Antarctic Program (USAP)

Attachments: Atcm38_att098_e.pdf: General UAS Risk Assessment

A risk-based approach to safe operations of unmanned aircraft systems in the United States Antarctic Program (USAP)

Information Paper submitted by the United States

Summary

At ATCM XXXVII/CEP XVII, the United States submitted WP 51 to encourage discussion of the safe and environmentally-sound use of unmanned aircraft systems (UAS) for research and monitoring. As a follow-up, this Information Paper conveys experiences and current practices relating to UAS operations within USAP.

UAS in the USAP

UAS have been employed in a wide variety of research programs within the USAP. Dr. John Cassano, of the University of Colorado – Boulder, with funding from the U.S. National Science Foundation (NSF), has conducted studies of mesoscale scale atmospheric circulation studies using two small, fixed-wing UAS. The Center for the Remote Sensing of Ice Sheets (CReSIS) at the University of Kansas developed mid-sized UAS to perform radar soundings and collect images of the ice sheet in the Whillans Ice Stream area. National Oceanographic and Atmospheric Administration (NOAA) researchers estimated abundances of krill-dependent predators with multicopters to help fulfill Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) monitoring obligations (IP XX).

As a result of the rapid development and increasing accessibility of UAS technology, in September 2014, the USAP released a programmatic notice stating that UAS use in Antarctica by USAP personnel was prohibited without specific authorization by the NSF. Requests for UAS use by USAP participants or on/near USAP facilities are currently considered on a case-by-case basis. Reviews of proposed UAS operations are based on guidelines for operationally- and environmentally-safe use of UAS informed by a risk assessment process.

Operational Guidelines

Guidelines for the use of UAS in the USAP are included in a chapter of the program's Air Operations Manual (AOM). The UAS guidelines are based primarily on regulations established by Civil Aviation Authorities (CAA; e.g. FAA, ICAO). The USAP continues to make improvements to the UAS guidelines. The most recent additions include guidelines for smaller classes of unmanned aerial vehicles (UAV) as those technologies become more prevalent and as CAA rules and regulations evolve.

The USAP AOM chapter on UAS includes guidance on: planning and preflight operations, including the development of a Concept of Operations (ConOps); rules for flight operations, including in-flight emergency procedures and safe separation; crew requirements, including training and certification; and airworthiness and flight safety standards. The USAP divides UAS into three categories based on weight and airspeed (I: <25 kg, <70 kt; II: 25-150 kg, <200 kt; III: >150 kg, >200 kt) and is currently considering a fourth category, the "microUAS" weighing less than 2.25 kg.

In addition to the ConOps, USAP participants are required to submit documentation such as certifications, log books, and manufacturer specifications and to complete a questionnaire. The questionnaire allows for collection of information about the UAS and the planned operations to be reviewed by the USAP Airworthiness and Flight Safety Review Board. Prospective UAS users must answer questions about: aircraft specifications; command, control, and communications; configuration and software management; pre- and in-flight operations; maintenance; certifications and qualifications; and the area of operations.

USAP participants proposing to use small and micro-class UAS are advised of additional requirements for those vehicles including the use of blade guards; high-visibility coloring; constant maintenance of visual contact with the UAV; restricted operating radius (<300 m) and altitude (<120 m above ground/sea level); and spatial and temporal separation from all other aircraft and non-participant personnel. Commercial, off-the-shelf (COTS) status in these small-sized UAV is considered sufficient for airworthiness certification. Pilot certification from a recognized authority is required, but the requirement is more flexible for pilots of these smaller craft given their reduced risks.

Ship-based UAS operators are required to submit a ConOps, a completed questionnaire, and certifications of crew qualifications and airworthiness. In addition, the UAS crew is expected to establish and maintain regular communications with the ship's captain regarding the intended UAS operations. A standard operating procedure (SOP) is under development for USAP ship-based UAS operations. The SOP will include special considerations for maritime operations including: weather and wind; ship operations; UAV retrieval from the sea or sea ice; and take-off/launch and landing methods and space. The SOP will be based, in part, on risk assessments for ship-based operations and can be adapted to projects using small or micro-UAS, particularly those capable of vertical take-off and landing (VTOL; i.e. multicopters).

