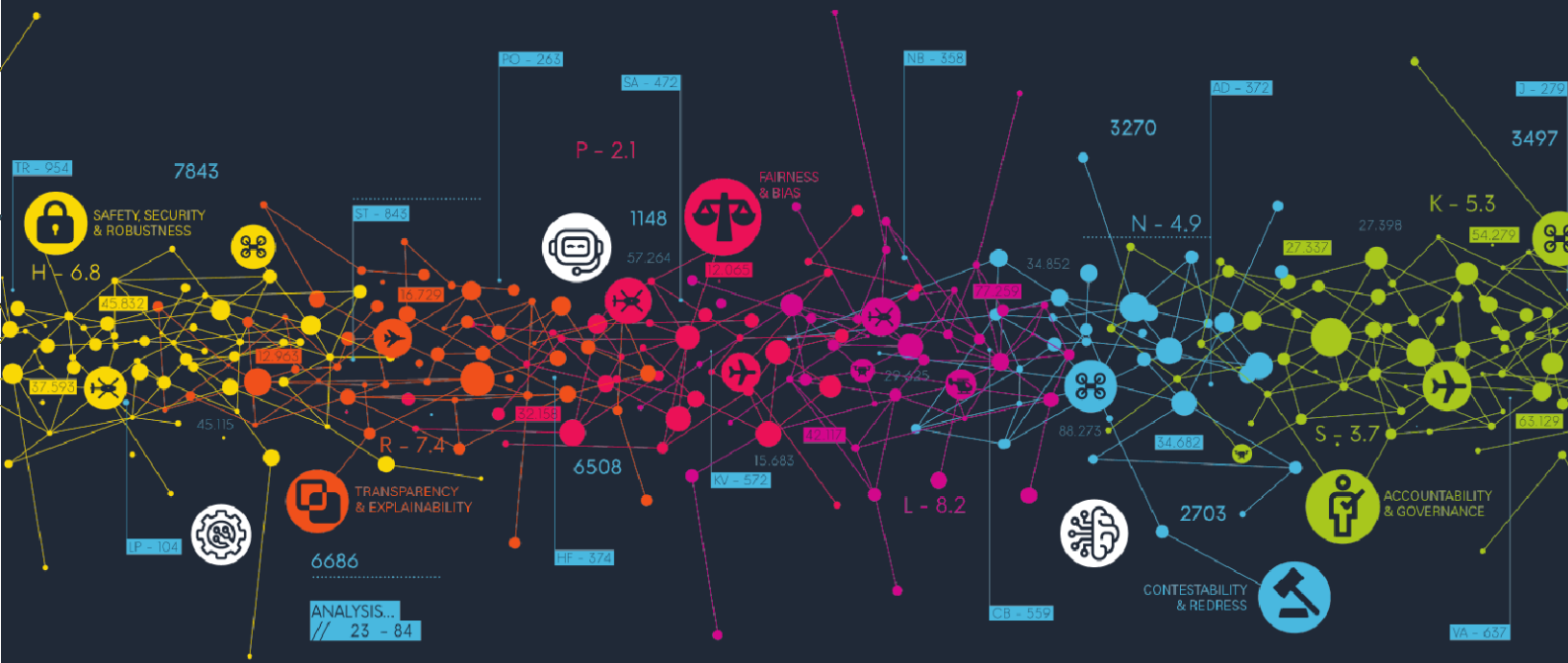
UK Civil Aviation Authority

CAA's Response to Emerging AI-Enabled Automation

CAP3064



PROTECTING PEOPLE, ENABLING AEROSPACE

CAA Ai Innovation Strategy

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Executive Summary

This document addresses the transformative impact of artificial intelligence (AI) on the aerospace sector and the role of the Civil Aviation Authority (CAA) as a regulator.

AI technologies are rapidly evolving, presenting significant opportunities and challenges across the entire aerospace sector. This technology promises many benefits but also demands robust regulatory frameworks to ensure safety, security, and standards for its responsible use.

We face emerging challenges that stem from the need to regulate AI in aerospace and from using AI within the CAA. To regulate well, we need to understand AI risks like bias and safety issues. At the same time, using AI ourselves could make our work faster and better. However, we need to be careful about how this affects trust in the CAA.

To address these complexities, we have created our response to emerging AI-enabled automation. This outlines principles for managing both the introduction of AI in aerospace and also within internal operations. These are supported by a common framework that aims to foster innovation while safeguarding regulatory integrity and public trust.

