INTEGRATION OF RPAS INTO CLASS G AIRSPACE

A PAPER BY FASVIG

26 FEBRUARY 2017

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S1. Executive Summary

S1.1 **Situation**. The UK Class G Airspace currently plays host to over 34,000 aircraft of all types. These aircraft are regulated nationally and pilots receive appropriate training in order to gain their licences to operate. Although difficult to quantify accurately, a similar order of magnitude number of RPAS are now being operated in the same airspace by a mix of professional, hobbyist and leisure users. With the number of RPAS likely to more than double over the next 20 years the risks of collision or infringement are likely to rise commensurately unless measures are taken to integrate or segregate the various Class G Airspace users.

S1.2 **RPAS/VFR Integration**. There are existing initiatives designed to inform and (to a degree) regulate the 4 identifiable groups of RPAS user (military, commercial, hobbyist and leisure). In particular, the NATS RPAS Airspace Awareness Programme seeks to educate RPAS users and facilitate certain RPAS operations in regulated airspace. The CAA Dronecode advises RPAS operators to maintain at or below 400ft and this simple regulatory measure, aided by technology such as the NATS Drone Assist App could be a useful first step towards RPAS/VFR integration.

S1.3 In order to gauge the level of concern amongst General Aviation (GA) pilots, concerning RPAS operations, FASVIG conducted a survey amongst a cross-section of Class G Airspace users – the survey results are at Annex A. In broad terms the survey identified that GA pilots strongly believe: there is a VFR/RPAS integration issue; that regulatory action should be taken to mitigate what they perceive to be the main threat to manned aircraft; that technological measures be taken to aid the “see and avoid” process and; that educational and publicity measures be taken to improve the level of aviation knowledge of RPAS operators.

S1.4 EASA is currently consulting on Unmanned Aircraft Prototype Regulations which could inform part of the regulatory debate (operator accountability and height separation). The UK Government is similarly engaged, with a DfT survey currently being conducted on the Safe Use of Drones in the UK. This survey has already highlighted issues such as insurance and electronic identification for further development.

S1.5 **Considerations for Future Changes to RPAS/VFR Integration**. The opinions gathered in surveys, backed by statistical evidence clearly identify that RPAS pose an additional hazard to existing operations in Class G Airspace. The formal training of professional RPAS operators and education of those hobbyists who are members of the British Model Flying Association (BMFA) would seem to be productive in mitigating much of the risk associated with mixed VFR/RPAS operations. However, suitable steps to apply the same measures to the RPAS leisure users have yet to be tabled. Tools such as the NATS Drone Assist App and application of the CAA Dronecode will not be fully effective without appropriate publicity, backed by regulatory action and technological solutions to aid “see and avoid” principles. Summarised recommendations that fall from the analysis and conclusions, developed in this paper, are as follows:

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S1.5.1 RPAS >250g are limited, electronically and legally, to 400ft AGL (unless covered by a CAA exemption).

S1.5.2 RPAS >250g are registered.

S1.5.3 CAA investigates VFR/RPAS collision risk through the use of modelling tools.

S1.5.4 Large RPAS "segregated airspace growth" be halted.

Once "see and avoid" technology is CAA approved and appropriately mandated:

S1.5.5 RPAS are fully integrated into Class G Airspace.

S1.5.6 BVLOS should be further regulated by the CAA.

Within the extant RPAS/VFR integration system:

S1.5.7 The ANO be amended to limit all small RPAS to 400ft.

S1.5.8 NATS provide the Drone Assist database to RPAS manufacturers.

S1.5.9 Private strip owners be encouraged to ensure they are listed in the NATS Drone Assist App database.

S1.5.10 Manufacturers of consumer RPAS provide a printed copy of the Dronecode with all RPAS sales.

S1.5.11 Manufacturers of consumer RPAS should not state performance capabilities that are contrary to the Dronecode.

S1.5.12 Leisure users complete a tick test as part of RPAS registration.

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1. Introduction

1.1 The FASVIG Implementation Programme contains a number of airspace efficiency enablers. Package A.2.7 entitled "UAS Policy Compatible with VFR Operations" was enabled during FASVIG year 1 work and sought to initiate dialogue with the UAS community to seek to improve mutual understanding. This successful engagement led to further funding being agreed in year 2 work, as milestone f), and sought to develop RPAS[1]/VFR policy alongside the NATS programme to integrate RPAS in national airspace. This paper seeks to expose the risks associated with the unregulated operation of both manned and unmanned aircraft in the same class of airspace and make recommendations to mitigate that risk.

2. Current Situation

2.1 As of 1 January 2017, the CAA lists a total of 20,027 fixed-wing, rotary-wing, glider, gyroplane, hang-glider, balloons and microlight aircraft registered in the UK[2]. Additionally, the military have approximately 404 fixed-wing and rotary-wing aircraft that are regularly flown at low level[3]. There are also in the region of 7000 unregistered aircraft. This totals over 27,000 UK manned aircraft that fly mainly in Class G Airspace.

2.2 There is no substantiated data for sales of commercially sold RPAS in the UK; however, Maplin Electronics is one of several UK retailers who sell consumer RPAS and in 2014 sold approximately 17,000[4]. On the assumption that 25% are for use indoors[5] over 12,000 from that one company alone will have accessed Class G airspace in 2015. The CAA does not publish RPAS data in its UK Aviation Forecasts report; however, if the Federal Aviation Authority (FAA) Aerospace Forecast[6] were to be mirrored in the UK then growth over the next twenty years for consumer RPAS might be forecast to be 226%.

2.3 As of September 2015 the CAA issued 1036 Permissions for Aerial Work (RPAS Commercial Use <20kg) and as at 19 August 2016 that figure has risen to 2173[7].

2.4 The UK Airprox Board Annual report of 2015 noted that in 2014 there were 6 Airprox reports (possible collision) that positively identified RPAS and in 2015 that figure rose to 29. A summary report for 2016 has yet to be published.