Risk Assessment

NSF safety experts performed a risk assessment of UAS operations to validate and inform the evolving USAP guidelines. The risk assessment process involved the following: thinking of the hazards of operation; imagining events that might be caused by those hazards; estimating the probability and severity of those events before controls are implemented; noting the resulting risk; thinking of controls; rethinking the probability and severity with controls in place; and noting the remaining risk. As a result of a shortage of reliable data on UAS technology, this carefully considered risk assessment process was necessarily subjective and resulted in conclusions about the relative risks of various activities rather than, for example, quantifications of absolute risks, but was nonetheless very valuable.

The general risk assessment matrices for the three categories of UAS and for micro-UAS with VTOL capability (e.g. quadcopters) are included in the Attachment. The risk (very low to extreme) of an event is based on its probability (frequent [level I] to unlikely [level IV]) combined with its severity (grave [level A] to minor [level D]). For example, an out-of-control UAV could damage property (e.g. structures, vehicles, runway) if it crashed. The probability of this occurring is a bit higher (level III) than for the UAV colliding with a flying aircraft as a result of the greater amount and occurrence of property the UAV is likely to encounter. The severity of the outcome is relatively low (level B) because people will not be injured (risk of injury to personnel on the ground is assessed separately). The resulting risk is rated at medium. Controls, or mitigation measures, including crew qualifications and currency, as detailed in the USAP AOM for UAS, should reduce the probability (level IV). The risk, with controls in place, is therefore reduced to very low.

The risk assessment process can be tailored and conducted for individual projects. In those cases, a final step of analyzing any risks remaining after mitigation/controls are in place versus the benefits of the operation can be undertaken.

Review Process

Currently, the use of UAS by USAP participants requires special authorization by the NSF. Prospective UAS operators requesting authorization are notified of the required compliance with the guidelines in the USAP AOM chapter on UAS and that they will need to prepare and submit a ConOps and completed questionnaire.

NSF science program officers confirm the scientific justification for the UAS operations. The documentation and questionnaire responses provided by the UAS operators are then considered by the Airworthiness and Flight Safety Review Board. This safety and operational review ensures the protection of USAP persons and property. The operations information can be incorporated into a risk assessment customized to the project and can allow for the Review Board to consider the resulting risk-benefit analysis. For ship-based UAS, the ship's captain and crew also review the planned operations.

The final step before authorization is granted is an environmental review. Reviewers consider operational parameters intended to minimize the waste release resulting from the irretrievable loss of the UAV including: maintenance of visual line-of-sight, when applicable; weather and other operating conditions; in-flight emergency procedures, including return-to-home; and operational parameters such as minimum battery/fuel level and operating radius. The environmental review also considers plans for operating near concentrations of wildlife, Antarctic Specially Protected or Managed Areas (ASMA & ASPA), and historic sites and monuments (HSM) and suggests mitigation measures. Mitigation measures are evolving for operating near and/or monitoring wildlife populations as research on UAS safe operating distances from wildlife becomes available (Goebel *et al*., 2015 & Vas *et al*., 2015).

Considerations

The USAP guidelines and the review process for the use of UAS are thorough yet adaptable to many different UAS, projects, and objectives. The United States welcomes discussion of our risk-based approach to operationally- and environmentally-safe use of UAS in Antarctica. We are interested in sharing best practices and look forward to working with other national Antarctic programs as requirements and standards evolve.

