



A National Strategy for Drones Across Land, Sea and Air

Timely and decisive intervention is vital to promote UK leadership in drone adoption whilst preventing serious safety and security risks to the general public

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1 Executive Summary

For the purposes of this paper, the term drone is used to describe robotic and autonomous systems across all domains (land, sea and air).

See ISO 21384-4 'definition of a drone'

There is little doubt that drones will become increasingly automated and integrated into complex operational systems. It is in the public interest for operating regulations and construction standards not only to embrace, but also to lead this rapidly emerging industry.

Traditionally, and for very good reason, regulations have been developed in isolation for each operating domain (air, sea and land). Each has evolved to regulate and standardise what 'safe' means for technology and operating practices within each domain. Drone technology and more specifically autonomy has highlighted weaknesses and inefficiencies in this approach.

This paper, supported by 3 associated documents¹, argues in favour of unifying and harmonising many aspects of drone regulation and standardisation across all domains.

The potential value of the drone industry to the UK has been the subject of several prominent studies, all projecting significant growth to GDP. Despite this, the UK's approach to the development of regulations in this sector remains 'orthodox' and 'risk averse' which has caused a movement of business to countries with more progressive regulatory frameworks. Scope exists to check this outflow, without unduly compromising public safety and promoting efficiencies within regulatory bodies.

The guiding principle is that drones in all domains (land, sea and air) **must be built safe to operate and be operated safely**. It is in support of this principle that this paper has been developed cross-industry to suggest guidance to Government agencies for the regulation of this sector.

To encourage the adoption of drones in the UK and to deliver clear social, economic, and environmental benefits, the development of harmonised 'cross-domain' regulations for drone technology and operations, which refer to industry developed 'Safety and Quality' standards, as an 'Acceptable Means of Compliance' (AMC) is urgently needed.

Regulators have a responsibility to engage early in the development of 'Safety and Quality' standards, something that has, to date, not always been the case.

This paper respectfully suggests the implementation of a strategy for a harmonised approach to the regulations of drone technology and operations across all domains as part of a policy promoting '**standards heavy - regulation light**'. This would shift the emphasis towards industrial self-responsibility as systems progress towards increasing levels of autonomy.

To achieve this, Regulators across all domains are now challenged to enable the controlled development of autonomy within the commercial sector through harmonised regulation and standardisation:

- ensuring the agility of the regulatory environment matches the agility needed in a rapidly evolving industry;
- ensuring the safe and efficient operation of all drone technology systems, side by side with current manned equivalents, by harmonising the approach to the development of regulations to enable innovation and economic growth of this, important, emerging industry;

¹ Associated papers to be read in support of this white paper are available here - <https://www.dronedeliverygroup.org/industry-white-papers/latest-release>

- overseeing the controlled development of autonomy in the drone industry rather than simply allowing its development without core safety principles;
- developing appropriate certification 'schemes' for drone technology across all domains to enable commercialisation;
- actively support development of national and international 'Safety and Quality' standards through the UK's national standards body (BSI) and the mirrored ISO committees.

While Government departments may be resourced for steady state business activities, the rise of autonomy and cross-domain operations have created a paradigm shift that requires focused and rapid evolution in the way in which the UK regulates for this sector.

Tackling this issue now can offer significant cost savings and provide a boost to the industry in the UK, which is currently losing companies to more accommodating European countries.

2 Value Proposition

Drones² operate within, or travel through all domains (land, maritime, air and space) and they are required to abide by the regulations and standards set for each domain.

A recent PWC Report³ estimates that drones will save businesses an estimated £22bn by 2030 and contribute £45bn to the UK economy and this estimate, which focusses only on the use of drones in the air, is far from the actual figure for all drone technology across all domains (land, air & maritime). To achieve these estimates, the UK Government needs to establish a methodology to regulate their use for commercial purposes, without compromising the existing provisions for the safety of manned vehicles.

3 Scope

This paper promotes the development of harmonised regulations for drones across all domains, underpinned by relevant 'Safety and Quality' standards, as an effective and efficient way of ensuring safety, coherence, consistency and interoperability across the emerging drone industry.

