The Civil Aviation Authority's Climate Change Risk Assessment – October 2011

Contents

1. Executive Summary

1.1 The following Executive Summary takes account of the Defra Statutory Guidance for Reporting Authorities (2009) that sets out a defined structure to allow consistency in headline reporting as well as to ensure that key messages are included and easily analysed by Government.

1. Information on organisation	
Name of organisation	Civil Aviation Authority
Organisation's functions, mission, aims, and objectives affected by the impacts of climate change A summary of your organisational purpose and key strategic priorities which are or will be affected by climate change is important when identifying risks to your organisation.	The CAA is the UK's specialist aviation regulator. The CAA's strategic objectives are: - To enhance aviation safety performance by pursuing targeted and continuous improvements in systems, culture, processes and capability. - To improve choice and value for aviation consumers now and in the future by promoting competitive markets, contributing to consumers' ability to make informed decisions and protecting them where appropriate. - To improve environmental performance through more efficient use of airspace and make an efficient contribution to reducing the aviation industry's environmental impacts. - To ensure that the CAA is an efficient and effective organisation which meets Better Regulation principles and gives value for money.

2. Business preparedness before Direction to report was issued	
Has your organisation previously assessed the risks from climate change? Have you a baseline assessment of the risks of climate change to your business currently? The requirements of the Direction can build upon any existing risk assessment you have in place. Please include a summary of findings from your previous risk assessment(s) in your report.	The risks from climate change and adaptation measures required to address the risks have not been considered in isolation previously. Up until now the issue has been addressed under the CAA's Estates services (office accommodation etc.) and as part of business continuity plans. The issue is addressed at the strategic level through the CAA's risk management process in as far as exceptional natural events are seen as a risk to the delivery of the CAA's strategic objectives.
If so, how were these risks and any mitigating action incorporated into the operation of your organisation? It is useful to understand whether, and to what extent, climate change risks are already incorporated into your business risk management processes at the strategic level.	

3. Identifying risks due to the impacts of climate change	
What evidence, methods, expertise and level of investment have been used when investigating the potential impacts of climate change? What evidence have you assimilated to inform your risk assessment? What has been your approach (quantitative, qualitative, scenario based)? What resource (£ / person / days) have been assigned to this assessment? Briefly summarise your approach – in house staff, professional advisors, research expertise?	The CAA determined early during the consultation process over the Direction that it would be able to address the Direction and assess the potential impacts of climate change on its business using in-house capabilities. A wide-range of internal expertise was called upon in the process, including economists, airspace management specialists, environmental officers, meteorologists, estates management and business risk analysts. Climate change forecasts were primarily based on UKCP09. However, the CAA's infrastructure and investment project scope extends only to the next 10 years or so, during which time the different emission scenarios give broadly similar outcomes to the projected climate changes. The assessment of the impacts on CAA functions is largely based on qualitative approaches, with some scenario planning when considering business continuity aspects. In addition, the CAA does not assess specific climate change risks for the individual organisations that it regulates nor does it require them to take measures to adapt. The CAA believes that the airports and air navigation service providers are well placed to determine the key issues for their businesses and to work with their own stakeholders to determine the actions required. The CAA's responsibility is to ensure that whatever adaptation strategies and solutions are implemented by airlines, airports, air navigation service providers and others, such measures remain compliant with applicable safety and/or economic requirements. In terms of resources, it is estimated that 20 staff days were spent overall on the background research, analysis and compilation of the report in total.

4. Assessing risks	
How does your organisation quantify the impact and likelihood of risks occurring? Provide here a brief summary of the methodological approach to quantification where this has been possible and your categorisation of likelihood and impact. State what criteria you have used to characterise the significance of the risks (high, medium, low, negligible) and how these have been derived. What level of confidence do you have in the analysis?	- All business risks to the CAA's business and commercial activities are managed using a common framework and process for the assessment, monitoring and control of risks to the organisation's day-to-day activities or long-term objectives. Business risks may be described as adverse impacts to the objectives of the organisation estimated in terms of likelihood and severity. - The CAA currently uses a 4x4 risk matrix to rate risks by their likelihood and severity (although is in the process of moving to the Office of Government and Commerce, Management of Risk Approach recommendation of the use of a 5x5 risk matrix for rating business risks). The analysis of the risks takes into account an assessment of their frequency of occurrence. Additional factors that are taken into account when assessing likelihood include complexity (how complex is the risk or process in terms of multiple tasks or technology or the business/regulatory environment) and susceptibility (how susceptible or vulnerable is the business to the risks and how new people or processes may increase risk, the number of stakeholders involved and the level of change etc.). - Since the current business risk management process looks out to the next five years, (relating to the CAA Business Planning period), one risk identified has been classified as exceptional natural event e.g. extreme weather. The likelihood has been assessed as low i.e. there is less than 20% chance that the event will occur within the planning period. However, in terms of severity, a major storm, period of snow or heatwave has the potential to seriously impact the CAA's business as usual activities. - As the business planning period and risk assessment covers the next 5 years, there is good confidence in the analysis as it remains largely unaffected by uncertainties in the climate change predictions in terms of possible (emission scenario) inputs.

5. Uncertainties and assumptions	
What uncertainties have been identified in evaluating the risks due to climate change? Where are the key uncertainties in the analysis of the impacts of climate change and what impact do these have on the prioritisation of adaptation responses and risks for your organisation. How have these uncertainties been quantified and, in brief, what are the implications for the action plan?	As the CAA business planning period and risk assessment covers the next 5 years, the uncertainties associated with climate change prediction do not really have a significant impact on the adaptation response and risks for the organisation. Looking to the future, as the CAA develops its accommodation strategy and further develops its risk-based regulatory oversight, the CAA will continue to evaluate new climate information (such as new climate projections) and any new research that assists with reducing uncertainty in amounts, timings and rate of change of climate change impacts, to inform future adaptation measures.
What assumptions have been made? The key strategic business assumptions and methodological assumptions that underpin your analysis of impacts, action plan and analysis of risks. Well-evidenced and justified assumptions are important to the credibility of and confidence in the risk assessment.	In terms of the CAA's functions, the key assumptions made are that in the short-term the effects of climate change will see a potential increase in the occasions of exceptional natural weather, such as high temperatures, more extreme rainfall / localised flooding and more frequent and extensive deep depressions and convective weather events. All of these have the potential to disrupt business as usual working and require increased building and other property maintenance.

6. Addressing current and future risks due to climate change – summary (one line is required per risk)

Business function	Climate variable (e.g. increase in temperature)	Primary impact of climate variable (e.g. health)	Threshold(s) above which this will affect your organisation	Likelihood of threshold(s) being exceeded in the future and confidence in the assessment	Potential impacts on organisation and stakeholders	Proposed action to mitigate impact	Timescale over which risks are expected to materialise and action is planned
Regulatory oversight activities	Sea level rise / extreme rainfall	Flooding	Variable, depending on location	Moderate to high	Inability to manage effectively business as usual activities	Consideration of climate change effects in future location strategy, building design. Crisis management plan to describe key actions to be taken in the event of interruption to business as usual activities	Risk expected to increase throughout century, whilst action planned between 2015-2020
Regulatory oversight activities	High temperatures	Health	Dependent on location and amount of exposure	High	Higher energy costs for cooling, productivity decrease, potential litigation and financial implications	Consideration of climate change effects in future location strategy, building design. Revised occupational health procedures and monitoring for staff working outdoors in high temperatures	Risk expected to increase throughout century, whilst action planned between 2015-2020
Regulatory oversight activities	Increased storminess	Travel disruption	Variable, depending on location	Moderate	Inability to manage effectively business as usual activities	Crisis management plan to describe key actions to be taken in the event of interruption to business as usual activities	Risk expected to increase throughout century, actions already in place to manage activities during periods of disruption
Airspace management	Changes in weather patterns / holiday destinations	Aircraft routing	Wholesale changes to aircraft destinations	Low	Redsign of airspace; new working procedure for air traffic controllers	CAA's Future Airspace Strategy	Beyond 2050, action planned 2011-2030

7. Barriers to implementing adaptation programme	
What are the main barriers to implementing adaptive action? What do you see as the key challenges to implementation of your action plan? How will these be resourced and addressed? Briefly, what additional work is required?	For the CAA, the key barriers to implementing adaptive action fall around economic and business uncertainty, scientific uncertainty and political uncertainty. The future economic climate and continued pressure on cost effectiveness is likely to require a prioritisation of adaptation measures that can be applied and will have an impact on how the business operates. The key issue will be in the planning, specification and location of future CAA offices and what, if any, future adaptation measures are required. The CAA's approach to the environment is being reviewed currently through a new initiative entitled 'Greening the CAA.' The initiative is looking at a holistic view to business sustainability and ensure alignment with current best practices where possible. Adaptation forms one of several areas that will be considered as part of an overall strategy and implementation plan for environmental matters. At the same time there is some political uncertainty in terms of how future legislative changes will affect the way in which the CAA regulates e.g. changes to the economic licensing framework that may affect how the CAA is able to assist the organisations it regulates to adapt. In terms of scientific uncertainty, as can be determined from the UKCP09 probabilistic information, climate science provides solid guidance of likely climate conditions that will be experienced in the future but this has a range of possible outcomes for a variety of possible (emission scenario) inputs. It also does not give a full picture of the day to day meteorological conditions that may be experienced nor the frequency of extreme weather events.
Has the process of doing this assessment helped you identify any barriers to adaptation that do not lie under your control? Interdependencies may arise where others' actions are likely to impact on your ability to manage your own climate change risks. Briefly comment on where this is the case.	The assessment has identified that for the CAA's activities, the biggest barrier to adaptation is likely to be funding; however most of the current planned activities are expected to come from current and expected future resources. In terms of interdependencies, the key utilities have a significant effect on the functioning of the CAA's activities; energy for heating, cooling and power, communications systems and drinking water. Surface access to the CAA's offices, airports and air traffic control centres forms an important aspect of the CAA's business as usual; and local authority action in respect of flood defences is another key interdependency.