2.5 From the figures listed above it is clear that use of Class G airspace is in high demand, from an eclectic mix of users. RPAS use is rising and will continue to do so for quite some time; the benefits for commercial use and to the UK economy are being seen each year as this technology develops but with it comes an increased risk of a collision with

[1] For the purpose of this paper the term Remotely Piloted Aircraft System (RPAS) covers unmanned aircraft (UA), UA Systems (UAS), drones and model aircraft
[2] CAA website - UK registered aircraft by class, weight and CofA, single year data
[3] Gov.UK website (National Statistics) – UK Armed Forces Equipment and Formations (2016)
[4] BBC Article "Are drones dangerous or harmless fun?" dated 5 Oct 2015.
[5] Dronesdirect.co.uk Survey dated 28 Nov 2016
[6] https://www.faa.gov/data_research/aviation/aerospace_forecasts/media/FY2016-36_FAA_Aerospace_Forecast.pdf
[7] CAA Small Unmanned Aircraft List 28 Nov 2016

manned aircraft. To minimise the risk should RPAS be integrated (and to what degree?), segregated, or should a mix of these measures be adopted?

3. RPAS/VFR Integration

3.1 **RPAS Categories**. RPAS fall into 4 groups: Military; Commercial (CAA permission required); Hobbyist (member of the British Model Flying Association (BMFA) and/or its affiliated clubs) and; leisure use.

3.2 **NATS RPAS Airspace Awareness Programme**. The NATS RPAS Airspace Awareness and Integration programme covers three areas:

3.2.1 Educate RPAS users on the safe and appropriate locations to use RPAS through the availability of online airspace awareness tools and resources.

3.2.2 Capture initial user requirements for an automated flight plan approval process for RPAS operations within controlled or other restricted airspace.

3.2.3 Progress the state of the art towards Beyond Visual Line of Sight (BVLOS) operations; assess the need and define high level requirements for Unmanned Traffic Management system(s) (UTM) to facilitate such operations.

3.3 FASVIG has common ground with NATS on the first area and this is covered in Section 4. The second does not refer to Class G airspace. It is possible that there may be common ground in the third area with respect to ensuring that BVLOS operations and its accompanying UTM should not impact manned Class G users with new restrictions or additional procedures – for example, by requiring VFR operators to file a flight plan.

3.4 **CAA Dronecode**. This code[8] advises that RPAS pilots should remain at or below 400ft. This makes good sense as, except for take-off, landing and authorised aerial work, manned aircraft must maintain 500ft from "persons, vehicles, vessels and structures"[9] but this has no place in law for RPAS that are less than 7kg[10]. For BHPA/BGA aircraft the 400ft Dronecode advice for RPAS could be an issue - they often fly below this height when hill soaring[11] and many are near silent. Use of the NATS Drone Assist App with an extensive BHPA operating site database could help alleviate this[12]. However, from discussions on this topic with the BHPA, there may be a reluctance to publicise launch sites as some are only permitted by agreement with the land owner for very low usage by local BHPA members. The NATS App is discussed in more detail in Section 4.

3.5 **RPAS Integration Survey**. In order to gauge opinion from the wider General Aviation community a FASVIG-sponsored survey entitled "RPAS/VFR Integration into UK Class G Airspace" was conducted at the end of 2016. A summary of results from that survey is at

[8] CAA Dronecode dated 29 November 2016
[9] Standard European Rules of the Air (SERA) 923/2012, as amended by the CAA
[10] Air Navigation Order (ANO) 2016
[11] All gliders are exempt the 500ft rule when hill soaring (Rule 5 of the UK Rules of the Air 1996)
[12] BHPA launch sites are often (but not always) near to hill soaring areas

Annex A. The survey was targeted at 100 pilots based on the CAA website list of UK registered aircraft by class, weight and CofA, mentioned earlier. The main outcomes of the survey are as follows:

3.5.1 75% believe there is an integration issue, with the main reasons given being:

3.5.1.1 Collision risk - as RPAS are generally difficult to see and avoid due to their small size.

3.5.1.2 Lack of training/aviation education of leisure use RPAS operators.

3.5.2 90% considered that the ANO should be changed to require that all unmanned aircraft less than 20kg to be limited to 400ft and not just the 7-20kg category. The main reasons given were that "visual line of sight" was too ambiguous and that 400ft would provide a buffer from the SERA 923/2012 500ft rule.

3.5.3 92% thought that leisure use RPAS were the main threat to manned aircraft.

3.5.4 90% considered that manufacturers should limit their drones by design to comply with the CAA Dronecode; the main reason given being that too many leisure users did not have an aviation education. Several respondents commented that if drones were limited then commercial operators should be allowed to have theirs delimited in accordance with any issued CAA exemption.

3.5.5 72% consider that all RPAS should be registered and 65% believe that they should all be insured (currently all but leisure users have insurance). However, several respondents feared that any such system might be difficult to enforce.

3.5.6 88% recommended that, before RPAS are permitted to operate BVLOS, they must be fitted with "see and avoid" technology to avoid manned aircraft as well as each other. Several respondents remarked that, if RPAS are operated BVLOS, then a NOTAM should be issued.

In the final question of the survey, respondents were given the chance to add any other comments. Recurring themes were:

3.5.7 RPAS users must be educated about manned aviation.

3.5.8 Private airstrips need publicising to RPAS operators.

3.5.9 Regulation may be difficult to enforce.

3.5.10 The Dronecode height limit advice of 400ft is too high.

One respondent wrote "I pay to fly, via registration, license, training. Those who want to 'integrate' need to do the same, otherwise this is an accident waiting to happen".

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3.6 From the small cross-section of manned aircraft operators, operating in Class G airspace that took part in the survey, it was (perhaps unsurprisingly) clear that they believe that RPAS pose a risk to manned aircraft. The general feeling being that RPAS should be limited - using a combination of legal backing to the CAA Dronecode; by amendment of the ANO; and RPAS manufacturers limiting their drones to assist users comply with the Code. This would not capture RPAS that have been built from kits but the majority of these aircraft will be used for racing at ultra-low level in organised and normally caged environments or operated commercially with a CAA Permit. General lack of aviation education amongst leisure RPAS users, who are using Class G airspace for the first time, is a major concern.