4 Current Position

Drones are an inevitable part of our future transport system and an important part of the UK's strategy for future growth, as demonstrated by a recent statement by the Department for Business, Energy & Industrial Strategy (BEIS)⁴.

² As defined by the International Organization for Standardization (ISO), a drone is 'any unmanned system which is remotely or autonomously controlled'. This includes driverless cars, pilotless aircraft, satellites, spacecraft, underwater ROVs, marine surface vehicles and hybrid systems which are breaking down environmental barriers by operating between land, sea and air or in all three.

³ Price Waterhouse Cooper (PWC) Report - Skies Without Limits V2.0 – The Potential to take the UK's economy to new heights - <https://www.pwc.co.uk/issues/intelligent-digital/the-impact-of-drones-on-the-uk-economy.html>

⁴ Department for Business, Energy & Industrial Strategy Statement - <https://www.gov.uk/government/news/new-aerospace-innovation-to-propel-uk-to-growth-and-greener-skies-backed-by-273-million>

The fact that drones will operate with varying degrees of autonomy between and across domains⁵, in many instances, side by side with current manned equivalents, needs to be acknowledged by regulators rather than taking a purely ‘remotely operated’ approach, which is prevalent in some domains. The speed of advancement of technology in the drone industry is unprecedented with systems already capable of low-level autonomous operation in multiple domains. The current approach to standards and regulation also needs to keep pace with these developments and be at least compatible and, preferably, unified across all domains.

Drones are not simply self-contained vehicles but are ‘systems operating within systems’ of extraordinary complexity with hardware, operated by programmed software, controlled by communications systems that carry potentially sensitive data, all of which should be subject to suitable regulation, safety and quality standards. Drones will, as a primary or secondary function, collect and generate data and the consistent management of that data across all domains is important from a security and regulatory perspective. Currently, this is not the case with each domain taking individualised and differing approach to the development of regulations and the corresponding use of standards.

It is acknowledged that Government departments may be resourced for steady state business requirements which could leave little additional capacity available to make the necessary regulatory changes to match the pace of evolving technology: Drone technology is moving at a much faster pace than legislation and/or regulation and that is liable to be the future trend. Add to this the increase in cross-domain operations, and the paradigm has shifted significantly, requiring a step change in outlook.

It is important to tackle this issue early by leading this fast-emerging industry by standardising and harmonising regulations for both drone technology and operations across all domains. Such a proactive approach is also likely to save significant manpower, cost and, more importantly, ensure that the industry continues to develop at pace in the UK, confident of a robust framework, consistent with international accords for each domain.

5 Challenges

5.1 Use of Standards

UK regulators can sometimes have an inconsistent relationship regarding the use of industry ‘Safety and Quality’ standards in support of regulations. Governments do not set industry standards, but failure to engage early in their development renders regulators blind to what industry considers as ‘Best Practice’. This has led, in many instances, to duplication of effort, conflict with international norms and deeper regulation than necessary.

Government Agencies’ engagement with the development of standards by the drone industry is limited, with many companies racing to develop and establish technology and concepts in the hope that, once established, standards would adapt to them.

⁵ For example, several drone systems are in development which can cross the water-air boundary operating effectively in both domains and, currently, air drone systems can operate, for example from maritime vessels to land on land based vehicles.

Much effort has already gone into developing international ‘Safety and Quality’ standards in relation to product, operations, autonomy, Unmanned Traffic Management (UTM), inter drone communications, Artificial Intelligence (AI), software, infrastructure and much more. Harmonising the use of these standards as suggested in this paper could save incalculable hours of Government work effort by authorities such as the Civil Aviation Authority (CAA), the Maritime and Coastguard Agency (MCA) and the Vehicle Certification Agency (VCA).

Despite leaving the EU, the UK continues to play its part in the development of European standards through the European Committee for Standardization (CEN). Looking to the International Organization for Standardization (ISO) standards as a basis for future UKCA standards would give coherence to the national regulations as an Acceptable Means of Compliance (AMC) and provide wider international applicability.