8. Report and review	
How will the outcome of the adaptation programme be monitored and evaluated and what is the timetable for this? Adaptation programmes are expected to reduce the residual risk to organisations from climate change. What measures will you put in place to monitor this?	The development of the climate change adaptation report has brought recognition across the CAA of the need to ensure that adaptation measures are considered as part of the strategic planning process. Key risks are reviewed by the Board on an annual basis with each business area managing its own particular risks and the potential impacts of climate change will be considered under this process. In addition it is intended that adaptation issues will be considered widely as part of the CAA accommodation strategy review later this decade.
How do you propose to monitor the thresholds above which impacts will pose a threat to your organisation (including the likelihood of these thresholds being exceeded and the scale of the potential impact)? It is possible that the current risk appetite within your organisation will change on account of the climate change risks identified. How will this be monitored?	The CAA Corporate Business Risk process remains the key methodology to monitor climate change risks on the organisation. It is likely that new climate information (such as new climate projections) and any new research that assists with reducing uncertainty in amounts, timings and rate of change of climate change impacts will inform the risk process and influence risk appetite.

9. Recognising opportunities	
What opportunities due to the effects of climate change and which the organisation can exploit have been identified? The risk assessment is also expected to generate opportunities for organisations, have these been captured? What are the key ones and the expected net benefits?	For the CAA, two key opportunities have been identified. The first is that it has helped contribute to the case for the CAA to strengthen its regulatory role in environmental matters. As a result, a new initiative has been initiated within the CAA, entitled 'Greening the CAA.' As a result, the CAA is likely to develop its expertise more generally in the environment and will allow it to offer advice and expertise to other organisations both within the UK and abroad. In addition, the adaptation work provides added weight to the CAA's Future Airspace Strategy and how the strategy to develop the UK's airspace system that supports the aviation sector must be flexible and adaptable to changing circumstances. For the aviation sector more generally, the key opportunity is the likely reduction in the incidence of some of the conditions that cause significant disruption at present, such as snow, ice and fog at a number of airports around the UK, which should offset some of the impacts and costs associated with increased extremes of strong wind, heavy rain and higher temperatures.

10. Further comments / information	
Do you have any further information or comments which would inform Defra (e.g. feedback on the process, the statutory guidance, evidence availability, issues when implementing adaptation programmes, challenges, etc)?	It has become apparent during the course of the development of the report and in discussions with other regulators of different sectors that the methodology of adaptation reporting by regulators can differ significantly from the regulated organisations e.g. different investment and risk assessment periods. However, the CAA believes that it is important that regulators remain fully involved in the adaptation reporting process, and it is clear that regulators have an important role in encouraging, facilitating its sectors organisations' adaptation programmes and reviewing progress. The CAA would be pleased to assist Defra in looking at how the process for future adaptation reporting by regulatory authorities could be revised to take this into account.

2. Introduction

2.1 Aviation plays an important role in the national economic and social fabric of the UK. An innovative and effective aviation sector is a key contributor to economic growth and the ability of people to connect with places and each other for business and pleasure.

2.2 Although aircraft operate in many different climates around the world, the fixed infrastructure that allows aircraft to operate safety, efficiently and in a reliable manner is one of the more critical aspects when considering aviation's susceptibility to climate change and therefore where adaptation is most required.

2.3 The Civil Aviation Authority (CAA) is the UK's independent specialist aviation regulator. Its activities include economic regulation, airspace policy, safety regulation and consumer protection.

2.4 The Department for Environment, Food and Rural Affairs (Defra) has directed the CAA to produce a report on adaptation to climate change. This stems from the Climate Change Act 2008, which introduced a new power for the Secretary of State to direct "reporting authorities" to prepare reports. The Climate Change Adaptation Report by the Civil Aviation Authority (CAA) Direction 2010 states that the CAA must prepare and send to the Secretary of State a report containing:

- an assessment of the current and future predicted impacts of climate change in relation to the CAA functions; and
- a statement of the CAA's proposals and policies for adapting to climate change in the exercise of its functions and the timescales for introducing these proposals and policies.

2.5 The assessment of impact must include:

- A summary of the statutory and other functions of the CAA;
- The methodology used to assess the current and predicted impacts of climate change in relation to those functions; and
- The findings of the assessment of the current and predicted impact of climate change in relation to those functions.

2.6 This report is intended to satisfy this legal requirement, and to demonstrate how the CAA is assessing and acting on the risks and opportunities from a changing climate. This report is structured according to the guidelines given by Department for Environment, Food and Rural Affairs (Defra) for reporting authorities and takes into account the risk assessment framework that has been developed by Cranfield University.

2.7 The CAA has reviewed the climate change risks highlighted by the 10 airports that have been directed to report by Defra as well as NATS, against the CAA's regulatory powers and has considered whether these facilitate adaptation. The potential barriers, uncertainties and interdependencies in relation to adaptation have been reviewed, and measures outlined to address them now and in the future.

3. The Functions of the Civil Aviation Authority

3.1 The CAA's strategic objectives are:

- To enhance aviation safety performance by pursuing targeted and continuous improvements in systems, culture, processes and capability.
- To improve choice and value for aviation consumers now and in the future by promoting competitive markets, contributing to consumers' ability to make informed decisions and protecting them where appropriate.
- To improve environmental performance through more efficient use of airspace and make an efficient contribution to reducing the aviation industry's environmental impacts.
- To ensure that the CAA is an efficient and effective organisation which meets Better Regulation principles and gives value for money.

3.2 The CAA employs around 1000 staff, the majority in two offices, CAA House in Holborn, London and Aviation House, near Gatwick Airport. At present the CAA operates 7 regional offices (East Midlands, Gatwick, Luton, Manchester, Stansted, Stirling and Weston-Super-Mare), although this will reduce to 4 by 2016, at Gatwick, Manchester, Stansted and Stirling

3.3 The CAA does not get any direct government funding, but runs entirely on subscriptions from aviation users and organisations. It is classed as a public corporation in the public sector. While the CAA's functions are conferred by Act of Parliament, it is sponsored by the Department for Transport and the Secretary of State is accountable to Parliament for the CAA's proper discharge of its duties.

3.4 The CAA works within a regulatory framework which includes international standards set by the International Civil Aviation Organisation, European and UK legislation. The main legislation that defines the CAA's role is set out below.

- **The Civil Aviation Act 1982** gives the CAA a role in:
  - licensing air transport
  - licensing the provision of accommodation in aircraft (air travel organisers' licensing)
  - licensing and operating aerodromes and providing air navigation services[1]
  - providing assistance and information to the Secretary of State.

- Many of the CAA's functions and duties, especially for safety, are prescribed in secondary legislation made as Air Navigation Orders under section 60 of the Civil Aviation Act 1982

- **The Airports Act 1986 Part IV** sets out the CAA's role for the economic regulation of airports

- **The Transport Act 2000 Part 1** sets out the CAA's role in regulating air traffic services (other than safety) and the CAA's air navigation functions

- **The Civil Aviation Act 2006** section 8 gives the CAA responsibility for the health of people on board aircraft.

[1] Whilst the Civil Aviation Act conferred service provision activities on the CAA, including aerodrome operation and air traffic management, all such activities have been disposed of

3.5 In addition, there are a number of European Regulations that have a bearing on the CAA's role; the main ones are described below.

- **EC Regulation 216/2008** sets common safety rules for civil aviation and establishes the European Aviation Safety Agency. UK legislation designates the CAA as the UK National Aviation Authority for the purposes of this regulation.