3.7 **EASA Proposal**. EASA is currently consulting on Unmanned Aircraft Prototype Regulations[13]. The following table is a very simplified summary:

Category	MTOM	Registered	ID	Training	Height	Distance	Geofence[14]
Open AO	250g	No	No	No	50m/150ft*	100m*	No
Open A1	25kg	Yes	No	No	50m/150ft*	VLOS	No
Open A2	25kg	Yes	Yes*	No	50m/150ft*	VLOS	Yes*
Open A3	25kg	Yes	Yes*	Yes	50m/500ft*	VLOS	Yes*
Specific	CAA authorisation and operator has Light UA Operator Certificate						
Certified	UA is certified, remote pilot licensed and operator CAA approved						

* Built into the design of RPAS

There appears to be no objective method of deciding which Open Category RPAS fall into; however, there is a subjective description of risk of severe injury to persons on the ground or damage to manned aircraft:

Category	Risk
Open AO	Negligible
Open A1	Negligible
Open A2	Limited
Open A3	Higher

3.8 In the absence of further guidance, it is anticipated that RPAS mounted with a camera/sensor would fall into the Open A3 category. At the Royal Aeronautical Society (RAeS) 2016 “Drones in Daily Use” conference Dr Graeme Nash of Frazer Nash Consultancy demonstrated the possible use of software modelling to understand the risk of collision between RPAS and manned aircraft. Modelling tools are currently certified for assessing the risk of bird strike damage to commercial aircraft and there is a strong case to investigate the risk to all types of manned aircraft from collision with RPAS.

3.9 On balance, it would seem that the EASA proposal would favour UK Class G airspace users, in that it will facilitate accountability (registration and ID) and some separation for the vast majority of RPAS flights (geofence height limit). There are some observations:

[13] EASA ‘Prototype’ Commission Regulations on Unmanned Aircraft Operations – dated 22 August 2016

[14] Geofence is an automatic function to limit the access of RPAS to airspace areas or volumes

3.9.1 The height limit of Open A2 might be perceived to be overly restrictive, considering the RPAS is required to limit this parameter. However, as indicated in the RPAS Integration Survey comments some manned aircraft pilots would not be unhappy with this.

1.9.2 The 500ft limit for Open A3 does not tally when registered manned aircraft are limited to a minimum of 500 ft. A safer height would be 400ft, as stated in the CAA Dronecode, to provide a 100 ft buffer. That said, as mentioned above, the Code height is not legally binding at present for RPAS <7kg.

3.9.3 BVLOS is not covered in the regulation but, by the time this regulation is enacted in 2020, that technology will be arriving and the regulators could find themselves one step behind. It could be argued that the RPAS industry should lead proposals for commercial BVLOS operations only, as the onus should be on them not to inconvenience current Class G users.

3.9.4 The Open category is clearly written with the multi-rotor RPAS in mind but, by definition, will encompass model aircraft. For many years manned aircraft in the UK have co-existed with members of the BMFA; and either EASA or the CAA should be encouraged to give an exemption to model aircraft, otherwise it will have a severe effect on model flying that is not proportionate to known risk (as detailed in the 2015 UK AIRPROX Board Annual Report).

3.10 **UK Government Policy**. The House of Lords conducted a very detailed inquiry into Civil Use of Drones in 2015[15] and as a result the Department for Transport (DfT) has issued a consultation on "The Safe Use of Drones in the UK"[16]. There are over 60 questions for respondents to answer but the essential proposals of insurance, registration (>250g) and guidance at point of sale (Dronecode) are mandated.

3.11 Based on the DfT questionnaire replies received to date (the survey concludes on 15 March 2017) these proposals would be supported by the majority of the RPAS Integration Survey respondents. Insurance will be an interesting proposal. Commercial RPAS have to be insured but the current provisions do not mirror those for registered aircraft and if they are required to do so there is a cost issue. Hobbyists have insurance through membership of the BMFA so it is the leisure user who the government will probably have the most difficulty dealing with, as the issue is relatively complex (for example, level of risk and non-compliance). One solution could be to make insurance part of an annual registration update, similar to manned aircraft.

3.12 One question, in the DfT survey, that may cause concern to manned Class G users is Q40 - "Should electronic identification for manned general aviation be mandatory? Why?" By the end of 2017 any general aviation aircraft with a radio must upgrade to 8.33 Khz and with many general aviation pilots voluntarily electing to adopt additional means of electronic identification, such as Mode S transponders, the additional cost is significant.

[15] House of Lords – Civil Use of Drones Report, 24 Feb 2015
[16] Government Consultation on the Safe Use of Drones in the UK, 21 Dec 2016

Whilst there are tremendous advantages to GPS being fed to a Mode S Transponder to produce the ADS-B Out signal, which would almost certainly be the "electronic identification" mentioned in Q40, the issue is one of cost, principle and practicality[17]. In recognition of this issue the CAA is scoping options for "free" handheld ADS-B devices for all aircraft. That said the carriage of a transponder by all aircraft does not in itself provide any collision avoidance. Either a radar controller must always be in the loop and in communication with the parties (impractical) or the parties must use a TCAS system (which does not exist) – even so, the number of transmitting and responding units would likely overwhelm the spectrum.

3.13 If RPAS industry could bring about the volume production of low-cost 1090MHz ADS-B Out solutions suitable for use by RPAS it would make these RPAS electronically conspicuous to other RPAS, to ATC units (once ADS-B data is incorporated into radar displays) and to manned aircraft equipped with ADS-B In technology plus traffic displays or collision avoidance systems. Without electronically conspicuous RPAS, manned aircraft pilots are highly unlikely to make visual contact with conflicting small-to-medium size RPAS in sufficient time to take avoiding action. Research has shown that, when looking out for other aircraft, "alerted see and avoid" is eight times more effective than pure "see and avoid"[18].