Resources

Websites accessed April 2015

USAP NSF Programmatic Notice, dated September 15, 2014, Restrictions for Use of Unmanned Aerial Vehicles in the United States Antarctic Program, https://www.nsf.gov/geo/plr/plr_announce/uav_policy_09152014.pdf

John Cassano, Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder, http://cires.colorado.edu/about/organization/fellows/john-j-cassano/

Center for the Remote Sensing of Ice Sheets (CRESIS), University of Kansas, https://www.cresis.ku.edu

National Oceanographic and Atmospheric Administration: Antarctic Ecosystem Research Division (NOAA Fisheries, U.S. AMLR), http://swfsc.noaa.gov/aerd/

Goebel, M.E., Perryman, W.L., Hinke, J.T., Krause, D.J., Hann, N.A., Gardner, S., LeRoi, D.J. 2015. A small unmanned aerial system for estimating abundance and size of Antarctic predators. *Polar Biology*, Open Access. http://dx.doi.org/10.1007/s00300-014-1625-4

Vas, E., Lescroel, A., Duriez, O., Boguszewski, G., Gremillet, D. 2015. Approaching birds with drones: first experiments and ethical guidelines. *Biology Letters* **11**, 20140754. http://dx.doi.org/10.1098/rsbl.2014.0754

Environmental Guidelines for operation of Remotely Piloted Aircraft Systems (RPAS) in Antarctica

ATCM XLI - Resolution 4 (2018). CEP XXI, Buenos Aires
STATUS, adopted 18/05/2018
CATEGORY, Environmental protection
TOPICS, Guidelines
ATTACHMENTS
Annex: Environmental Guidelines for Operation of RPAS in Antarctica
RELEVANT FINAL REPORT PARAGRAPH, 123

Environmental Guidelines for operation of Remotely Piloted Aircraft Systems (RPAS) in Antarctica

The Representatives,

Recalling Article 3 of the Protocol on Environmental Protection to the Antarctic Treaty ("the Protocol"), which requires that activities in the Antarctic Treaty area shall be planned and conducted so as to limit adverse impacts on the Antarctic environment and dependent and associated ecosystems;

Recognising that increasing use of Remotely Piloted Aircraft Systems ("RPAS") is being made in the Antarctic Treaty area and that the technology offers many benefits, including for science and operations, and also has the potential to reduce environmental impacts in some circumstances;

Recognising also that RPAS have the potential to cause environmental impacts, and that there is benefit to adopting best practice environmental guidelines for RPAS based on the precautionary principle in order to help minimize those impacts and to assist users in meeting their obligations under the Protocol;

Welcoming the development through broad consultation amongst members and the science community, including with the Scientific Committee on Antarctic Research ("SCAR") and the Council of Managers of National Antarctic Programs ("COMNAP"), of the Environmental Guidelines for operation of Remotely Piloted Aircraft Systems (RPAS) in Antarctica ("Environmental Guidelines for operation of RPAS") that Parties can apply and use, as appropriate;

Recommend that their Governments:
1. endorse the non-mandatory Environmental Guidelines for operation of RPAS, annexed to this Resolution, as representing current environmental best practice for planning and undertaking RPAS activities, as appropriate, in Antarctica;
2. consider when appropriate the Environmental Guidelines for operation of RPAS during the environmental impact assessment process for RPAS activities within Antarctica;
3. encourage all those authorised to use RPAS to plan and undertake RPAS activites to abide, to the best of their ability by the Environmental Guidelines for operation of RPAS;
4. encourage SCAR and the scientific community to develop research on the environmental impacts of RPAS in order to reduce current uncertainties; and
5. encourage the Committee for Environmental Protection to continue to develop these

guidelines as both the technology and scientific understanding of the potential impacts of RPAS are advanced.

Environmental Guidelines for operation of Remotely Piloted Aircraft Systems (RPAS)[1] in Antarctica (v 1.1)[2].

Introduction

Deployment of Remotely Piloted Aircraft Systems[2] (RPAS) can, in some circumstances, reduce or avoid environmental impacts that might otherwise occur. Their use may also be safer and require less logistical support than other means of deployment for the same purpose.

These Environmental Guidelines for operation of RPAS in Antarctica aim to assist implementation of Environmental Impact Assessment (EIA) requirements and aid decision-making for use of RPAS through provision of guidance based on current best available knowledge.