Our response introduces distinct visions for both the regulation and use of AI: enabling AI to enhance aerospace efficiency, sustainability and scalability, while ensuring safety, security, consumer protection, and environmental sustainability through proportionate governance; and leveraging AI internally within the CAA to enhance efficiency and service delivery. It emphasises proactive engagement with stakeholders and ongoing adaptation to technological advancements and regulatory needs.

Structured in three parts, our response includes a foundational AI framework that will ensure consistency and enable capability enhancement across regulatory and operational domains. We will support this with continuous updates and stakeholder feedback. This underpins our strategy for the regulation of AI in aerospace (part A); and provisions for effective adoption of AI-enabled automation within the CAA (part B).

While aligning with the UK Government's pro-innovation approach to AI regulation, the CAA's response also considers international AI regulations and standards. Collaboration with global aerospace bodies and standards development organisations is pivotal for maintaining thought leadership and regulatory coherence.

Ongoing stakeholder engagement is integral to our success. CAA forums and other mechanisms for industry collaboration and public input will ensure regulatory responsiveness and alignment with evolving AI advancements and societal expectations.

In navigating the AI landscape, the CAA's response aims to balance innovation with regulatory rigor, ensuring the UK aerospace sector remains at the forefront of safe and responsible AI adoption. By fostering transparency, ethical governance, and stakeholder

collaboration, the CAA seeks to uphold its mission of safeguarding safety, security, consumer protection, and environmental sustainability amidst rapid technological evolution.

Chapter 1

Introducing the CAA's Response to AI-Enabled Automation

1.1 The emergence and rapid evolution of artificial intelligence technologies represent a substantial step-change for the aerospace sector and the Civil Aviation Authority as its regulator. The increasing use of AI-based systems, particularly leveraging machine learning techniques, across various aerospace domains poses great opportunities coupled with unique challenges. The evolving AI landscape is characterised by its complexity, rapid pace of development, and the potential for widespread disruption. As AI capabilities advance, they are likely to transform numerous aspects of aerospace operations from aircraft design, manufacturing and certification to air traffic management, flight operations, maintenance, and customer experience. We will also see transformation in our regulatory and business processes within the CAA, where AI-based tools are likely to be incorporated into our routine ways of working. This transformation presents both opportunities and risks that must be proactively addressed through a well-defined regulatory framework alongside a coherent strategy for the safe and responsible use of AI within the CAA.

1.2 These challenges and opportunities must be carefully managed to ensure the continued safety and security of the aerospace sector, drive towards its improved environmental sustainability, and protect its consumers and the public.

1.3 Recognising the substantial changes brought about by AI and the need to manage this transformation effectively, the CAA has developed our initial response to AI-enabled automation. Through a structured and proactive approach, the CAA aims to ensure that the adoption and regulation of AI technologies in the aerospace sector align with our core regulatory responsibilities.

The Purpose of Our Response

1.4 In response to the broad strategic challenge facing us, this response is intended to lay the foundations for a principles-based approach to managing and enabling AI introduction both in the aerospace sector and within the CAA. It establishes common enabling elements that will provide consistency in our approach while also separating out the regulation of AI in aerospace and the use of AI in the CAA into two distinct strategic plans.

1.5 The scope of the response considers all possible permatations where AI could influence the CAA, as in Figure 1, which describes the potential scope of impact

of AI at the CAA. While we recognise that using AI to regulate AI in aerospace is an eventual possibility, it is not an area we expect to explore at this stage.

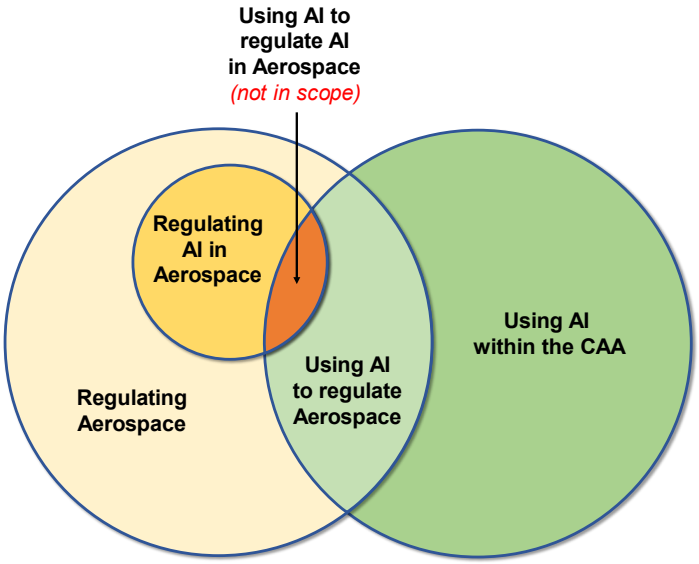

Figure 1: The scope of our response to emerging AI-enabled automation.