3.14 Should RPAS industry mass-produced low-cost ADS-B Out solutions become a reality they may also be taken up by General Aviation, enhancing aviation safety more generally, reducing the risk of mid-air collision and improving the chance of preventing airspace infringements. ADS-B Out equipped GA aircraft would be electronically conspicuous to ADS-B In equipped RPAS, allowing automated navigation algorithms to steer RPAS away from detected traffic, even in very poor visibility conditions.

3.15 However, when Amazon Prime Air was consulted in the preparation of this paper, their spokesperson felt that ADS-B was not the answer for technical and cost reasons; it is Amazon's view that fully autonomous "see and avoid" is the way forward. As a solution for one RPAS detecting other small RPAS or even detecting medium to large RPAS or manned aircraft in poor weather conditions this view is questionable. This technical capability has been pursued for manned aircraft for many years without commercial success.

3.16 The general view is that if a new user of Class G wishes to operate in that airspace then they should do so without posing any additional risk, cost or operational constraints to current users.

3.17 **Large RPAS**. Large RPAS (>20kg) are subject to stricter rules and (so far) have been segregated in restricted airspace, such as D202 in West Wales, for research, development and certification by both civil and military organisations. In the future, when fully autonomous see and avoid technology has been demonstrated, large RPAS will be certificated to operate with manned aircraft. This should not present an issue, as the certification standard will need to be the same as manned aircraft for whichever

[17] Because of the size and power requirements it will be impractical for all aircraft to operate Mode S.
[18] Australian Transport Safety Bureau; Limitations of the See-and-Avoid principle, April 1991, reprinted November 2004.

classification of airspace they will operate in.

3.18 One concern, highlighted by some RPAS Integration Survey respondents, was the fear of restricted airspace, like D202, increasing in size and creating choke points (VFR Significant Areas) with either controlled airspace or terrain; and possibly lead to either an infringement or a reduction in safe weather avoid options. These issues are currently being addressed in another FASVIG workstrand.

4. Considerations for Future Changes to RPAS/VFR Integration

4.1 **RPAS Integration Principles**. The Eurocontrol website states *"The integration of RPAS into the present manned aircraft environment is based on a few basic but essential principles:*

- *They should not pose an additional hazard to existing operations.*
- *They should be as safe as or safer than manned aircraft operations.*
- *They should operate in a transparent manner for ATC.*

These principles have been agreed at an international level".

4.2 Regarding these principles, it is evident from the statistics already detailed that RPAS pose an additional hazard to existing operations. This view was also expressed by Class G users in the RPAS Integration Survey. Military and commercial RPAS operators receive formal training and understand the principles and rules of flying in Class G airspace. Whilst there have been occasional AIRPROX with model aircraft over the last few decades it has been seen that these incidents have been minimised where model flyers have gained aviation knowledge through membership of the BMFA[19]. This would seem to indicate that model flying is relatively safe – reinforced by ICAO's view[20] on model aircraft that "*In the broadest sense, the introduction of UAS does not change any existing distinctions between model aircraft and aircraft. Model aircraft, generally recognized as intended for recreational purposes only, fall outside the provisions of the Chicago Convention, being exclusively the subject of relevant national regulations, if any.*" This view would seem to imply that hobbyist RPAS users should be the subject of minimal regulation.

4.3 The case for supporting the leisure user is not as easy. Operation of RPAS with the capability and mass of a multi-rotor drone, by an individual who has little or no knowledge of aviation, does not satisfy the principles of integration and therefore potentially presents a clear risk to manned aircraft. This disparity between the model flyer (who has received appropriate instruction) and the leisure user should be the subject of further scrutiny, with either limitations or CAA exemption(s) put in place to balance the risk to all Class G airspace users.

[19] The BMFA is very active in supporting the Dronecode and trying to recruit leisure users, in order to educate them and provide them with insurance (which is included in BMFA membership).
[20] ICAO Circular 328 – Unmanned Aircraft Systems (2011)

4.4 The ANO, paragraph 94 "Small unmanned aircraft" (<20kg), limits 7 to 20kg aircraft to 400ft. However, a person in charge of a small unmanned aircraft that is <7kg in weight is only required to "*maintain direct, unaided visual contact with the aircraft sufficient to monitor its flight path in relation to other aircraft, persons, vehicles, vessels and structures for the purpose of avoiding collisions"* – quite clearly this could lead to flight of such aircraft above 400ft. Military fast jets and training aircraft routinely fly to a minimum of 250ft and there could be an argument to limit small unmanned aircraft to this height. Counter to this is the fact that military low flying has reduced dramatically in recent years to a point where the risk may be minimal. It remains that the CAA Dronecode uses 400ft as the vertical limit even though, at present, that is not enforceable for drones <7kg (the majority).

4.5 Although the 400ft limitation does not encompass all types of manned operations in Class G, it should reduce the risk - providing RPAS are electronically limited (as judging 400ft from the ground is virtually impossible). Military, commercial and hobbyist RPAS users should be able to seek a CAA exemption based on a safety case if they wished to operate above this height.

4.6 **NATS Drone Assist App and Airspace Awareness**. Whilst the EASA proposal includes geofencing (automatic function to limit the access of RPAS to airspace areas or volumes) that database will probably not include all known manned aircraft take-off and landing sites. The NATS Research and Development Team has FAS funding to educate RPAS users by developing airspace awareness tools including their Drone Assist App that was released in December 2016. This contains a similar database to manned aircraft apps (like Sky Demon) and will alert the RPAS user when outside of Class G or near to a manned aircraft take-off/landing site. Like all databases they are only as good as the data and there is a possibility that small airstrips may not be detailed. The Drone Assist App relies on the user to download/sign up and then run the App to benefit from the information it can provide. Although responsible leisure users will probably use this App they are already likely to constitute the least risk to other airspace users, due to their attitude to safety. It would make more sense if the Drone handset controller, which can be either dedicated or a smartphone, had the Drone Assist database integrated into it. This is a view shared by some UK RPAS manufacturers[21].