System failures and/or RPA loss in Antarctica may release waste into the environment. The short and long-term impacts of RPAS, including of noise and visual intrusion on Antarctic wildlife, are presently not well understood, and there remain uncertainties about the extent to which RPAS have the potential to cause environmental impacts. As such, there is a recommendation to proceed with a precautionary approach to use of RPAS in Antarctica at the same time as seeking to maximise the many potential scientific, logistic and other benefits of RPAS technology.

It is recognised that in some cases it may be desirable deliberately to operate close to fauna or flora to meet specific scientific or other objectives that have been assessed in the EIA or permitting process. Scientific understanding of the impacts of RPAS on Antarctic wildlife is currently not well developed, with limited knowledge of physiological or long-term demographic effects. Species vary widely in the extent to which they appear to be affected by RPAS operations, and this may also vary by many other factors such as breeding stage, local conditions, etc. Behavioural displays, or their lack, are not necessarily clear indicators of the level of disturbance occurring to wildlife. RPAS operations over or near wildlife should be sufficiently justified taking into account potential for disturbance through the EIA or permitting process.

Guidelines to address aspects of RPAS in Antarctica are available from the Council of Managers of National Antarctic Programs (COMNAP), and a number of competent authorities have also prepared practical manuals for RPAS use within national programmes. RPAS users are referred to these guidelines for essential additional information, particularly related to operational and safety aspects (see Appendix 1).

Pre-deployment Planning and Environmental Impact Assessment (EIA)

1 Requirements of the Madrid Protocol and its Annexes

1.1 Any proposed activities undertaken in the Antarctic Treaty area shall be subject to the procedures set out in Annex I of the Madrid Protocol[3] for prior assessment of the impacts of those activities on the Antarctic environment.

---

[1] A Remotely Piloted Aircraft System (RPAS) is defined by the International Civil Aviation Authority (ICAO) (2015) as "A remotely piloted aircraft, its associated remote pilot station(s), the required command and control links and any other components as specified in the type design". A Remotely Piloted Aircraft (RPA) is "An unmanned aircraft which is piloted from a remote pilot station". RPAS are one class of Unmanned Aerial System (UAS), and they are often referred to as Unmanned Aerial Vehicles (UAVs), Unmanned Aircraft Systems (UAS) or 'drones'. In these guidelines RPAS is used for all types of remotely piloted drone systems and RPA is used to refer specifically to the aircraft itself.

[2] These guidelines are intended primarily for application to RPAS of small to medium size (≤25 kg in weight). While many of the principles and guidelines also apply to use of large RPAS (>25 kg in weight), these operations may present additional potential risks in need of specific management procedures that should be addressed in project-specific EIAs.

[3] As required by Art. 8 of the Madrid Protocol.

1.2 Flying or landing an aircraft in a manner that disturbs concentrations of birds and seals is prohibited in Antarctica, except in accordance with a permit issued by an appropriate authority under Annex II to the Madrid Protocol[4].

1.3 Removal of wastes from Antarctica, including electrical batteries, fuels, plastics, etc. is required by Annex III[5], which should be considered in contingency plans for lost or damaged RPAS as part of the Environmental Impact Assessment (EIA).

1.4 A permit issued by an appropriate national authority is required to enter an Antarctic Specially Protected Area (ASPA)[6], and special requirements to operate RPAS may apply within an ASPA or an Antarctic Specially Managed Area (ASMA): any planned RPAS operation within ASPAs or ASMAs, including any overflight of these areas, must be in accordance with the respective ASPA or ASMA Management Plan.

2 General considerations

2.1 When planning RPAS use in Antarctica, the current approved versions of the documents listed in Appendix 1, which include, *inter alia*, recommendations, guidelines, Codes of Conduct and manuals prepared by the Antarctic Treaty Parties, SCAR and COMNAP and also recent published scientific papers such as those listed in Appendix 2 may be helpful additional considerations to these guidelines.

2.2 Consider the relative environmental advantages and disadvantages of RPAS and other alternatives, and consider the environmental characteristics of the RPAS and the values present at the proposed location(s) of operation, weighing up both the benefits and environmental impacts of RPAS use.