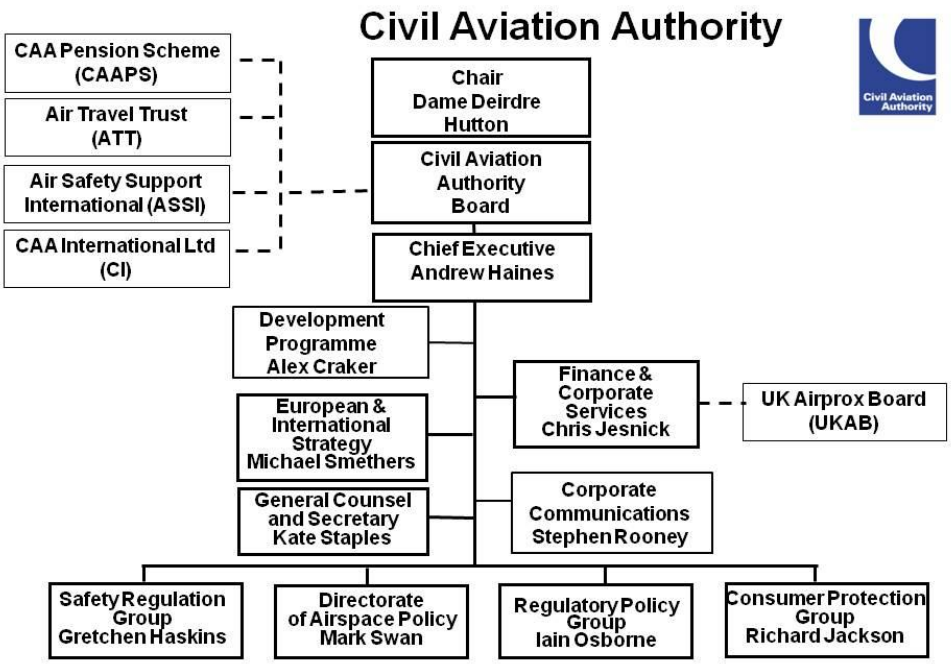
- **Four initial EC Regulations** establish Single European Sky – the European Community's programme to increase airspace capacity and reduce delays. **EC Regulation 549/2004** sets a framework for the creation of the Single European Sky, **EC Regulation 550/2004** on the provision of Air Navigation Services, **EC Regulation 551/2004** on the organisation and use of airspace and **EC Regulation 552/2004** on the interoperability of the European Air Traffic Management network. UK legislation designates the CAA as the UK National Supervisory Authority. These have been supplemented by a detailed suite of Implementing Rules and Community Specifications.

- **EC Regulation 1794/2006** lays down a common charging scheme for air navigation services. It covers the principles of the charging scheme, the establishment of charging zones, the calculation and allocation of costs, the calculation of en route charges, incentive schemes and the collection of charges. UK legislation designates the CAA as the UK National Supervisory Authority.

- **EC Regulation 1008/2008 on common rules for the operation of air services in the Community**. The CAA was designated as the UK competent authority for implementing most of this legislation.

- **EC Regulation 261/2004** provides for compensation and assistance in the event that air passengers are denied boarding, or have their flights cancelled or delayed. EC Regulation 1170/2006 establishes rights for disabled people and persons of reduced mobility when travelling by air. The CAA has enforcement powers for both regulations under UK legislation.

3.6 The CAA is divided into four Groups; Safety Regulation, Regulatory Policy, Airspace Policy and Consumer Protection. The CAA's structure is shown the organogram below:



3.7 The safety regulation of aviation by the CAA is conducted within a global framework of standards and recommended practices set by the International Civil Aviation Organisation. The CAA also works within a European legislative framework in conjunction with the European Aviation Safety Agency. EASA develops rules, standardises the way that National Aviation Authorities ensure these rules are applied and certifies the designs for the majority of new aircraft.

3.8 The role of the CAA's Safety Regulation Group (SRG) is to ensure that UK civil aviation standards are set and achieved in a co-operative and cost-effective manner. SRG must satisfy itself that aircraft are properly designed, manufactured, operated and maintained; that airlines are competent; that flight crews, air traffic controllers and aircraft maintenance engineers are fit and competent; that licensed aerodromes are safe to use and that air traffic services and general aviation activities meet required safety standards.

3.9 To monitor the activities of this complex and diverse industry, SRG employs a team of specialists. They have an exceptionally wide range of skills, including pilots qualified to fly in command of current airliners; test pilots able to evaluate all aircraft types; experts in flying training, leisure and recreational aviation activities; aircraft maintenance surveyors; surveyors conversant with the latest design and manufacturing techniques; flight test examiners; aerodrome operations and air traffic control specialists; and doctors skilled in all branches of aviation medicine.

3.10 Specific responsibilities include:

- Commercial Aviation
- General Aviation
- Harmonising European Standards
- Flight Operations
- CAA/SRG Support to Government
- Passenger Safety
- UK Register of Civil Aircraft

- Aircraft Maintenance
- Structures, Materials & Propulsion
- Aircraft Airworthiness
- Aircraft Design & Manufacturing
- Flight Crew Licensing
- Medicals
- Human Factors
- Air Traffic Control Services
- Aerodrome Licensing & Inspections
- Incident Reporting
- Research

3.11 The CAA investigates and prosecutes, in appropriate cases, alleged breaches of UK and European safety legislation.

3.12 The Directorate of Airspace Policy (DAP) is responsible for the planning and regulation of all UK airspace including the navigation and communications infrastructure to support safe and efficient operations. DAP is staffed by civilian and military experts with experience of commercial, business, recreational and military aviation. The needs of all users are accommodated, as far as possible, with regard for safety as well as environmental, economic and national security considerations. Specific responsibilities include:

- Aeronautical Information Management
- Airspace Utilisation
- Controlled Airspace
- Off Route Airspace
- Surveillance and Spectrum Management
- Meteorological Authority

3.13 DAP also contains the Environmental Research & Consultancy Department (ERCD), dedicated to providing a range of services within the field of aviation and the environment. Its expertise spans a number of areas especially noise monitoring, noise contour production, aircraft emissions and research into the health effects of noise.

3.14 The Regulatory Policy Group's (RPG) remit is to provide policy advice to colleagues across the CAA, aiming to help the organisation to put the consumer at the heart of its work. It has four core functions:

- Economic regulation of the three designated airports (Heathrow, Gatwick and Stansted) and NATS.
- Enforcement of consumer legislation - for example, to protect consumers in instances of flight cancellation and denied boarding, and protect people of reduced mobility when they fly.
- Providing expert policy and economic advise and analysis across CAA, to government and others on airports, airlines and air traffic services.
- Collecting and analysing aviation statistics and survey responses.

3.15 RPG provides a holistic approach to the CAA's regulatory aims and ensures that all potential regulatory options are considered when deciding the ideal course of action to achieve best outcomes. The Group offers analytical and policy support across the CAA's mission, which includes environmental issues.

3.16 The responsibilities of the Consumer Protection Group (CPG) are to:

- regulate the finances and fitness of travel organisers selling flights and package holidays in the UK;
- manage the UK's largest system of consumer protection for travellers, Air Travel Organisers' Licensing (ATOL);
- license UK airlines and enforce European Council requirements in relation to their finances, nationality, liability to passengers for death or injury and insurance;
- enforce certain other legal requirements and codes of practice for protection of airlines' customers.

3.17 In addition to the above, the CAA provides advice and assists the Secretary of State for Transport on all civil aviation matters. In addition, the CAA represents consumer interests, conducts economic and scientific research, produces statistical data and provides specialist services.

3.18 Through a wholly owned subsidiary company, CAA International Ltd (CAAi), the CAA offers training, examination services and technical support in over 140 countries. The work contributes specifically to the overall safety of UK citizens travelling abroad and in general helps raise safety standards worldwide. CAAi's principal business activity is to provide independent expert advice to assist clients worldwide to enhance aviation safety.

3.19 Air Safety Support International Ltd (ASSI), a wholly owned subsidiary company of the CAA, ensures that the UK meets international obligations on aviation safety oversight in the UK's Overseas Territories, such as the Falkland Islands and the British Virgin Islands.

3.20 In addressing the CAA strategic sustainability objective outlined above, there are a number of principles that the CAA adopts in the delivery of its regulatory oversight activities:

- To ensure that environmental initiatives and regulations are developed and implemented in a manner that does not compromise aviation safety, and that all UK registered aircraft are compliant with relevant environmental certification requirements.
- The CAA will mitigate the impact of aviation on the environment in the planning, designing and revision of airspace procedures and arrangements, in the exercise its air navigation functions in accordance both with the CAA (Air Navigation) Directions 2001[2] and with the Secretary of State's Guidance to the CAA on Environmental Objectives.[3]
- The CAA will provide an independent regulatory framework for the aviation industry that encourages efficiency, service quality, and investment in capacity. In its policy advice role, to seek effective and practicable ways in which it can meet the costs of its environmental impacts – using market based solutions where appropriate, in a way that is consistent with sustainable development.