4.7 **CAA Dronecode Publicity**. In a CAA Consumer Drone Users Report[22] which involved drone owners, users, considerers and the general public, only 36% of owners were made aware of the Code at the point of sale and while 54% of owners were aware of the Dronecode only a few could recall specific rules when asked. One positive statistic is that 71% of persons considering purchasing a drone have heard of the Code. The report is the first of several that will be able to quantify the success of better Dronecode publicity and changing public attitudes to RPAS and their uses. The Code has been simplified recently and the CAA accepts it needs better publicity:

"This must take the form of engaging on YouTube at the research stage of the path to purchase, and in a wide-ranging media engagement programme across lifestyle, consumer,

[21] Interview with the Managing Director of Yuneek UK at the UK Drone Show – December 2016
[22] CAA (DfT Funded) Consumer Drone Users – An Audience Insight Report - 2016

technology, and gadget media where the public are finding their information about drones."

4.8 The Dronecode relies on the support of manufacturers, sellers and the manned aviation community too, as it is in the interests of all parties that these aircraft are operated safely. Whilst UK Consumer Law[23] states that the contract of sale is between the retailer and the consumer it would be more in the interest of safety that the co-operation of the manufacturers would produce a better knowledge of the Code and the users responsibility to other airspace users. Another positive safety step concerns the declaration of drone performance on their websites. Whereas better performance is likely to aid the sale of a product, if this stated performance is in contradiction to the Dronecode it should either be removed from online statements or be amended to carry a reminder of the Dronecode limits.

4.9 The UK Government is proposing in its consultation that this provision of guidance (Dronecode) becomes mandatory, though it is possible for the irresponsible user to discard the Code and not read it. One company, Yuneec UK, has already moved one step further. Yuneec drones are supplied de-activated and in order to activate it the user must pass a tick test based on the Dronecode and must also register via a small credit/debit card deduction. This is a positive example of one small manufacturer being pro-active on safety, which is ultimately in their interest as one major incident could devastate that part of the market. If the UK Government can combine the proposed mandated registration and guidance, using the same system as Yuneec UK, this could make a significant contribution to safety awareness and user responsibility.

5. Conclusion and Recommendations

5.1 This paper sought to expose the risks associated with the unregulated operation of both manned and unmanned aircraft in the same class of airspace and propose measures to mitigate that risk. From information gathered through interviews, governmental and non-governmental organisations' publications, statistical reports and surveys there is clear evidence that, at this stage of RPAS development, there is an integration issue associated with both collision and infringement risk. It is not possible to segregate small RPAS as Class G airspace, below 500ft, is used by manned aircraft for take-off, landing, training, military aviation and authorised aerial work; therefore, the logical step at this stage of development is to limit small RPAS to 400ft (ANO/Manufacturer) to remove at least part of the exposure volume. There is also a need to target the Leisure User by a mixture of education (Dronecode/Join BMFA) and legislation (ANO/Registration). It is also vital to assist all RPAS users with provision of airspace awareness tools such as the NATS Drone Assist App to help reduce the risk of airspace infringements.

5.2 Until "see and avoid" technology is CAA approved and appropriately mandated it is recommended that:

[23] Sale of Goods Act 2015

5.2.1 RPAS >250g are limited, electronically and legally, to 400ft from the RPAS take off/landing site unless a CAA exemption has been issued.

5.2.2 RPAS >250g are registered.

5.2.3 The CAA investigates the use of modelling tools to understand the risk of collision between RPAS and all manned Class G aircraft types.

5.2.4 Segregated airspace, used by large RPAS, should not be permitted to encroach further into Class G airspace, if there is a risk of causing airspace infringements by creating a choke point.

5.3 Once "see and avoid" technology is CAA approved and appropriately mandated it is recommended that:

5.3.1 RPAS are integrated fully into Class G, complying with the rules and regulations appropriate to this class of airspace.

5.3.2 BVLOS should further be regulated by the CAA.

5.4 It is recommended that the following changes be made to the extant RPAS/VFR integration system:

5.4.1 The Air Navigation Order (ANO) 2016 "Small unmanned aircraft" paragraph 94 be amended to remove the reference to mass in paragraph 94(4) – to limit all small UA to 400ft.

5.4.2 RPAS pilots be encouraged to make full use of all available technology, such as the free NATS Drone Assist App, to help them comply with the ANO and develop awareness of nearby airfields and restricted airspace.

5.4.3 NATS make the NATS Drone Assist database freely available to RPAS manufacturers.

5.5 It is recommended the CAA direct that the following publicity/presentational measures are taken:

5.5.1 Publicity be made to private strip owners to check they are included in the NATS Drone Assist App database.

5.5.2 Manufacturers of consumer RPAS include a printed copy of the Dronecode in the RPAS packaging.

5.5.3 Manufacturers of consumer RPAS should not state performance parameters that are contrary to the Dronecode.

5.5.4 Leisure users should complete a simple Dronecode tick test as part of

registration.

Annex:

A. RPAS Integration Survey – Results Summary.

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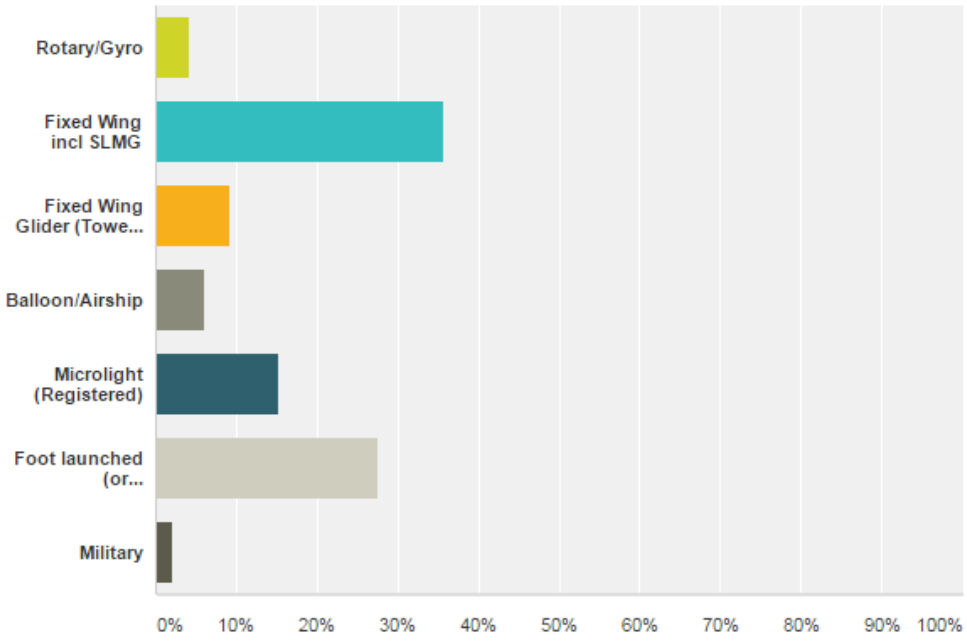
Annex A

RPAS/VFR Integration Survey- Results Summary

Q1 Customize Export

What type of aircraft do you mainly fly in Class G airspace?