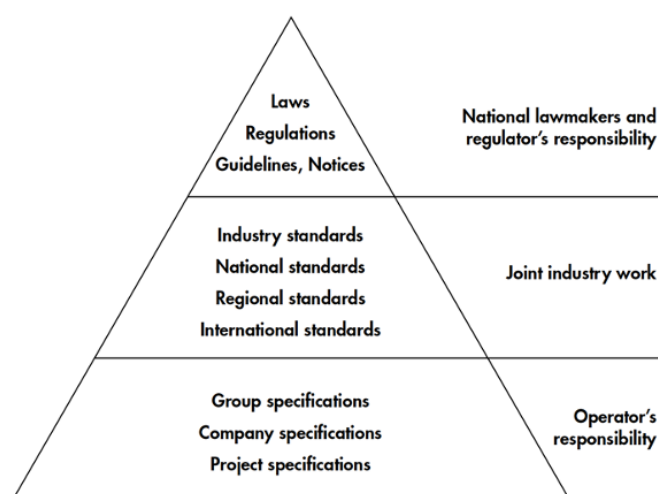


Figure 1 clearly shows how regulations and standards are applied.

It is important to recognise that Regulators have a responsibility to engage in the development of 'Safety and Quality' standards, something that has not been the case to date.

5.2 The Case for Harmonisation

For very good reason, each domain (air, sea and land) has evolved separately to regulate and standardise ‘safe’ means for technology which will remain intrinsically within its relevant domain, governed by respective international accords and laws. Drone technology, and, more specifically, autonomy, has highlighted a weakness in this legacy approach which should be addressed to ensure that what is deemed ‘safe’ for drone technology is applied consistently across all domains.

This disparity may be illustrated by such examples as:

5.2.1 Multi-Domain Operations

As drone systems are designed to operate autonomously in multiple domains, it is necessary to ensure that safety and security is maintained **consistently** across them all.

Commercial manufacturers and operators need clear and consistent direction on the requirements for safety of manufacture and operation of drones across all domains. This should be led by regulators, using industry 'Safety and Quality' standards with maximum commonality, coordinated within Government departments including DfT (CAA, MCGA, VCA), OFCOM and BEIS.

Harmonising the approach to regulating drone technology is particularly important in the areas of safety-critical design, software and data security, communications and operations.

5.2.2 Autonomous Operations

Software and algorithmic techniques such as Machine Learning (ML) and Artificial Intelligence (AI), have advanced rapidly, enabling the evolution of automated drone operations. While full autonomy may not be possible or desirable for some years, the use of 'human in the loop'⁶ or 'human on the loop'⁷ autonomous systems could bring significant benefits to industry, the economy and society in general, so it is vital that such systems are regulated and standardised in a coherent and consistent way.

The UK's approach has tended to side-line full autonomy, perhaps as illustrated by the CAA renaming of their Unmanned Air System (UAS) Unit to Remotely Piloted Air System (RPAS) Unit. This narrower approach is likely to impact the adoption and commercialisation of drone technology adversely.

It is recognised internationally that the UK does not allow commercial autonomous drone operations despite many trials in this area. This approach, which is not mirrored across some other countries is resulting in companies moving their operations overseas.

5.3 The Need for Certification Schemes

Currently, there appears to be a marked lack of direction or best practice available to enable drone manufacturers and operators to certify against. As a result, the processes required to establish whether a technology or operation is 'safe' falls entirely on the relevant Regulator which is causing significant and delays to applications for permission to operate drones in the UK. Such delays inevitably lead to additional costs and damage to companies seeking to establish commercial drone operations. As a result, UK companies are simply moving their operations, and in some cases, their companies to other countries.

If certification schemes were in place, conformity audits/assessments could take place and commercial operations could be achieved more rapidly

⁶ Human-in-the-loop (HITL) is defined as a model that requires human interaction.

⁷ Human-on-the Loop (HOTL) is defined as a model does not rely on human input but where a human is monitoring and can take control

The identification or creation of Acceptable Means of Compliance (AMCs) for drone manufacturers and operators is needed to underpin the creation of certification schemes in the UK.

The marked lack of certification schemes for drone manufacturers and operators in the UK is adversely affecting the pace of commercialising the drone industry.

acknowledge that, while drones are highly complex and safety critical systems, many of the ‘Safety’ principles are common across all domains so a coordinated and harmonised approach to their regulation is needed.