2.3 Undertake detailed pre-flight planning, including thoroughly assessing the particularities of the operational site in advance of deployment, to ensure an appropriate understanding of its topography, weather and any hazards that may impact upon an environmentally sound operation. Where possible, carry out simulated flights using software tools.

2.4 Map out flight plans, prepare contingency plans for incidents or malfunctions, including alternative landing sites and plans for RPA retrieval should there be a crash.

2.5 Assess the particularities and dynamics of the values that could be affected at the site, including the species of fauna and flora present, their numbers and/or extent, and where they are located to assess their concentrations, as part of the environmental impact assessment process and mission planning. Where appropriate, adjust flight plans, including the timing of the mission to avoid sensitive breeding periods (including for all species that may be present in addition to any study species), so that potential disturbance is minimised.

2.6 Identify any specially protected sites (eg, ASPAs, ASMAs, Historic Sites and Monuments (HSMs) and any special zones within these areas), or sites subject to Antarctic Treaty Visitor Site Guidelines, in the vicinity of planned RPAS operations and ensure any overflight restrictions specified in their management plans or site guidelines are followed.

[4] As required by Art. 3 Annex II to the Protocol. This permit can only be granted under certain conditions.
[5] As required by Art. 2 Annex III to the Protocol.
[6] As required by Annex V to the Protocol.

2.7 Consider options and contingencies carefully in the EIA before planning to operate in and over potentially environmentally sensitive areas (*eg*, wildlife colony, or extensive vegetation cover that could be impacted by trampling), or where retrieval of a lost RPA would be difficult or impossible, while recognising that such areas may also be of particular interest for RPAS surveys.

2.8 If you plan to operate RPAS from boats or ships, be aware of elevated risks of collisions with flying birds that often follow ships.

2.9 Where multiple RPAS operations are anticipated to occur in the same area or repeatedly over time, consider in the EIA the potential for cumulative environmental impacts.

3 RPAS Characteristics

3.1 Carefully select the type of RPAS and sensors that will be most appropriate for fulfilling the objectives of planned air operations and where possible use Best Available Technology to minimise environmental impacts. Carry out test flights outside Antarctica to verify your choice (*eg*, testing sensor capabilities at different flight altitudes, and where practicable selecting sensors or lenses that allow greater separation distances from wildlife).

3.2 Consider selecting RPA models with the lowest practicable noise levels, and models with non-threatening shapes, sizes and/or colours, for example that do not closely resemble aerial predators likely to be present at the site of operation to minimise stress on prey species and/or attacks by territorial species.

3.3 Ensure the RPAS is well-maintained and operates reliably before deployment to reduce risk of failure and loss. The use of RPAS equipped with a Return To Home (RTH) feature is recommended. Ensure sufficient power or fuel to accomplish missions. For electric RPAS closely monitor battery capacity and performance, which varies with conditions. For combustion RPAS, check there are no fuel leaks, that fuel caps are secure, use best practice when handling fuel and refuelling and ensure that fuel spillage counter-measures are in place.

3.4 To reduce the risk of non-native species introductions, ensure that the RPAS and all associated equipment and carrying cases are clean and free of soil, vegetation, seeds, propagules or invertebrates prior to shipment to Antarctica. To reduce the risk of species transfer within Antarctica, carefully clean RPAS and associated equipment after use and prior to use at another site.

4 Operator Characteristics

4.1 RPAS pilots should be well-trained and experienced before undertaking operations on-site in Antarctica.

4.2 Before operating in Antarctica, RPAS test flights should be undertaken in a variety of conditions by the pilot that will be operating in Antarctica with the specific type, model and payload of RPAS that will be deployed.

4.3 RPAS operations should comprise a pilot and, as appropriate, at least one observer. Pilots should have good knowledge of the environmental requirements as listed in Section 1, and all aspects of the planned site of operations before deployment to the field, including site sensitivities and potential hazards.

On-site and In-flight Operations

5 General considerations

5.1 Pilots and any designated observers should operate within Visual Line Of Sight (VLOS) with the RPA at all times, unless the operation is approved by a competent authority to operate "Beyond Visual Line Of Sight (BVLOS)".