AI in Aerospace

1.6 The CAA must develop a comprehensive understanding of the unique risks and challenges associated with AI systems, including issues related to transparency, explainability, bias, safety, security, and ethical considerations. The traditional regulatory approaches may need to be adapted or supplemented to address the complexities of AI technologies, which often exhibit opaque decision-making processes and can be susceptible to unintended consequences or vulnerabilities.

1.7 To guide the development and subsequent delivery of our response, our Horizon Scanning & Insights team conducted research into the use cases for AI and their potential impacts in terms of aircraft, infrastructure, and air traffic management. The CAA's publication CAP3019[1] explores the horizon for trends relating to artificial intelligence and we will continue to routinely provide these insights to the CAA's development of this response to AI-enabled automation.

1.8 To inform this, we also conducted a survey in February 2024 and a workshop with representatives from the sector in March 2024. The results of this activity are summarised in CAP3022[2]. Dedicated mechanisms for engaging with the sector and for seeking feedback will enable us to continue this engagement more systematically, further guiding the CAA's focus on AI alongside horizon scanning.

[1] CAP3019: AI Technology Outlook, available at www.caa.co.uk/CAP3019

[2] CAP3022, Summary of Responses to the AI Strategy Survey, March 2024, available at www.caa.co.uk/CAP3022

AI in the CAA

1.9 There are numerous applications of AI in regulatory functions that could enhance our efficiency and effectiveness. This could allow us to process applications quicker, carry out more comprehensive assessments, or extract greater volumes and quality of intelligence from safety data. Equally, like any other kind of business we recruit new employees, manage financial resources, develop media products, and train our colleagues.

1.10 The responsible adoption of AI tools requires careful consideration of potential risks, such as algorithmic bias, data privacy, and the impact on workforce skills and roles. As AI permeates into our everyday lives, customers and colleagues will come to expect the CAA to utilise AI capabilities to improve services and operational effectiveness. The CAA must navigate the challenges of leveraging AI technologies within its own operations, so a measured and risk-based approach is necessary to maximise the benefits of AI while mitigating potential drawbacks and ethical concerns. There is already a wealth of expertise and best practice being developed across industry, the government, and other regulators that we intend to monitor and collaborate with.

A Vision to Guide our Approach

1.11 A vision is often used to articulate a future aspirational state and indicate a direction of travel. In this case, our response to AI-enabled automation encompasses two distinct areas of focus that benefit from independent but connected visions of the future.

Part A: Regulation of AI in Aerospace

1.12 The Civil Aviation Authority will enable AI to enhance aerospace efficiency, sustainability and scalability, while ensuring safety and security through proportionate governance..

Part B: Using AI in the CAA

1.13 Empowering our colleagues, customers, and consumers by enhancing the efficiency, decision-making, and service delivery within the CAA while upholding the highest standards in safety, security, responsible conduct, and transparency.

Chapter 2

Our Strategic Response

2.1 The CAA's response to AI-enabled automation marks the first step on a long and transformative journey for the CAA and the aerospace sector. We recognise that the integration and regulation of AI in aerospace is a complex, evolving process that requires ongoing collaboration and adaptation as the technology continues to develop. As we move forward, we are committed to working closely with the aerospace industry, our colleagues, and consumers to shape a future where AI enhances safety, efficiency, and sustainability in aerospace. This collaborative approach will ensure that our response remains aligned to technological advancements, industry needs, and public expectations as we navigate the challenges and opportunities presented by AI.

2.2 Figure 2 below outlines how the CAA's response to AI-enabled automation is supported by horizon scanning and the AI Framework. It describes how horizon scanning and the strategies themselves inform the strategic directions, which in turn inform the CAA's AI Portfolio.