Answered: 98 Skipped: 0



Answer Choices	Responses	
Rotary/Gyro	4.08%	4
Fixed Wing incl SLMG	35.71%	35
Fixed Wing Glider (Towed or winched)	9.18%	9
Balloon/Airship	6.12%	6
Microlight (Registered)	15.31%	15
Foot launched (or towed/powered) Hanglider or Paraglider	27.55%	27
Military	2.04%	2
Total		98

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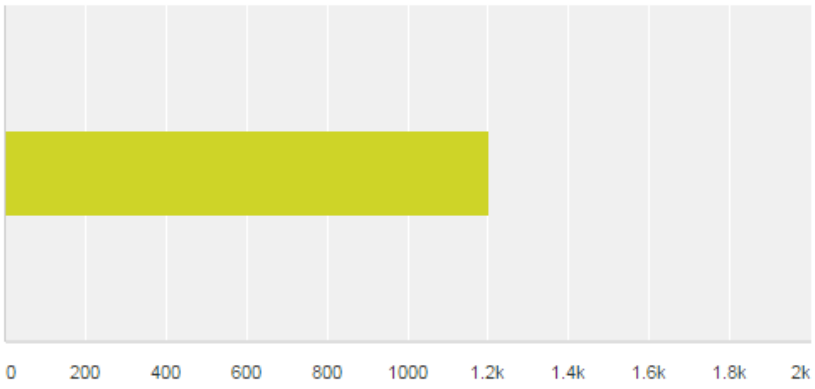
Q2 Customize Export

Your flying experience?

Answered: 98 Skipped: 0



Answer Choices	Average Number	Total Number	Responses
Responses	1,204	118,000	98

Total Respondents: 98

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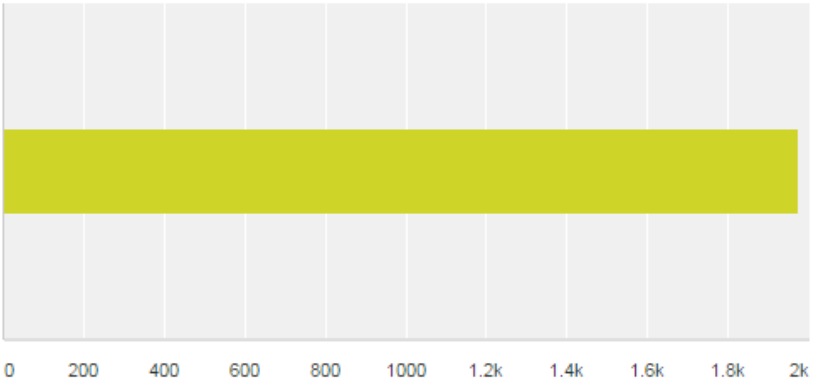
Q3

Customize Export

What is your average operating height in UK Class G?

Answered: 97 Skipped: 1



Answer Choices	Average Number	Total Number	Responses
Responses	1,975	191,600	97

Total Respondents: 97

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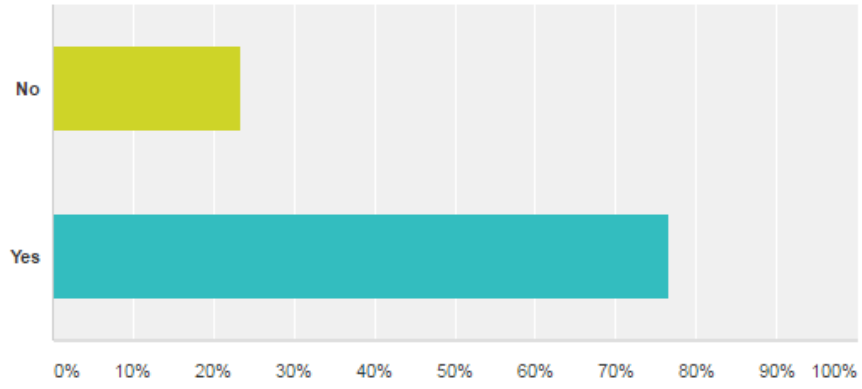
Q4 Customize Export

Do you see current RPAS/VFR Integration as an issue?

Answered: 98 Skipped: 0



Answer Choices	Responses	
No	23.47%	23
Yes	76.53%	75
Total		98

Comments (72)

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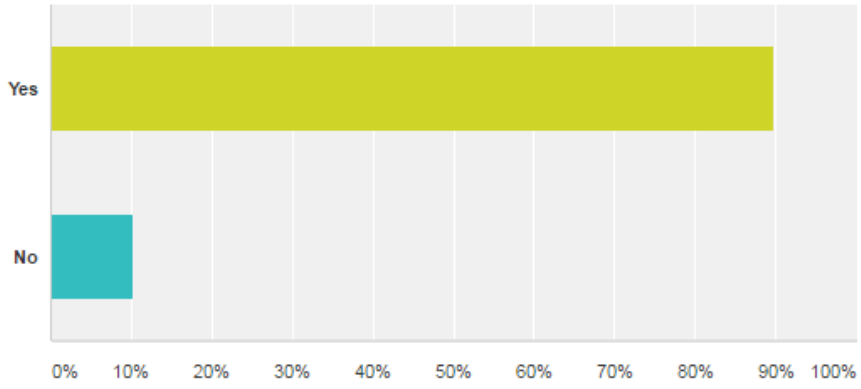
Q5 Customize Export

The ANO does not have a height limit for RPAS < 7 Kg = "Visual line of sight" - but CAA advice is 400 ft AGL and this is also the limit for RPAS >7 Kg. Should this advice be included in the ANO as a fixed limit for RPAS < 7 Kg?