3.21 CAA's key stakeholders are:

- The travelling public

[2] Transport Act 2000 Section 66(1)

[3] 'Guidance to the Civil Aviation Authority on Environmental Objectives Relating to the Exercise of its Air Navigation Functions', Department for Transport, Local Government and the Regions (now Department for Transport), January 2002. See also Transport Act Section 70(2)(d). Currently being updated and about to be re-published

- The general public
- Airlines, aircraft owners and operators
- Airports
- Air Navigation Service Providers
- Professional and private pilots
- Military
- Other airspace users (e.g. parachutists, unmanned aircraft systems etc.)
- Engineers and maintenance organisations
- Aircraft design organisations and aircraft part production organisations
- Her Majesty's Government
- Other National Aviation Authorities
- Eurocontrol and European Aviation Safety Agency
- International Civil Aviation Organisation

4. Current CAA Business Practices

4.1 There is recognition within the CAA that making changes to the business that (i) reduce the potential further impacts of climate change and (ii) prepare the business for future climate conditions that will occur irrespective of what measures are applied now, have synergies and, in general, make good business sense as well.

4.2 Over the last 10 years, the CAA has been looking into 6 key areas as a means of adapting its business with the wider environment in mind. The CAA's policy is to reduce where practicable the impact of our business operations on the environment in six target areas - energy use, water use, paper use, waste production, staff transportation and procurement.

4.3 This is being achieved by means of:

- Auditing and measuring our activities and operations to identify the resources used and where applicable implementing initiatives to reduce resource consumption;
- Reducing energy and resource consumption by setting and implementing targets for the use of resources in the target areas;
- Ensuring that contract terms and conditions align with our Environmental Policy to encourage environmental awareness in our contractors;
- Raising awareness of the environment issues and initiatives amongst our staff;
- Reporting on internal environmental performance in the CAA Annual Report.

4.4 The current approach is under review through a new initiative entitled 'Greening the CAA.' The initiative will look to take a holistic view to business sustainability and ensure alignment with current best practices where possible. Adaptation forms one of several areas that will be considered as part of an overall strategy and implementation plan for environmental matters.

4.5 In terms of workplace accommodation, regional offices are typically leased on a 5 year contract with a 3 year break clause The London head office's lease expires in 2019 and whilst the CAA owns the building and freehold at its Gatwick site, there are plans to develop an accommodation strategy beyond 2019 by around 2015 that will consider the future of both main offices.

4.6 CAA policy for its offices are that landlords are required to fit offices to a CAA supplied specification, including requirements covering windows, lighting and use of the CAA's corporate energy supplier.

4.7 There is an increasing need for new offices to take into account flexible working practices, particularly as CAA staff spend increasing amounts of time working at stakeholders' sites. In addition, there is also a recognized need for suitable engineering design, both in terms of minimizing carbon dioxide emissions and energy consumption as well as being able to withstand the changes in weather that might be expected as a result of climate change e.g. more extreme temperatures and rainfall rates.

4.8 The CAA currently has a comprehensive crisis management plan which has been written in accordance with the Civil Contingencies Act (CCA) 2004. The plan is designed to provide staff with the information required to manage the effects of any crisis requiring a response from the Authority. The plan outlines the framework for managing and co-ordinating this response and ensures:

- Co-ordinated and flexible response by the Authority to a crisis.
- Co-ordinated mobilisation and direction of staff and resources.
- Effective restoration of normal services as rapidly as possible.

4.9 To compliment the Civil Aviation Authority's capability to respond to crises, business recovery procedures have been developed to ensure that the organisation can be resilient if:

- A crisis affects the organisation directly, therefore potentially threatening critical service delivery.
- A third-party major crisis draws significant resource away from the organisation, therefore threatening critical operation.

4.10 In addition, the CAA has developed and implemented a pre-agreed strategy for responding to, and recovering from, an unplanned disruption affecting its operations at any of its workplace buildings. The strategy essentially plans to use existing CAA locations as business continuity sites for others. Therefore, for example, in the event of an incident affecting the CAA's offices at Gatwick, a number of London-based staff will be displaced from their normal offices and their desks made available for key business critical staff from Gatwick. Regional offices will provide back-up cover for each other and, where appropriate, will provide supplementary accommodation for staff normally based at the CAA's offices at Gatwick. As part of the strategy, procedures for home working have been developed as well as identification of critical dependencies, key IT systems that are prioritised for resumption of service and key documentation. Additionally, policy and procedures have been put in place to deal with licences, certificates, approvals, permission and exemptions, that enable the CAA to continue to discharge its obligations during periods of disruption.

4.11 All business risks to the CAA's business and commercial activities are managed using a common framework and process for the assessment, monitoring and control of risks to the organisation's day-to-day activities or long-term objectives. Business risks may be described as adverse impacts to the objectives of the organisation estimated in terms of likelihood and severity.

4.12 The CAA's approach to risk management is designed to fit the current context of the organisation and is based on an understanding of the internal and external environment. Three key aspects of the CAA's business is considered; categorised as Consumer, Strategic or Business Risks.

4.13 Consumer risks are considered as risks to consumer welfare using a broad definition of the term consumer welfare. The term consumer was deemed to include both passengers and end users of aviation services such as private pilots and cargo customers. Welfare covers a wide range of consumer detriments, such as decreased levels of safety and reduced value etc. Risks to the public are included in this category to cover risks such as safety risks for people on the ground, risks of environmental damage and the risk of impairing national security. Consumer risks are unlikely to change particularly quickly but will need to be regularly reviewed. Consumer risks are best addressed by developing the right regulatory policies and implementing a regulatory approach that is targeted and proportionate.

4.14 Strategic risks are those that those that affect the achievement of the target outcomes that the CAA has set out in the Strategic Plan. These risks could be:

- Risks to the delivery of any of the strategies set out.

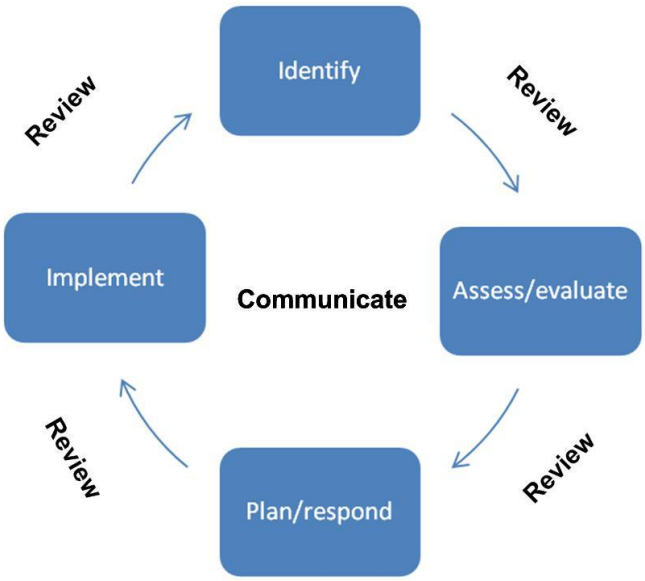
- Risks that despite our best efforts, the industry does not perform as expected and hence our target outcomes are not achieved.
- Risks associated with the possibility the CAA have set the wrong target outcomes and/or the wrong strategies to deliver them.

4.15 CAA Groups identify, manage and monitor group level business risks through their own management processes and through their Group business Plans. Business risks identified by CAA Groups that are considered CAA-wide operational risks such as risks relating to Finance, IT, Human Resource etc. and which impact on the CAA's capability and capacity to discharge its day-to-day responsibilities will in the first instance be managed and monitored by the CAA's Finance and Corporate Services. Risks considered by the Groups to have an impact on the achievement of CAA strategic objectives should be escalated and monitored through the CAA business planning monitoring process.

4.16 The following principles support the CAA's business risk management policy:

- Risks should be managed and recorded only if a risk event is identified that could affect the CAA's business objectives.
- Risk management is to become aligned with The Office of Government and Commerce Management of Risk Approach.
- Progress in implementing risk management across the organisation will be monitored and reviewed.
- CAA colleagues will receive appropriate risk management training and development.

4.17 The business risk management process is comprised of a number of stages. For business risk management to be effective risks must be identified, assessed/evaluated, planned/responded to and then identified responses implemented. The various process stages are detailed in the diagram below.



4.18 The CAA Board ultimately has responsibility for the management of business risk and for overseeing the business risk process within the organisation. As part of the process, it delegates the responsibility for implementing the policies to the business areas. The business areas are then responsible for identifying and evaluating risks and to design, operate and monitor a suitable system of internal control which implements the policies adopted by the Board. It is the responsibility of the CAA Board to ensure that all significant risks are identified.