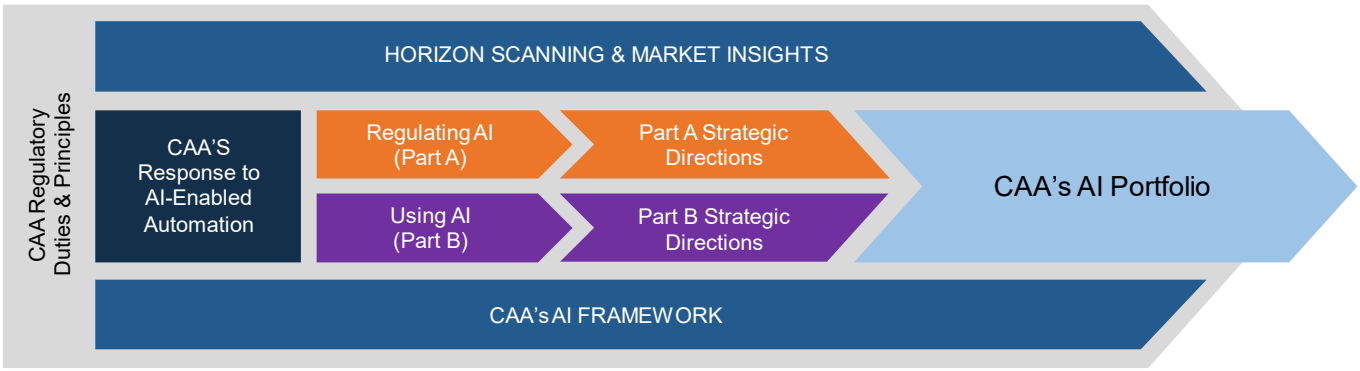

Figure 2: The structure and approach of our response to emerging AI-enabled automation.

Structure of our Response

2.3 The overall approach is structured in three parts, each with their own purpose:

- **Our Response: An enabling framework**
  The purpose of this document is to bring together those elements that are common across both the regulation and use of AI. Doing so ensures that we can effectively and consistently build trust in AI in aerospace and in our own use of AI. Following a common framework also supports the education and capability development of colleagues across the CAA by exposing them to both aspects.

- **Strategy for Regulating AI in Aerospace (Part A)**
  The purpose of Part A is to outline the approach that the CAA will take to regulating AI that is used in aerospace applications. This could range across airborne systems, air traffic management, air travel organisers, or baggage screening. If the application of AI in aerospace affects any areas covered by the CAA's regulatory responsibilities, we will need to assess and consider its implications.

- **Strategy for Using AI in the CAA (Part B)**
  The purpose of Part B is to ensure that colleagues are empowered with the latest AI technology in both regulatory and business functions, while maintaining the CAA rigorous information and personnel safety and security. The benefits that AI could bring for colleagues, customers, and other stakeholders is expected to be sizeable, so the strategy enables us to realise these benefits while ensuring that we hold ourselves to account for the responsible use of AI.

An Integrated Approach

2.4 Our response to AI-enabled automation must integrate across the CAA and within the UK regulatory ecosystem. Key organisations and groups affected by and involved in AI aviation policy include: UK Government, setting policy direction and coordinating regulatory approaches across UK sectors; the aerospace industry and research institutions, developing and implementing AI-based solutions; consumers & the public, representing end users and affected parties; and across all components of the CAA to reflect the broad applicability of AI.

The CAA's AI Framework

2.5 We have identified that there are common elements that permeate into both the regulation and use of AI. Bringing these elements into a CAA AI Framework enables consistency in our approach and enhances our capability on both fronts.

2.6 Developed in parallel with the strategies, this AI Framework includes 3 elements in its first iteration. These will be further enhanced as our capabilities and insights develop, with later versions to include additional tools and guidance to support both strategies.

AI Framework (v1): Common Language, Building Trust, and Horizon Scanning

2.7 The first edition of the AI Framework consists of 3 elements:

(1) **A Common Language for AI** (CAP2966). The consistent and accurate use of language is important to ensure that the capability of products and services are clearly understood and that subsequent regulatory conversations are on an equal footing. Automation, Autonomy, and

Artificial Intelligence are often misused or confused with each other. This tool clarifies our understanding of the terms. This builds on experience within the CAA's Innovation Hub since 2019 and has been validated with experts from academia, industry, and other sectors in the UK and internationally.