Answered: 98 Skipped: 0



Answer Choices	Responses	
Yes	89.80%	88
No	10.20%	10
Total		98

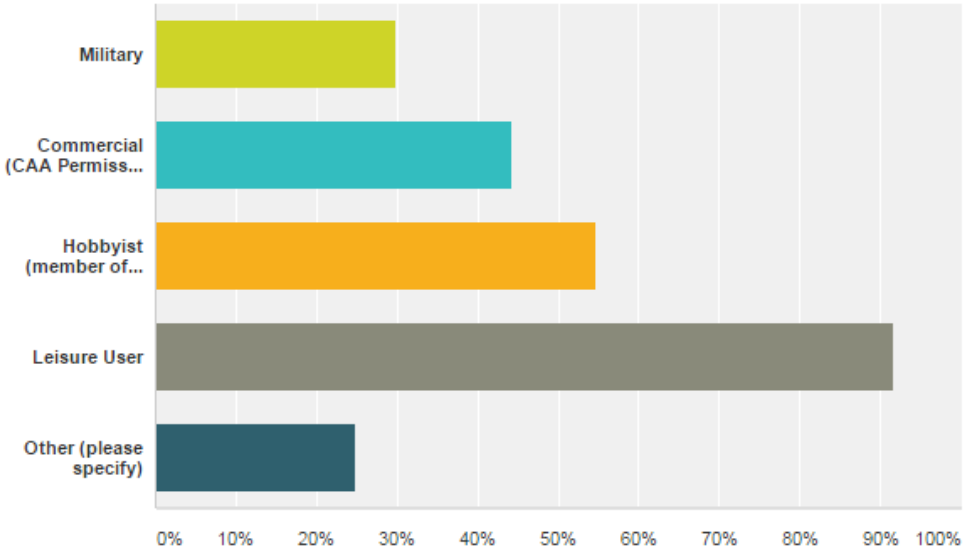
Comments (40)

Q6

Customize Export

Which RPAS, if any, do you believe to be a threat to VFR users of class G airspace? (tick as many that apply)

Answered: 97 Skipped: 1

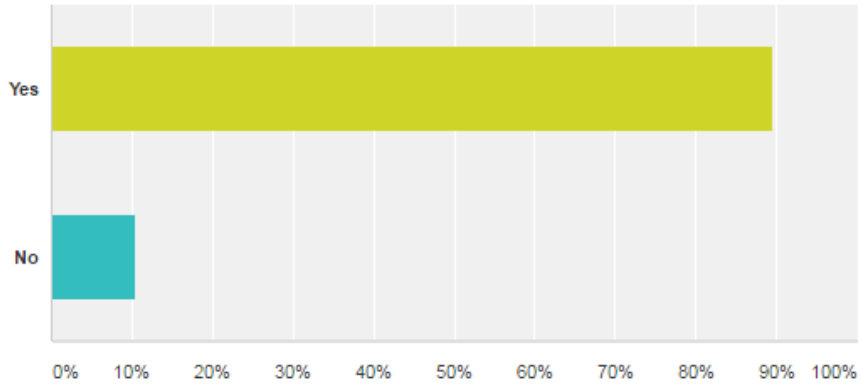


Answer Choices		Responses	
Military		29.90%	29
Commercial (CAA Permission required)		44.33%	43
Hobbyist (member of British Model Flying Association)		54.64%	53
Leisure User		91.75%	89
Other (please specify)	Responses	24.74%	24
Total Respondents: 97			

Q7 Customize Export

Currently there are two main small RPAS(Drone) companies - DJI and Yuneec. DJI does not limit its drones. Yuneec limits theirs to 400 ft AGL and 500m range out of the box but can be edited by contacting the company. Should manufactures be regulated to limit their drones?

Answered: 95 Skipped: 3



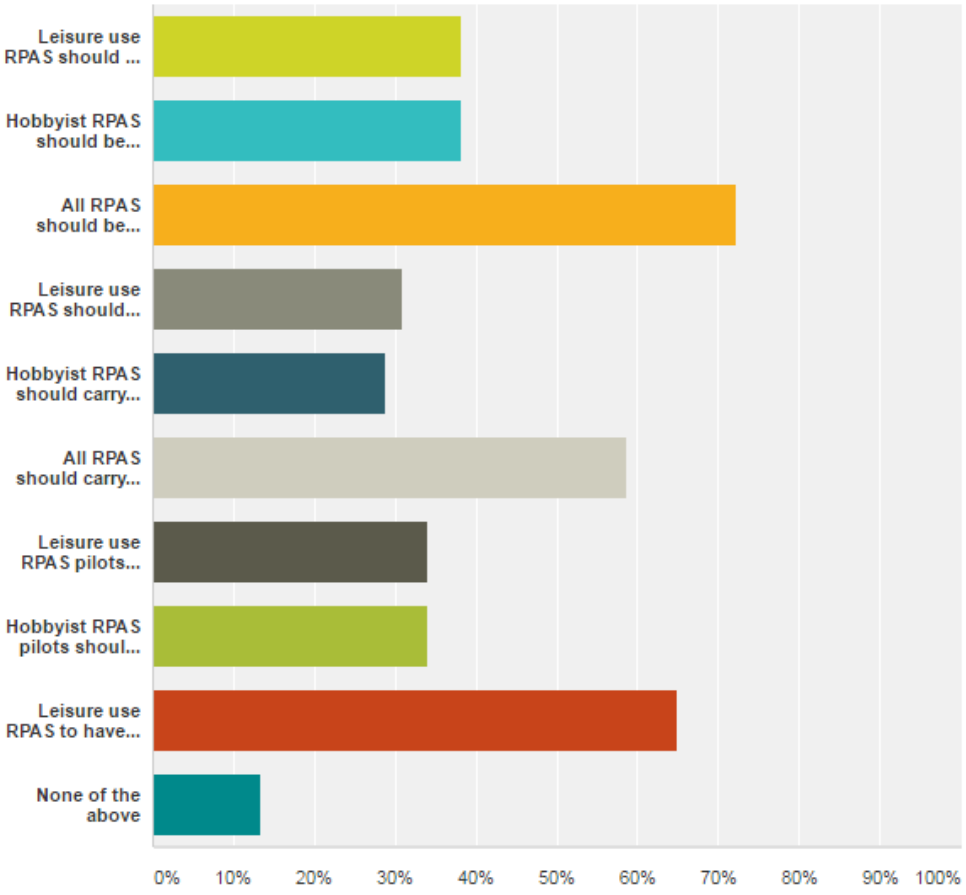
Answer Choices	Responses	
Yes	89.47%	85
No	10.53%	10
Total		95