4.19 The CAA Board is responsible for approving the Risk Management Procedures and for ensuring there is adequate budgetary provision for the implementation and maintenance of them. Both the CAA Board and the CAA's Executive Committee play a key role in determining the high-level organisational risks.

4.20 Formal recording of risk information is used to enable the identification, tracking and escalation of risks. Risk reviews take place regularly, typically on a monthly basis. An annual Risk and Internal Control paper is submitted to the Executive Committee, Audit Committee and Board each year. An interim report is also provided to the Executive Committee and Audit Committee. The CAA currently uses a 4x4 risk matrix to rate risks by their likelihood and severity.

4.21 The analysis of the risks requires an assessment of their frequency of occurrence. Additional factors that are taken into account when assessing likelihood include complexity (how complex is the risk or process in terms of multiple tasks or technology or the business/regulatory environment) and susceptibility (how susceptible or vulnerable is the business to the risks and how new people or processes may increase risk, the number of stakeholders involved and the level of change etc.). Table 1 below provides descriptions and indicators used to support likelihood ratings.

Descriptor	Level	Likelihood of occurrence	Indicators
Unlikely	**1**	The event will only occur in exceptional circumstances or as a result of a combination of unusual events	There is less than 20% chance that the event will occur within the planning period
Possible	**2**	The event may occur at some time but not likely to occur in the foreseeable future (i.e. within 5 years) [4]	There is greater than or equal to 20% yet less than 50% chance the event will occur within the planning period
Likely	**3**	The event may occur within the foreseeable future or medium term (i.e. within five years)	There is greater than or equal to 50% but less than 80% chance the event will occur within the planning period
Almost certain	**4**	The event will probably occur in most circumstances (i.e. within 5 years)	There is greater than or equal to 80% chance the event will occur within the planning period

Table 1: Determination of risk likelihood in the CAA

4.22 The impact of risks can be described in a number of ways and table 2 below illustrates the consequences of safety, strategy, compliance/litigation, reputation, publicity, and organisation impacts to the CAA. Each key impact is rated in terms of its severity from minor to catastrophic. In addition, the history of a particular risk is considered when assessing its severity (i.e. to what extent is the risk known to have occurred previously), the cumulative effect of the risk within the period under review (e.g. an increase in the number of this type of risk during the period under review) and if the risk impacts more than one area (e.g. financial and compliance) the 'worst case' outcome is reflected in the severity rating.

[4] Five years relates to the CAA Business Planning period

Descriptor	Level	*Safety*	*Financial*	*Strategy*	*Compliance / Litigation*	*Reputation*	*Publicity*	*Organisation*
Minor	**1**	Limited impact. Little or no exposure.	**Minor** <£0.5m	CAA policy or procedures are seen to have a negative impact on a single stakeholder.	Minor contractual issue.	Limited low-level negative input from stakeholders, no public pronouncements.	Local news. Low-key online coverage.	Limited impact on the effectiveness and efficiency of the business. Limited impact on staff.
Moderate	**2**	CAA fails in part to fulfil its safety regulatory obligations. Limited damage to CAA's credibility.	**Moderate** £0.5m - £2m	CAA implements policy that fails to meet user needs, affecting a single stakeholder group or a small number of stakeholders.	Legal challenge. Potential court action.	Stakeholders negatively engage with and scrutinise CAA and question strategy.	Regional News. Online/specialist coverage. National News - limited interest.	Some business / systems disruption. Loss of productivity affecting a small number of stakeholders. Some impact on staff.
Major	**3**	CAA fails in part to fulfil its safety regulatory obligations. Some damage to CAA's credibility.	**Major** £2m - £5m	The CAA is seen to have failed to provide independent best practice regulation and/or expert advice and its professionalism and integrity are called into question leading to the CAA publicly defending itself.	Court action undertaken.	Stakeholders and opinion formers consistently engage CAA and make negative public statements, which receive media coverage, about strategy. Politicians query CAA and stakeholders submit CAA to critical scrutiny.	National News - sustained interest.	Business operation / systems affected. Loss of productivity affecting a large number of stakeholders. Loss of employee goodwill / employer reputation.
Catastrophic	**4**	Accident or major incident where blame is directly attributed to the CAA. Severe damage to CAA's credibility.	**Catastrophic** >£5m	The CAA fails to discharge its duties and/or contravenes the Civil Aviation Act 1982, which has a detrimental impact on its continuation as a corporate body.	Very serious court sanction imposed, e.g. conviction of CAA and / or individuals.	Sustained focus from international stakeholders, politicians, and opinion formers. Sustained negative statements from all receiving media coverage alongside hostile scrutiny of CAA. Sustained questioning of CAA strategy and policy.	National and International news - sustained interest.	Complete systems / infrastructure breakdown. Severe data breach – criminal offence. Severe damage to employer / employee relations.

Table 2: Determination of risk impact in the CAA

4.23 The Office of Government and Commerce, Management of Risk Approach guidance recommends the use of a 5x5 risk matrix for rating business risks. The CAA is presently considering the most appropriate way of following best practice business risk management and be consistent with OGC Management of Risk practice.

5. Risks Due to the Impact of Climate Change

5.1 There is widespread scientific consensus that man-made greenhouse gas emissions are leading to climate change. Even if all greenhouse gas emissions ceased tomorrow, the impacts of emissions to date are likely to be experienced for many decades, due to inertia in the climate system. Clearly reducing emissions is key to avoiding the worst effects of climate change in the longer-term, however there is a need to consider how organisations can adapt their assets, infrastructure and services to cope with the unavoidable changes to come and resulting impacts.

5.2 The threat that inevitable climate change poses to the UK economy has been well documented in the Stern Review, published by the Treasury at the end of 2006, as well as research published under the framework of the UK Climate Impacts Programme (UKCIP). Government policy across a range of issues is beginning to reflect this fact. The UK Climate Change Act requires that a UK-wide climate change risk assessment is undertaken every five years and that a national adaptation programme is put in place.

5.3 The direction to report asked the CAA to describe how all potential primary and secondary climate effects are assessed that may impact on the organisation's statutory functions. In addition, the direction required an assessment of the barriers, uncertainties and interdependencies in relation to adaptation by the CAA and those we regulate, as well as to consider how these may be overcome and potential opportunities that adaptation offers.

5.4 The CAA has taken account of the statutory guidance in defining the methodology to assess the climate change risks. Using the methods illustrated in "Climate adaptation: risk, uncertainty and decision-making process" from the UK Climate Impact Programme, we have considered how this applies to the CAA's regulatory role.

5.5 The CAA has examined the potential impacts of climate change across the whole of its regulatory business and its functions. The CAA has used the UK Climate Projections 2009 (UKCP09), published by the Department for Environment, Food and Rural Affairs (Defra) and Department of Energy and Climate Change (DECC) in June 2009. They provide information on observed and future changes in the UK's climate, including a probabilistic projection of climate change, based on quantification of the known sources of uncertainty in climate modelling. The main climate change risks that have been highlighted by UKCIP are summarised below:

- Average UK summer temperature is likely to rise by 3-4°C by the 2080s. In general, greater warming is expected in the southeast than the northwest of the UK, and there may be more warming in the summer and autumn than winter and spring.
- Average summer rainfall across the UK may decrease by 11% to 27% by the 2080s. While this is the average, there will be a big change in rainfall between the seasons, with winters becoming wetter and summers drier.
- Sea levels are expected to rise. For example, the central estimate (taking into account land movement) highlight sea level is projected to rise by 36cm in London by the 2080s. In addition increases in storm surge height are expected.
- Significant decreases in soil moisture content in summer

- Extreme weather events are likely to become more common. For example, research published by the Met Office Hadley Centre suggests the summer heat wave experienced in 2003 could become a normal event by the 2040s; central estimates are for heavy rain days (rainfall greater than 25 mm) over most of the lowland UK to increase by a factor of between 2 and 3.5 in winter, and 1 to 2 in summer by the 2080s under the medium emissions scenario.