caa.co.uk/CAP2966

(2) **Building Trust in AI** (CAP2970). The application of AI may invoke scepticism and concern about privacy, security, human factors, and equitable distribution of benefits. Complex applications of AI in aerospace, especially in areas where consumers see a direct and tangible impact, are some years away and so the technology is not yet accessible and relatable. As regulators for safety, security, consumer protection, airspace, and environment sustainability we have a key role to play in helping the sector to build trust in its products and services. By ensuring that the industry and regulators work together to develop and operate products and services against the 5 AI Principles adopted by UK Government (**Error! Reference source not found.**), trust can be built in these AI-based systems.

caa.co.uk/CAP2970

(3) **An AI Technology Outlook** (CAP3019). It is important that we do not build and sustain a strategy based on limited visibility of the technology. AI is evolving more rapidly than most other emerging and disruptive technologies and has a wider spectrum of applications than most innovative technologies the CAA is used to dealing with. We need to stay up to date with these developments and continuously challenge the CAA's approach. This first technology outlook provides a brief overview of some of the possible applications for AI across the aerospace sector. Subsequent iterations will be released periodically and will provide insights into the state-of-the-art of AI in aerospace more broadly.

caa.co.uk/CAP3019

Improving and expanding the framework

2.8 Using the insights gathered from research, engagement, and feedback, and using the existing tools we will refresh these documents to reflect the latest understanding and capabilities of the technology, the sector, the Government's policy, and the CAA's approach.

2.9 We also intend to add further tools to the AI Framework that we hope will make the regulation and use of AI more accessible.

The Strategic Directions

2.10 The two strategies and our AI Framework dictate the high-level principles underpinning everything relating to AI and autonomy across the CAA and the considerations that need to be answered for: safety, security, airspace, environmental sustainability, and consumer protection.

2.11 The strategic directions will provide us with an initial steer towards areas of AI adoption that need to be explored. These will likely build on themes, objectives, or strategic goals set out by (a) Government; (b) the sector; or (c) the CAA itself. They will be presented as hypotheses to be investigated and will direct all activities that contribute to the AI Portfolio. For example:

- How can AI be integrated in the aviation system safely and securely (AI Safety & Security)?
- How can AI be used to improve safety and security in the aviation system (AI for Safety & Security)?
- How can AI be used to drive economic growth for the aviation industry through improved efficiency and increased scalability of operations?
- How can AI be used to drive economic growth for the aviation industry through novel products and services?
- How can AI be used to help the aviation sector meet its environmental targets?

The AI Portfolio

2.12 While our response to AI-enabled automation is described in this document and the two strategies, the AI Portfolio is the delivery body of this initiative. The activities necessary to deliver against the strategies and strategic directions are far reaching across the organisation and the sector. This extensive breadth of activity needs to be effectively managed and reported on according to our governance proposals.

2.13 To enable this, the AI Portfolio encompasses any strategically significant activity associated with our visions for regulating and using AI. Managing this centrally

within an AI Portfolio enables the CAA to define specific outcomes, ensure a consistent approach that aligns to the stategies, efficiently monitor progress against the strategic plans, and provide transparent and coherent reporting to all stakeholders.

The AI Strategy & Portfolio Hub

2.14 To address the complex challenges presented by AI in aerospace and to enable its responsible adoption across both the aerospace sector and within the CAA, we propose establishing a new AI Strategy & Portfolio Hub (AI Hub). The first parts of this organisational function of the CAA will be scoped and established during 2025/26.

2.15 Once fully established, the AI Hub aims to serve several purposes:

- To ensure a **consistent approach** to the regulation and use of AI throughout the CAA that aligns to our AI Framework, providing **oversight and support** across all the CAA's regulatory and business functions on the delivery of the AI Portfolio.
- To enable AI-specific expertise, education, and foresight for the benefit of the whole CAA.
- To drive forward the **evolution of the CAA's Response to AI-Enabled Automation**, responding to the rapid evolution of the technology and its uptake in aerospace.
- To **promote the responsible use of AI in aerospace** through collaboration with industry and academia.
- To **lead and coordinate external engagement** with international aviation organisations, government, and other regulators on AI and Autonomy.

2.16 The AI Hub aims to provide strategic leadership on AI and autonomy within the CAA and for our external stakeholders. It will have ongoing responsibility for managing the AI Portfolio that will encompass the wide scope of AI programmes and activities and be responsible for reporting on the implementation of the 5 AI principles to central UK government.

2.17 Complementing the AI Hub, we propose an AI Operating Model that reflects how the established capability will operate. This model features the AI Hub at its core, interacting with colleagues and customers.