This need not be onerous for Government, as the bulk of the work could be developed by the International Standardization Organization (ISO), through the development of ‘Safety and Quality’ standards, supported by industry bodies and experts, with engagement from regulators.

6.1 The Case for Supporting Regulations with Standards⁸

The recent report on drones by the Regulatory Horizons Council (RHC) highlighted that ‘Simpler regulation, backed by robust safety and quality (foundation) standards, would bring cost-reduction and new growth opportunities’

The UK tends to be ‘regulation heavy and standards light’ but regulations, which stem from legislation, are time-consuming and difficult to change. A greater emphasis on the use of standards to underpin regulations would:

- relieve regulatory authorities of the need to devise new, detailed, or complex requirements relating to materials, processes, design considerations and criteria, technical procedures, test methods, etc;
- permit detailed technical requirements to be embodied into the text of a regulation simply by referencing a standard or the relevant parts of a standard, making regulations thinner and more focussed;
- simplify and accelerate legislative work and lower cost to Government in developing and enforcing regulations;
- promote uniformity of technical requirements;
- encourage participation in the development of standards;
- avoid duplication of effort and optimize the use of scarce resources by taking into consideration the results of international standardisation work;
- reduce barriers to trade by referring to recognised national standards which have been harmonised internationally.

⁸ For background information, please read ‘ISO Standards – A Practical Application’ | Authors Rikke Carmichael & Robert Garbett - <https://www.dronedeliverygroup.org/iso-standards-a-practical-application>

7 Summary & Recommendations

Historically, regulations have been developed in isolation for each domain (air, sea and land). Each has evolved to regulate and standardise what 'safe' means for technology operated within the context of each domain and their respective international accords. Drone technology and, more specifically, the advent of autonomy has, highlighted weaknesses and inefficiencies in this legacy approach.

This paper highlights the urgent need to tackle what is seen as a gap in the coherence between individual operating contexts and domains, and the opportunity that this presents to UK Government to provide confidence to the UK drone industry and, through adding coherence, efficiency savings across regulatory agencies.

To achieve this, it is recommended that Government:

- actively supports and engages with development of national and international 'Safety' mirrored ISO committees.
- Implements a strategy for the development of harmonised, regulations that refer to 'Safety and Quality' standards, as part of a policy promoting **'standards heavy - regulation light'**.
- harmonises the way regulations are developed to ensure that, for autonomy, what is considered 'safe' is consistent across domains.
- develops appropriate 'Acceptable Means of Compliance' (AMCs) and certification 'schemes' for drone technology, and its operation, across all domains to enable commercialisation;

At a time when the UK Government is seeking cost and efficiency savings, this offers an effective solution that could greatly assist in the development of coherent, synchronised standards and regulations, while significantly reducing the workload associated with the development of guidance and detailed regulations.

The rise of autonomy and cross domain operations have created a paradigm shift that requires focused and rapid evolution in the way the UK regulates. Tackling this issue now can offer significant cost savings and provide a boost to the industry in the UK, which is currently losing companies to more accommodating European countries.

Glossary of Terms

BEIS	Department for Business, Energy and Industrial Strategy
BSI	British Standards Association
BVLOS	Beyond Visual Line of Sight
CE	Conformité Européenne
CEN	European Committee for Standards
DAA	Detect and Avoid
DDG	Drone Delivery Group
DfT	Department for Transport
EUROCAE	European Organisation for Civil Aviation Equipment
GNSS	Global Navigation Satellite
HMG	Her Majesty's Government
ISO	International Organization for Standardization
JARUS	Joint Authority for Rulemaking on Unmanned Systems
MASS	Maritime Autonomous Surface Shipping
MCA	Maritime and Coastguard Agency
ODC	Operational Delivery Committee (of the DDG)
OFCOM	Office of Communications
RP	Remotely Piloted
RPAS	Remotely Piloted Air System
ROV	Remotely Operated Vehicle
RPS	Remote Pilot Station
SAE	Society of Automotive Engineers
SOLAS	International Convention for the Safety of Life at Sea
UAS	Unmanned Aerial System
WG	Working Group