5.2 Pilots and any designated observers should be vigilant during operations and maintain good communications with each other throughout operations, watching for wildlife moving into the area of operations.

5.3 Complete flight operations with number and duration of flights as practicable, while still achieving mission objectives.

6 Operations over or near wildlife

6.1 Select RPAS launch/landing site(s) carefully, considering topography and other factors (*eg*, prevailing wind direction) that may influence selection of the optimal distance from wildlife. Where practicable, consider locating RPAS launch/landing sites out of sight (bearing in mind any requirements to operate within VLOS) and downwind from concentrations of wildlife, and as far away from wildlife as possible.

6.2 Consider the noise level emitted by the RPA during launch and flight to inform decisions about the location of launch/landing site and flight altitude, taking into account the influence of wind conditions on noise at ground level.

6.3 Where practicable, consider attaining flight altitude while avoiding unnecessary overflight of wildlife.

6.4 Where practicable, consider operating RPAS at times of the day or year when the risk of disturbance to species present is minimised.

6.5 During VLOS operations, pilots and any designated observers should be aware of and monitor the proximity and behaviour of predators that could attack animals or their young within the area of RPAS operations, or attack the RPA to present significant risk of collision. Should proximity of predators be observed and if their behaviour is observed to exceed levels of disturbance deemed acceptable in approvals for the activity, RPAS operations should be modified or ceased.

6.6 To the extent practicable, consider avoiding unnecessary or sudden RPA manoeuvres over wildlife, or flying RPA directly at or from above wildlife, and if possible fly in a grid flight pattern while still achieving mission objectives.

6.7 Fly as high as practicable and not lower than necessary when operating near or over wildlife. Where operation of RPA near wildlife is necessary, exercise minimum wildlife disturbance flight practices, maintaining a precautionary distance from wildlife at all times during flight which ensures that no visible disturbance occurs. Wildlife reactions to RPA vary extensively, for example depending on the species, their breeding status, the flight altitude and whether flight approaches are either horizontal or vertical.

Where multiple species are present, follow the most precautionary approach and if wildlife disturbance is observed at any separation distance, a greater distance should be maintained.

6.8 Pilots and any designated observers should operate with special care near cliffs where birds may be nesting, and where practicable maintain the horizontal separation distance. During VLOS operations, pilots and any designated observers should watch for, and inform each other of, signs of wildlife disturbance. They should be mindful that outward behavioural displays may not be a good indicator of the actual level of stress being experienced by wildlife, which should also be taken into account in the EIA and planning phase. Should wildlife disturbance be observed to exceed levels deemed acceptable in approvals for the activity, pilots should adopt a precautionary approach by considering increasing RPA distances from animals if safe to do so, and considering ceasing operations if disturbance persists.

6.9 When BVLOS operations over or near wildlife concentrations are planned, consider the practicality of placing an observer nearby to note potential behavioural changes and inform the pilot.

7 Operations over terrestrial & freshwater ecosystems

7.1 Pilots and observers should take care to minimise disturbance to sensitive geological or geomorphological features (*eg*, geothermal environments, fragile surface features such as crusts or sedimentary deposits), soils, rivers, lakes and vegetation in the area of RPAS operations, and conduct their activities, including walking over the site, so as to avoid sensitive sites to the maximum extent practicable.

7.2 Should it be necessary to make an unplanned landing and/or retrieve an RPA from an unfamiliar area, the pilot and/or observer should be especially careful to minimise disturbance to site features that may be sensitive, such as wildlife, vegetation or soils.

8 Human considerations

8.1 To the extent practicable, avoid operating RPAS over Historic Sites or Monuments (HSMs) to minimise the risk of RPA loss at these sites. Should retrieval of a failed RPA within an HSM be necessary, notify the appropriate authority and receive advice before undertaking any action.

8.2 RPAS operators should be aware that many people value Antarctica for its remoteness, isolation and aesthetic and wilderness values. Respect the rights of others to experience and appreciate these values, and where practicable adjust flight operations (*eg*, timing, duration, distance) to avoid or minimise intrusion.