- Internally, the AI Hub will collaborate with key departments such as the Safety and Airspace Regulation Group (SARG), Aviation Security, Consumer & Markets Group, Corporate Enabling Services, and others. We will support this through the establishment of an AI Community of Practice, comprising colleagues across the organisation who have existing responsibilities for policy development, oversight, or business services but will help implement AI initiatives and share knowledge.
- Externally, the AI Hub will engage with a range of stakeholders including:
  - Other UK Regulators and the government
  - International bodies and regulators
  - Industry partners
  - Standards bodies
  - Academic and research institutions

2.18 This operational model is designed to ensure that the CAA can effectively navigate the broad and complex challenges presented by AI in aerospace.

2.19 As we move forward with our AI Portfolio, the AI Hub and the associated operational model will be key to our success in fostering safe, innovative, and responsible AI adoption in UK aerospace. Into the future, its role, purpose, and existence will be kept under continual review to ensure that the CAA is maximising its resources most efficiently.

Powered by Collaboration & Engagement

2.20 Ongoing engagement with a wide range of stakeholders is crucial as we navigate the rapidly evolving landscape of AI in aerospace. To ensure our regulatory approach remains suitable and up to date, we must maintain active dialogue with the aerospace sector, other industries where AI is being utilised, fellow regulators who are tackling the same issues, and government bodies both in the UK and internationally. This collaborative approach will help us stay abreast of the latest AI developments and their potential impacts across the CAA's remits.

2.21 We will use dedicated engagement forums and accessible channels for stakeholders and the CAA to collaborate. These platforms will serve multiple purposes: they will allow industry experts, researchers, and other interested parties to provide valuable insights and evidence that will inform our regulatory approach. Additionally, these channels will facilitate the dissemination of guidance and promote the use of our AI framework tools. By fostering this two-way communication, we aim to create a dynamic and responsive regulatory environment that can adapt to the pace of technological change.

2.22 Our engagement strategy will be carefully aligned with the CAA's main strategic priorities. This alignment ensures consistency across our activities and helps avoid duplication of efforts. By integrating our AI-focused engagement within our broader strategic framework, we can leverage existing expertise and networks across the CAA, maximising our reach and effectiveness. This approach will allow us to tap into diverse perspectives and experiences, enriching our understanding of AI's impact on aerospace and informing our regulatory decisions.

Chapter 3

The UK and International Context

UK Government's Pro-Innovation Approach to AI Regulation

3.1 In 2024, the UK Government adopted a pro-innovation stance towards AI regulation with the aim to position the UK as a global leader in AI development and adoption. This approach, outlined in policy documents and statements[3], seeks to balance the promotion of innovation with the need for responsible AI use.

3.2 The approach is rooted in the belief that overly restrictive regulation could stifle innovation and economic growth, except where strict controls are necessary. Instead, it advocates for a flexible, principles-based framework that can adapt to rapidly evolving technologies. The Government stated that "existing regulators will implement [the principles] using their domain-specific expertise to tailor implementation to the specific context in which AI is used".

3.3 As the UK's aviation regulator, we align our response to AI with this pro-innovation approach and the cross-sector governance structures that oversee AI regulation, enabling us to feedback evidence to government. This may include advisory bodies, ethics committees, and central government functions to coordinate efforts across different sectors.

3.4 The CAA will remain closely aligned with developments in UK government policy, adapting our approach as necessary to reflect any changes in direction.

Assessing the CAA's Readiness for AI

3.5 The International Civil Aviation Organisation (ICAO) Critical Elements (CEs) exist to provide a comprehensive framework for assessing and implementing effective safety oversight systems in aerospace. In our response to AI, we've adapted these critical elements to address the regulation of AI in the aerospace sector, while also assessing who our own use of AI technologies impacts of the CAA's critical elements. This approach allows us to leverage a well-established and recognised framework, ensuring a thorough and consistent evaluation of our readiness and maturity in dealing with AI. In Parts A and B we delve into the specific applications of the critical elements to AI regulation and use respectively.

[3] Notably, "Policy Paper: AI regulation: a pro-innovation approach", Gov.uk. Available at https://www.gov.uk/government/publications/ai-regulation-a-pro-innovation-approach

International Context for AI Regulation in Aerospace

3.6 The regulation of AI in aerospace is an evolving field internationally, with various approaches being developed.

3.7 In the United States of America (USA), the Federal Aviation Administration (FAA) is developing guidelines for AI and machine learning in aviation systems, focusing on safety assurance and certification processes. The European Union Aviation Safety Agency (EASA) has published a mature roadmap for AI in aviation, emphasising a human-centric approach and the need for explainable AI that is aligned to the EU's AI Act.