5.6 The potential impacts of these changes that may be of relevance to CAA business operations include:

- An increase in the risk of flooding
- Greater pressure on drainage systems due to more extreme rainfall rates and rainfall totals
- Water supply shortages
- Increased summer cooling demands
- Significant changes in weather patterns affecting consumer demand (and therefore numbers of air traffic movements and routing through UK airspace)
- Buildings becoming uncomfortably hot
- Health issues, including staff working at off-site locations and, in particular, outdoors

5.7 The CAA does not assess specific climate change risks for the individual organisations that it regulates nor does it require them to take measures to adapt. The CAA believes that the airports and air navigation service providers are well placed to determine the key issues for their businesses and to work with their own stakeholders to determine the actions required. The CAA's responsibility is to ensure that whatever adaptation strategies and solutions are implemented by airlines, airports, air navigation service providers and others, such measures remain compliant with applicable safety and/or economic requirements. In the case of the three economically regulated airports, the CAA has four equal duties:

- To further the reasonable interests of users of airports within the UK
- To promote the efficient, economic and profitable operation of such airports
- To encourage investment in new facilities at airports in time to satisfy anticipated demands by the users of such airports
- To impose the minimum restrictions that are consistent with the performance by the CAA of its functions as economic regulator

5.8 Because of the nature of the CAA's work, which is mainly desk-based with occasional travel and work onsite at stakeholders' locations, the day to day running of the CAA is thought unlikely to be seriously affected by climate change in the next 10-20 years, which is the limit of the CAA infrastructure and investment project scope. Current measures already being applied are considered to mitigate immediate concerns. Additionally, the CAA considers that in the majority of cases its adaptation will be effected through existing business review processes and will be covered by existing risk management activities. This is reflected in the current CAA corporate business risks, the relevant ones for which are given at Annex B. Nevertheless, with important decisions on its workplace strategy to be taken in the next few years, the process of fully embedding climate change adaptation within the CAA's risk and investment policy and programmes will be matured.

5.9 There are a number of examples of the direct impacts of climate change on the wider aviation industry. For example, increased local temperature could result in reduced aircraft performance, changing runway length requirements on takeoff (potentially reducing the size of aircraft that could operate from a runway of a given length) and climb performance (requiring modifications to airspace and standard operating procedures). Global temperature increases are likely to cause significant sea level rises which may impact on UK coastal airports and other low lying airports subject to tidal storm surges. This could result in the impact of operations at the airport or require very expensive sea defences to be put in place to enable continued safe operations. Changes to the tropopause, jet stream and winds could affect aircraft during the cruise phase of operations in terms of optimal routing, altitudes and speeds for most efficient trajectories which minimise cost/emissions. Airline operations could more frequently be disrupted by adverse weather, especially increased intensity or changed location of convective weather activity, winter storms, heavy and/or prolonged rainfall, severe turbulence, wind shear and occurrence of snow, ice and fog.

5.10 Outside of the takeoff and landing phases of flight, aviation is not as constrained to fly along particular tracks, as say cars along roads or trains on tracks. This affords some flexibility to the pilot, operator and air traffic controllers as to how the flight is conducted to avoid unfavourable winds or hazardous en-route weather. However, whenever such conditions exist in high density air traffic areas (e.g. Northwest Europe), there are often knock-on impacts to airspace capacity, which can introduce delays that affect flights arriving and departing from multiple airports. Therefore, airports will need to be able to have some resilience to climate change related events that occur outside of the UK but impact flights to and from the UK.

5.11 In addition to the direct impacts of climate change on aviation, there are likely to be secondary effects. Government and industry responses to climate change could significantly influence the price of air transport and hence passenger and air freight demand. When coupled with changing weather conditions, this could affect patterns of demand and destinations, resulting in the need for greater flexibility of systems and processes to accommodate future aviation requirements.

5.12 The CAA has reviewed the adaptation reports from the 10 airports that have been directed to report by Defra as well as NATS[5]. Annex A highlights the key risks, impacts and adaptation measures that the airports and air traffic service provider have identified. The assessments of the airports directed to report show generally consistent findings and appear to accord with the changes identified by UKCP09 and other studies. As might be expected, NATS has identified different issues to the airports, with changes in flight patterns and decreases in aircraft movements, for several reasons, felt to be key risks for air traffic service provision.

5.13 The potential adaptation measures required to address climate change effects by the companies regulated by the CAA will have a bearing on the work of the CAA itself, particularly in economic regulation. For example, long-term investment plans by airports may include new infrastructure as part of an

[5] http://www.defra.gov.uk/environment/climate/sectors/reporting-authorities/reporting-authorities-reports/

adaptation strategy for phenomena that may not occur for years to come. It could also mean carrying out remedial work on current infrastructure and transport links to ensure that they are more able to withstand flooding, storm damage, heat waves and subsidence. However, whilst price controls are the main regulatory instrument at the CAA's disposal to ensure that regulated companies address adaptation needs, this is only applied to three airports and NATS currently. The remaining airports that have been directed by Defra would need to address adaptation under normal business operations.

5.14 Under the Airports Act 1986 the CAA has to set price caps on airport charges that airports, designated by the Secretary of State for Transport, can charge airlines. The rationale for designation of the three designated airports, Heathrow, Gatwick and Stansted, is that competition is not sufficiently developed in the provision of airport services to prevent them from exploiting their market power. Designation periods are generally set every five years. In addition, NATS En-Route Limited (NERL) holds an air traffic services licence[6] issued by the Government in 2001 under the Transport Act 2000 as part of the Public-Private-Partnership (PPP) through which NATS was transferred from its previous wholly public ownership. The NERL licence includes a number of conditions initially set by the Government but which can be modified by the CAA under the provisions of the Transport Act 2000. These include conditions that impose price controls on elements of NERL's business, which are prescribed for periods of 5 years.

5.15 The longer the life cycle for investment, the more climate change risks there are to consider. For the CAA's economically regulated organisations in particular, it is difficult to build in an assessment for costs taken now while possible benefits will only be realised in over 25 years time, particularly when there are concerns about prices and affordability in the short-term.

5.16 It is HM Government's intention to introduce legislation to Parliament in 2012 to reform the framework for airport economic regulation. This will give the CAA a primary duty focused on the interests of present and future passengers. It will also give the CAA power to consider more tailored and flexible regulatory arrangements than permitted under its present powers.

5.17 One major difference to other sectors is that in aviation there is a greater interplay between competition and regulation. However, there does appear to be a number of regulators looking at improved incentive mechanisms and focusing more on consumer outcomes – themes that have a resonance in aviation. The CAA expects to undertake a small number of joint work programmes with other economic regulators over the next couple of years as well as drawing on information and experience from economic aviation regulation in other countries, both in Europe and beyond.

5.18 The CAA will be considering with stakeholders ways in which regulation can better reflect the commercial realities of capital expenditure planning. One potential option is to have a two-tier approach. Certain core capital expenditure could be separated from development capital expenditure. Core capital expenditure could be fully defined and costed programmes. These could be subject to incentives mechanisms such as triggers. Development capital expenditure would cover programmes that are less well defined, not fully costed,

[6] http://www.caa.co.uk/docs/5/erg_ercp_natslicence_april07.pdf.pdf

and/or discretionary. This may allow the regulatory regime to incentivise efficient planning and response to issues such as adaptation measures to climate change.

5.19 The Government's proposed economic licensing framework offers the CAA further opportunities to better tailor the regulatory model in a flexible way, for example, by changing the duration of price controls to be either longer or shorter than the five years prescribed in the current Act. Although most regulators tend to adopt a standard four or five year duration for price controls, there are variations. In the case of energy network regulation, Ofgem has recently decided to consider durations of up to eight years to encourage greater investment certainty where there are significant infrastructure investment requirements, as well as to introduce a framework to match revenue against incentives, innovation and outputs (the so-called RIIO framework). As a result, adaptation needs can be addressed through output requirements, and through the innovation stimulus package, i.e. additional funding for innovative measures and projects. The CAA is keen to explore how this might be applied to its designated airports and will be looking to the new legislation to enable its use.

5.20 In addition, the CAA is likely to be able to apply licence conditions to the designated airports, requiring for example, operational resilience in respect of particular issues and for the airport to report on actions that it is taking in this regard. This tool may also offer a useful mechanism to monitor climate change adaptation in the future – but will only apply to the airports designated by the Secretary of State for Transport.

6. Going Forward

6.1 It is clear that the CAA can do more to promote adaptation measures across the industry in terms of where we apply our regulatory tools, particularly in economic regulation. In addition, during the course of the reporting process, the CAA has met with other economic regulators who have been asked to report under the Defra direction, which has enabled comparison of approaches to be carried out and to coordinate on measures to mitigate uncertainties and barriers to adaptation.

6.2 As part of a wider review, the CAA is currently considering how to develop its environmental capability to meet the Secretary of State's objectives for the CAA Chair to 'develop the CAA's capability to consider and advise the Department on future challenges which require policy solutions, with particular reference to the environmental impact of the aviation industry'. This is being addressed through an initiative entitled 'Greening the CAA.' The initiative will look to take a holistic view to business sustainability and ensure alignment with current best practices where possible. Adaptation forms one of several areas that will be considered as part of an overall strategy and implementation plan for environmental matters.

6.3 Engagement has been a key part of the work and in addition to various internal initiatives to raise awareness and promote understanding and buy-in across the CAA, there have been a number of facilitated meetings and workshops to better understand the work the CAA does with an environmental dimension.