Post-flight Actions and Reporting

9 Actions

9.1 In the event of an unplanned forced landing or crash, and mindful of the obligations for removal of waste from Antarctica in accordance with the Madrid Protocol (see Item 1.3), retrieve the RPA if:

- It is safe to do so;

- There is a risk that human life, wildlife or important environmental values are endangered, in which case notify the competent authority and as appropriate emergency procedures should be taken to neutralise the risk;
- The environmental impact of removal is not likely to be greater than that of leaving the RPA *in situ*;
- The RPA does not lie within an ASPA for which you do not have a Permit for entry, unless the RPA poses a significant threat to the values of the ASPA in which case notify the competent authority and as appropriate emergency procedures should be taken to neutralise the risk.

9.2 If a lost RPA cannot be retrieved, notify the competent authority, providing details of the last known position (GPS coordinates) and the potential for any environmental impacts.

10 Reporting and updating these Guidelines

10.1 Observe and record animal reactions before, during and after RPAS flights, preferably by a dedicated observer rather than the pilot who should be principally focused on RPA systems and control.

10.2 Post-activity reporting should be completed in accordance with the EIA and/or permitting associated with the activity. Consider including details of any environmental impacts and consider how such impacts may be avoided in the future. Where practicable, consider using a standard format to report this information (*eg*, see forms provided in the COMNAP RPAS Operator's Handbook), and consider making the information accessible in order to improve RPAS environmental best practices in the future.

10.3 RPAS operators are encouraged to carry out further research into the environmental impacts of RPAS to help minimise uncertainties, undertake regular reviews of the research, and publish observations in the literature to help refine and improve these Best Practice Environmental Guidelines for the operation of RPAS in Antarctica.

Appendix 1: Selected technical documents relevant to environmental guidelines for Remotely Piloted Aircraft Systems (RPAS) in Antarctica

Antarctic Treaty Parties, Resolution 2 (2004) Guidelines for the Operation of Aircraft Near Concentrations of Birds in Antarctica.

Antarctic Treaty Parties, Committee for Environmental Protection Non-Native Species Manual (Version 2017).

COMNAP (Council of Managers of National Antarctic Programs) 2017. Antarctic Remotely Piloted Aircraft Systems (RPAS) Operator's Handbook. Version 7, 27 November 2017.

IAATO (International Association of Antarctica Tour Operators) 2016. IAATO Policies on the use of Unmanned Aerial Vehicles (UAVs) in Antarctica: update for the 2016/17 season. Information Paper 120, XXXVIII ATCM held in Santiago, Chile, 23 May – 01 Jun 2016.

ICAO (International Civil Aviation Organisation) 2015. *Manual on Remotely Piloted Aircraft Systems (RPAS)* First Edition. International Civil Aviation Organization Document 10019. Montréal, Canada.

SCAR Code of Conduct for Terrestrial Scientific Field Research in Antarctica (2009).

SCAR Code of Conduct for Activity within Terrestrial Geothermal Environments in Antarctica (2016).

Appendix 2: Selected peer reviewed scientific papers on the environmental impacts of Remotely Piloted Aircraft Systems (RPAS).

Acevedo-Whitehouse, K. Rocha-Gosselin, A. & Gendron, D. 2010. A novel non-invasive tool for disease surveillance of freeranging whales and its relevance to conservation programs. *Animal Conservation* 13: 217–225.

Borrelle, S.B. & Fletcher, A.T. 2017. Will drones reduce investigator disturbance to surface-nesting seabirds? *Marine Ornithology* 45: 89–94.