3.8 Regulators in countries such as Canada, Australia, and Japan are also developing frameworks for AI in aviation, often focusing on specific applications like autonomous aircraft or AI-assisted air traffic management.

3.9 The International Civil Aviation Organisation (ICAO) is also considering the impacts of modern AI across its Standards & Recognised Practices (SARPs) through the network of working groups that report to the Air Navigation Commission.

3.10 It should be noted that the regulatory responsibilities and scope of these bodies may differ from those of the UK CAA, reflecting variations in national legal frameworks and aviation ecosystems.

Industry Standards for AI in Aerospace

3.11 International and national industry standards will play a crucial role in shaping the regulatory approach to AI in aerospace. Key groups developing these standards include:

- ASTM International (formerly American Society for Testing and Materials)
- RTCA (Radio Technical Commission for Aeronautics)
- EUROCAE (European Organisation for Civil Aviation Equipment)
- International Organization for Standardization (ISO)
- Institute of Electrical and Electronics Engineers (IEEE)
- SAE International (formerly Society of Automotive Engineers)
- Joint Authorities for Rulemaking on Unmanned Systems (JARUS)

3.12 These organisations are working on standards covering various aspects of AI in aerospace, including safety-critical systems, software assurance, and ethical considerations.

3.13 Collaboration with and influence over these standard-setting bodies is crucial for the CAA. By actively participating in the development of these standards, we can

ensure they align with our regulatory objectives and reflect the unique needs of the UK aerospace sector. This involvement will also help us stay at the forefront of technological developments and best practices in AI regulation.

3.14 Our strategy for regulating AI in Part A will draw heavily on these emerging standards, likely using them as a foundation for our regulatory approach. Additionally, CAA accreditation to international AI management standards is being considered. This alignment with international standards will help ensure interoperability and consistency in the global aerospace ecosystem while allowing for necessary adaptations to the UK context.

Chapter 4

Getting involved, providing feedback and more information

4.1 We are committed to maintaining open channels of communication and collaboration as we implement and refine our AI strategy. We encourage engagement from all stakeholders and offer several ways to stay informed, provide input, and get involved:

CAA Website

4.2 Our website now includes a dedicated AI page at www.caa.co.uk/AI, serving as a central portal for all AI-related information. Here, you'll find the latest guidance, updates on regulatory developments, and links to relevant resources from across the CAA and beyond. We encourage you to visit this page regularly for the most up-to-date information on AI in aviation.

Email Contact

4.3 For enquiries, requests, or to share insights, please contact us at StrategyforAI@caa.co.uk. This central mailbox is monitored regularly, ensuring timely responses to your queries and contributions.

Feedback

4.4 We welcome feedback on all aspects of this strategy. Your input is invaluable in helping us refine our approach and ensure it remains relevant and effective. We aim to be collaborative, accessible, and supportive in enabling innovation in AI in aerospace and in the CAA, and your feedback plays a crucial role in achieving this goal.

A Note on AI Assistance

4.5 In the spirit of embracing the technologies we are discussing we would like to acknowledge that generative AI tools were used in the drafting of this strategy document. This approach has brought several benefits, including improved use of time, effective summarisation of complex information, and improved accessibility of the content. All content has been carefully reviewed and validated by our team to ensure accuracy and alignment with CAA policies and standards.

4.6 We look forward to working with you as we navigate the exciting and challenging landscape of AI in aviation. Together, we can ensure that the UK remains at the forefront of safe, innovative, and responsible AI adoption in the aerospace sector.

APPENDIX A

Abbreviations

AI	Artificial Intelligence
CAA	Civil Aviation Authority
CAP	Civil Aviation Publication
CE	Critical Elements
EASA	European Union Aviation Safety Agency
EU	European Union
EUROCAE	European Organisation for Civil Aviation Equipment
FAA	Federal Aviation Administration
ICAO	International Civil Aviation Organisation
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Organization for Standardization
JARUS	Joint Authorities for Rulemaking on Unmanned Systems
RTCA	Radio Technical Commission for Aeronautics
SAE	Formerly Society of Automotive Engineers
SARG	Safety & Airspace Regulatory Group
SARP	Standards and Recommended Practices
UK	United Kingdom
USA	United States of America