6.4 The assessment of adaptation requirements to climate change will be an ongoing piece of work that are likely to be informed further as the National Climate Change Risk Assessment is developed and finalised. The CAA will continue to strengthen its expertise in matters relating to climate change science and work closely with relevant government departments (e.g. Department for Transport, Defra, the Environment Agency and Department for Enery and Climate Change), other regulators, industry, consumers, NGOs, and academia to further develop policy to address mitigation and adaptation issues. The CAA will also look to build in monitoring actions on climate change adaptation in its assessments of price controls, licensing conditions and performance indicators.

6.5 The climate change adaptation has brought recognition across the CAA of the need to ensure that adaptation measures are considered as part of the strategic planning process. As noted earlier in the report, key risks are reviewed by the Board on an annual basis with each business area managing its own particular risks. The CAA Corporate Business Risk process remains the key methodology to monitor climate change risks on the organisation. It is likely that new climate information (such as new climate projections) and any new research that assists with reducing uncertainty in amounts, timings and rate of change of climate change impacts will inform the risk process. It is intended also that adaptation issues will be considered widely as part of the CAA accommodation strategy review later this decade.

6.6 For the CAA, two key opportunities have been identified. The first is that it has helped contribute to the case for the CAA to strengthen its regulatory role in environmental matters, which has resulted in the 'Greening the CAA' initiative. As a result, the CAA is likely to further develop its expertise in the

environment and will allow it to offer advice and expertise to other organisations both within the UK and abroad.

6.7 Climate change adaptation has synergy with the CAA's Future Airspace Strategy (FAS). This is an adaptive system that takes account of a number of variables to provide flexibility in the future airspace system. It is likely that the number of flights in UK airspace will increase over the next decade or so but the volume of traffic in the future and the rate of change is not known precisely. However a number of improvements to the air traffic system and supporting policies and infrastructure are required to deliver additional capacity. Annex C gives a more detailed overview of the concept. FAS is a CAA-led initiative that has been received with significant interest around the world, which has offered the opportunity to market this expertise internationally.

6.8 For the aviation sector, key opportunities for the future include the likely reduction in the incidence of some of the conditions that cause significant disruption to aviation at present, such as snow, ice and fog at a number of airports around the UK, which should offset some of the impacts associated with increased extremes of strong wind, heavy rain and higher temperatures. There is likely to be reductions in heating costs during the winter but this will be balanced by increased summer cooling costs.

6.9 It is also clear that a number of airports and NATS have developed their own expertise in climate change issues, which is likely to be of benefit in other countries, for example across Europe, as they begin to tackle adaptation issues. Whilst the specific actions required for each airport may be different, the principles and processes applied to reach the solution will be similar.

7. Uncertainties, Barriers and Interdependencies Associated with Adaptation

7.1 For the CAA, the key barriers to implementing adaptive action fall around economic and business uncertainty, scientific uncertainty and political uncertainty. The future economic climate and continued pressure on cost effectiveness is likely to require a prioritisation of adaptation measures that can be applied. One key issue will be in the planning, specification and location of future CAA offices and what, if any, future adaptation measures are required. Adaptation, however, is one of several areas that will be considered as part of an overall strategy and implementation plan for environmental matters that is being addressed through the 'Greening the CAA.' Initiative.

7.2 At the same time there is some political uncertainty in terms of how future legislative changes will affect the way in which the CAA regulates e.g. changes to the economic licensing framework that may affect how the CAA is able to assist the organisations it regulates to adapt. In terms of scientific uncertainty, as can be determined from the UKCP09 probabilistic information, climate science provides solid guidance of likely climate conditions that will be experienced in the future but this has a range of possible outcomes for a variety of possible (emission scenario) inputs. It also does not give a full picture of the day to day meteorological conditions that may be experienced or the frequency of extreme events.

7.3 There are a number of uncertainties associated with the development of adaptation strategies that have been identified by the airports and NATS. They can be summarised as follows:

- Economic uncertainty – the current economic climate makes raising money for large capital expenditure programmes extremely difficult.
- Scientific uncertainty – Uncertainty over the accuracy of the UKCIP projections increases the difficultly in making a robust business case to support these types of substantial capital investment. In addition, whilst the three emissions scenarios provide useful probability information on the likely range of outcomes, the outcome will be affected by government policies domestically and internationally, and how effectively they are implemented. Additionally, some climate variables which may be of particular interest to aviation, such as changes to wind direction (which could affect runway utilisation) and wind speed at altitude (which could affect the time aircraft take to fly sectors), are not currently encapsulated within the UKCP suite of climate projections.
- Organisational uncertainties – there is often a turnover of staff in organisations that can result in corporate knowledge being lost, a change in strategic direction of the organisation or changes in the market that result in an organisation being reluctant to commit to long-term adaptation strategies, particularly when their planning cycle is typically 10-20 years.
- Political uncertainty – policies on possible expansion limitation or changes in taxation can result in constraints on future strategies. In addition, balancing interdependencies can cause difficulties e.g. an airport reducing reliance on the electricity grid by producing power through an on-site combined heat and power plants. This would provide greater resilience during adverse weather conditions but may well contribute to air quality issues around the airport, which may be politically unacceptable.

- Regulatory uncertainty – five year economic control periods can allow focus to bear on short-term issues, whilst benefits of investments are only realised many years later. In addition research work carried out on new materials or systems may require regulatory approval before they can be implemented, which may not be granted.

7.4 Work is underway to address the barriers and uncertainties that have been identified. There is a tendency of aviation organisations to focus on the short term, and give limited consideration to innovation and cross-sector interactions. This could impact on the ability of regulated companies to proactively address their adaptation needs. The new economic licensing framework for the CAA may assist in improving this aspect. However, the business case for large investments that will only fully deliver benefits many years down the road can be difficult to progress, particularly in economically difficult times.

7.5 For the economically regulated organisations, there is a need for the airports and NATS to fully identify adaptation strategies in order to inform their business plans. There is a barrier to adaptation set up if actions are missed and therefore not included as part of the organisation's revenue over a fixed period of time. Equally, overplaying the need for adaptation measures can also be a potential barrier. For the non-economically regulated airports, the development and use of performance indicators may assist in increasing awareness of the need for adaptation measures; funding, however, is always going to be challenging to secure for airports that operate in a full commercial capacity.

7.6 There are strong interdependencies between the aviation sector and other sectors. For instance, the key utilities have a significant effect on the functioning of airports and air traffic service units; energy for heating/cooling and powering sophisticated terminal buildings, communications systems for air traffic control centres and related infrastructure; water for a variety of uses across the airport. Surface access to the airports and air traffic control centres is also a critical issue. The aviation reporting authorities have generally assumed that the interdependencies will have taken suitable adaptation measures to ensure their continued function.

7.7 The CAA met other economic regulators from Ofgem, Ofwat, Ofcom and the Environment Agency on 19 September 2011 to learn from the experiences of the other regulators in compiling their respective reports, and to discuss the implications of emerging common themes. Further regular meetings with regulators of other sectors would be beneficial to maintain the cross-pollination of ideas and concepts, which in turn should ensure a more harmonised approach to regulatory policy on adaptation.

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Annex A: Direct impacts of climate change on the aviation industry

Parameter	Primary Climate Change Effects	Impact	Adaptation Measures Required	Confidence in forecast impact up to 2050, based on UKCP09 and uncertainty
Temperature	Higher mean surface temperatures	Increased building cooling	Impact on energy costs and new terminal / building design	High – long observational record of temperature increases, all studies considered concur on further increases and in patterns of regional and seasonal change
	Higher mean surface temperatures	Increased building cooling - overheating of operationally critical buildings which could impair performance of critical staff or equipment and breach regulated conditions	Review specification of cooling equipment against possible temperature extremes and mean temperature increases	High
	Higher mean surface temperatures	Increased aircraft cooling whilst on stand	Trade-off between use of aircraft auxiliary power unit to run aircraft aircon (noise and emissions impact) or need for airport ground power units (investment)	High
	Higher mean surface temperatures	Airport surfaces - UK tarmac standards (roads, aprons) begin to lose integrity once temperatures in the shade exceed 32°C. Runway surfaces design standards higher but can be affected by surface deformation.	Revised tarmac standards for future resurfacing works	High