Christiansen F, Rojano-Doñate L, Madsen PT and Bejder L. 2016. Noise levels of multi-rotor Unmanned Aerial Vehicles with implications for potential underwater impacts on marine mammals. *Frontiers in Marine Science* **3**: 277. doi: 10.3389/fmars.2016.00277

Erbe, C., Parsons, M., Duncan, A., Osterrieder, S.K. & Allen, K. 2017. Aerial and underwater sound of unmanned aerial vehicles (UAV). *Journal of Unmanned Vehicle Systems* 5: 92–101. dx.doi.org/10.1139/juvs-2016-0018

Goebel M.E., Perryman W.L., Hinke J.T., Krause D.J., Hann N.A., Gardner S. & LeRoi D.J. 2015. A small unmanned aerial system for estimating abundance and size of Antarctic predators. *Polar Biology* **38**: 619-630 doi:10.1007/s00300-014-1625-4

Hodgson, J.C. & Koh, L.P. 2016. Best practice for minimising unmanned aerial vehicle disturbance to wildlife in biological field research. *Current Biology* **26**: R404-R405 doi:http://dx.doi.org/10.1016/j.cub.2016.04.001

Korczak-Abshire, M., Kidawa, A., Zmarz, A., Storvold, R., Karlsen, S.R., Rodzewicz, M., Chwedorzewska, K., & Znoj, A. 2016. Preliminary study on nesting Adélie penguins disturbance by unmanned aerial vehicles. *CCAMLR Science* **23**: 1-16.

McClelland, G.T.W., Bond, A.L., Sardana, A. & Glass, T. 2016. Rapid population estimate of a surface-nesting seabird on a remote island using a low-cost unmanned aerial vehicle. *Marine Ornithology* 44: 215–220.

McEvoy, J.F., Hall, G.P. & McDonald, P.G. 2016. Evaluation of unmanned aerial vehicle shape, flight path and camera type for waterfowl surveys: disturbance effects and species recognition. *PeerJ* 4: e1831. doi: 10.7717/peerj.1831

Moreland, E.E., Cameron, M.F., Angliss, R.P. & Boveng, P.L. 2015. Evaluation of a ship-based unoccupied aircraft system (UAS) for surveys of spotted and ribbon seals in the Bering Sea pack ice. *Journal of Unmanned Vehicle Systems* 3: 114–22. dx.doi.org/10.1139/juvs-2015-0012

Mulero-Pázmány, M., Jenni-Eiermann, S., Strebel, N., Sattler, T., Negro, J.J. & Tablado, Z. 2017. Unmanned aircraft systems as a new source of disturbance for wildlife: A systematic review. *PLoS ONE* 12 (6): e0178448. doi:10.1371/journal.pone.0178448

Mustafa, O., Esefeld, J., Grämer, H., Maercker, J., Rümmler, M-C., Senf, M., Pfeifer, C., & Peter, H-U. 2017. Monitoring penguin colonies in the Antarctic using remote sensing data. Umweltbundesamt, Dessau-Roßlau.

Pomeroy, P., O'Connor, L. & Davies, P. 2015. Assessing use of and reaction to unmanned aerial systems in gray and harbor seals during breeding and molt in the UK. *Journal of Unmanned Vehicle Systems* 3: 102–13. dx.doi.org/10.1139/juvs-2015-0013

Rümmler, M-C., Mustafa, O., Maercker, J., Peter, H-U. & Esefeld, J. 2016. Measuring the influence of unmanned aerial vehicles on Adélie penguins. *Polar Biology* **39** (7): 1329–34. doi:10.1007/s00300-015-1838-1.

Smith, C.E., Sykora-Bodie, S.T., Bloodworth, B., Pack, S.M., Spradlin, T.R. & LeBoeuf, N.R. 2016. Assessment of known impacts of unmanned aerial systems (UAS) on marine mammals: data gaps and recommendations for researchers in the United States. *Journal of Unmanned Vehicle Systems* 4: 1–14. dx.doi.org/10.1139/juvs-2015-0017.

Vas, E., Lescroël, A., Duriez, O., Boguszewski, G. & Grémillet, D. 2015 Approaching birds with drones: first experiments and ethical guidelines. *Biology Letters* 11: 20140754. dx.doi.org/10.1098/rsbl.2014.0754.

Weimerskirch, H., Prudor, A. & Schull, Q. 2017. Flights of drones over sub-Antarctic seabirds show species and status-specific behavioural and physiological responses. *Polar Biology* (online). DOI 10.1007/s00300-017-2187-z.