Comments (44)

Q8 Customize Export

To fly your aircraft in Class G airspace (except BHPA members) it has to be registered and you are licenced. Please tick those answers that you believe should apply to RPAS.

Answered: 97 Skipped: 1



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Answer Choices	Responses
Leisure use RPAS should be registered	38.14% 37
Hobbyist RPAS should be registered	38.14% 37
All RPAS should be registered	72.16% 70
Leisure use RPAS should carry a registration number	30.93% 30
Hobbyist RPAS should carry a registration number	28.87% 28
All RPAS should carry a registration number	58.76% 57
Leisure use RPAS pilots should be tested (note model pilots are not - military/commercial RPAS pilots are tested)	34.02% 33
Hobbyist RPAS pilots should be tested (note model pilots are not - military/commercial RPAS pilots are tested)	34.02% 33
Leisure use RPAS to have 3rd party liability insurance (commercial/military/hobbyist RPAS do)	64.95% 63
None of the above	13.40% 13
Total Respondents: 97	

Comments (34)

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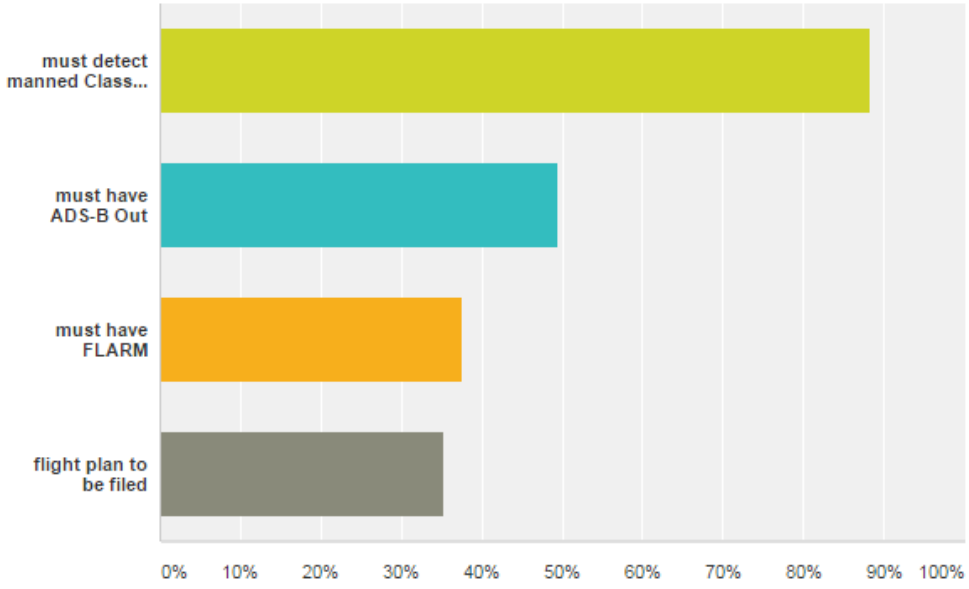
Q9

Customize Export

For RPAS to fly beyond visual line of sight you believe that RPAS (tick as many that apply):

Answered: 85 Skipped: 13



Answer Choices	Responses	
must detect manned Class G aircraft and avoid them	88.24%	75
must have ADS-B Out	49.41%	42
must have FLARM	37.65%	32
flight plan to be filed	35.29%	30
Total Respondents: 85		

Comments (28)

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RPAS/VFR INTEGRATION SURVEY SUMMARY

Response 98% As at: 2 Feb 2017

Q1 **Type**	**Done**	**Target**	**%**	2 **Avg Hrs on Type**	3 **Cruise Alt (ft)**	4 **Integration Issue? Yes %**	5 **ANO 400ft Limit? Yes %**	6 **Main Threat %**	7 **Limit Drone? Yes %**	8 **Register/Licence Insurance Top 2 %**	9 **BVLOS Main Requirement**	10 **Other Recurring Themes**
Rotary/Gyro	4	5	80	1350	1100	75	100	100 Leisure	100	100 All Registered 100 Reg No Display	Detect & Avoid	No Recurring
Fixed Wing	35	35	100	1000	2300	83	91	91 Leisure	88	100 All Registered 85 All Insured	Detect & Avoid	No Recurring
Gliders	9	9	100	2300	2000	63	100	88 Leisure	100	63 All Insured 50/50 All Register / Tested	Detect & Avoid	No Recurring
Balloon / Airship	6	6	100	1800	2100	67	83	83 Leisure	67	100 All Registered 67 All Insured	Detect & Avoid	No Recurring
Microlight	15	15	100	700	1800	87	93	100 Leisure	93	93 All Insured 60 All Registered	Detect & Avoid	Education
Military (Low Fly)	2	3	67	1150	1900	100	100	100 Leisure	100	All Equal	Detect & Avoid	No Recurring
Self-Launched	27	27	100	1300	1800	74	82	88 Leisure	89	74 All Insured 55 All Registered	Detect & Avoid	Education
Overall	**98**	**100**		**1200**	**2000**	**75**	**90**	**92**	**90**			**Education**

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