Parameter	Primary Climate Change Effects	Impact	Adaptation Measures Required	Confidence in forecast impact up to 2050, based on UKCP09 and uncertainty
Temperature	Higher mean surface temperatures	Outdoor workers affected by heat, sun (UV radiation) leading to reduced capability	Improved occupational health protection arrangements	High
	Higher mean surface temperatures	Increased fire risk (e.g. aircraft fuel spills, venting, vegetation fires etc.)	Airport fire service to consider increased risks	Medium – this is already an issue for some airports in hotter climates and therefore operational mitigation information available
	Higher mean surface temperatures	Aircraft performance on take-off impaired due to reduced air density. Changes may result in changes to aircraft types, load factors , noise, emissions and movement rates	May require airspace design changes or increased runway length	Medium – more likely to be an issue with airports with shorter runways
	Higher mean surface temperatures	Traffic demand changes	May require airspace design changes	Low – flexibility in-built in airspace design but capacity on some routes/locations may become an issue at times.
	Higher mean surface temperatures	Local residents around airports are disturbed by noise for more prolonged periods due to the need to keep house windows open	May require airports to subsidise air conditioning systems for affected home owners	Medium
	Higher, colder tropopause	Optimal cruise altitude raised - reduced engine efficiency	Changes to route structure	Low

Parameter	Primary Climate Change Effects	Impact	Adaptation Measures Required	Confidence in forecast impact up to 2050, based on UKCP09 and uncertainty
Precipitation & water supply	Increased winter precipitation and risk of flooding; decreased summer precipitation and potential water shortages	Airport availability and access	New investment in improved drainage systems, grooved runways, changes to aircraft operations and improvements to the resilience of transport access to the airport	High - Medium - All studies considered agree on seasonal patterns of precipitation change but not on exact magnitude. Uncertainty due to soil parameterisation in climate models.
	Increased winter precipitation and risk of flooding; decreased summer precipitation and potential water shortages	Ground movement / water ingress in buildings and underground services	Improved building specifications	High - Medium
	Increased winter precipitation and risk of flooding; decreased summer precipitation and potential water shortages	Drainage system / balance pond capacity to segregate de-icing fluids etc.	New investment in improved drainage systems	High - Medium
Surface wind	Wind strength and direction changes at surface; average speed expected to decrease but increased frequency of high winds associated with transitory deep depressions	Damage to buildings	Improved building specifications	Medium – Low - Large uncertainty with respect to changes in speed and direction, the latter which has not been considered as part of UKCP09.

Parameter	Primary Climate Change Effects	Impact	Adaptation Measures Required	Confidence in forecast impact up to 2050, based on UKCP09 and uncertainty
Surface wind	Wind strength and direction changes at surface	Airport availability due to cross-wind limitations for landing/take-off and/or use or aircraft steps and passenger bridges	Technological improvements to aircraft operations and airport building design / infrastructure. Consider re-aligning runway but may be impracticable in many cases.	Medium – Low
	Wind strength and direction changes at surface	Increased longevity of aircraft wake vortices due to decreased average wind speed	Reduced aircraft movements. Use of technology (e.g. Lidar) to monitor location and movement of vortices and flexible operating procedures	Low
Upper atmosphere Jets	Changes to the position of the polar and sub-tropical jet streams	Movement poleward and vertically higher in the atmosphere changes wind strength and direction resulting in changes to cruise routing and altitudes Potential reduced income for NATS	May require airspace design changes	Medium - Low – models tend to indicate a gradual movement poleward of the jets but the rate is uncertain.

Parameter	Primary Climate Change Effects	Impact	Adaptation Measures Required	Confidence in forecast impact up to 2050, based on UKCP09 and uncertainty
Snow & frozen ground	Fewer days of snow/frost	Reduced de-icing and snow clearance requirements	Need to retain some capability to deal with wintry polar weather or accept that for short periods aerodromes may close	High - Medium - all regional models considered showed same broad level response, but are driven by the same global model. Regional model projections concur with independent studies.
Convective weather	Increased intensity of precipitation events lightning, hail and thunderstorms	Refuelling activities interrupted by thunderstorms Maintaining stable electricity supply for critical systems Aircraft operations in the terminal area disrupted	Uninterruptible power supplies for critical systems, dual fed electricity supply. Ability for air traffic control to plan ahead for disruption / alternative operations.	Medium – Low - Severe convection results derived from changes in occurrence of related phenomena, such as intense precipitation events. Uncertainty surrounding modelling of convection and a limited number of studies give low confidence in exact magnitude of change.
Sea level	Increased mean sea level and impacts of storm surges and flooding	Airport availability and access	Improved sea defences	High – Medium – All studies considered concur that sea levels will continue to rise. UKCP09 predictions indicate a rise of between 19 and 43cm around the UK by the 2080s, depending on the location, emission scenario and not including accelerated rise due to ice sheet dynamics.
Visibility	Decrease in winter days affected by fog	Fewer capacity restrictions due to reduced visibility	None required	Low - Fog and haze are boundary layer features not well represented by climate models.
Transport	More extremes of	Passengers		Medium – days of

connections / flow of passengers	weather cause disruption to transport and impairs access to the airport	unable to get to or from airport		snow and ice are expected to be fewer whilst impacts from extremes of wind and rain more uncertain and more transitory

Annex B: Current Relevant CAA Corporate Business Risks Related to Climate Change

Ref	Target Risk Rating L S T	Risk Identification			Residual Risk Planned Actions to Target Rating	Actionee	Timescale	Current Risk Response	Risk Rating and Movement
		Risk Driver	Risk Event	Risk Effect					
5	1 4 4	Exceptional natural event e.g. extreme weather	Key resources required to ensure business as usual work carried out	Inability to manage effectively business as usual activities	Business Resilience Manager responsible for crisis management	Business Resilience manager	Ongoing	CAA Business Resilience Manager member of specialist groups for crisis management / business resilience input. Crisis Management Plans exercised and lessons learned	1 4 4
18	2 3 6	Inability to fund essential maintenance	Interruption to business operation caused by failing systems / equipment	Potential financial implications and loss of productivity.		Head of Estates Services		(i)Buildings dilapidations plan reviewed to ensure business essential interruption risks are mitigated. (ii) Board endorsed maintenance and funding requirements	2 3 6
28	1 3 3	Aviation Markets evolve, new business practices introduced/adopted and consumer preferences and expectations change.	CAA fail to recognise changes within aviation market including commercial practices and consumer behaviour.	Emerging issues not identified in a timely way.	Outcomes from Consumer Workstream Project	Director, RPG	Ongoing	(i)Undertake research into industry and consumer issues.(ii)Maintain good relationships with industry and consumer groups(iii)Consumer Issues Panel.	2 3 6
35	2 2 4	Economic fluctuations and / or changes in industry structure / strategy resulting in a sustained reduction in UK aviation activity	Significant level of aircraft operator financial **failure** and/or transfer of aircraft operations outside of the UK.	Decreased revenue streams.CAA no longer seen as 'fit for purpose' in terms of size and responsibility	Further development of Finance Contingency model.(ii) Undertake independent audit of recent failures to assess strength of internal controls.(iii) Further development of Charges Schemes to be more resilient to sudden economic effects.	Hd Finance	Ongoing	Finance Contingency model in place.(ii) Rigorous and effective planning and control by ExCo	2 3 6
42	1 2 2	CAA member of staff is involved in incident or develop illness associated with working conditions/arrangements	Incident/illness is attributed to a failure by CAA to discharge its legal Health and Safety Duties	Death or injury to CAA staff member leading to court action, reputation and financial implications for CAA	Review current controls and develop changes and additions to manage new ways of working	Health, Safety and Environment Adviser and Hd Estate Services		Home working and Lone Working procedures	3 2 6
43	1 2 2	Failure of business areas to define coherent business continuity plans.	IT business continuity plans incomplete or not aligned with the business requirement	Business areas impacted by systems being unavailable for longer than expected following a BCP incident	ISD participating in the Corporate Centre BCP Project	Hd ISD Busines Resilience Manager		Business Impact Analysis workshops commencing in April to review current business continuity plans and provide the business requirements in a business continuity event.(ii)ISD participating in the maintenance of BC.(iii)ISD assessment of IT impact on coherent business continuity plans, with follow-up actions	2 3 6

Annex C: Overview of the Future Airspace Strategy

The Future Airspace Strategy (FAS) is aimed at improving the use of UK airspace and should deliver significant efficiencies and environmental benefits through aircraft flying more direct routes and through more efficient arrival and departure profiles.

The FAS 2030 Vision is to establish:

- Safe, efficient airspace, that has the capacity to meet reasonable demand, balances the needs of all users and mitigates the impact of aviation on the environment.

The proposals in the FAS aim to enable aircraft to fly in more environmentally efficient ways. The environmental impact of air travel, both locally in terms of noise and air quality, and globally in terms of climate change, plays an important role in determining how the UK airspace system should develop. The FAS aims to drive the implementation of Air Traffic Management (ATM) improvements that reduce greenhouse gas emissions from aircraft and contribute to minimising aviation's environmental impact. The FAS also provides an opportunity to re-assess existing principles underpinning the treatment of aircraft noise and tranquillity in the context of new ATM technologies and operational concepts. Outwith the FAS remit, airports will also have to consider the effect of local issues, such as air quality and noise, as factors which may restrict individual expansion plans in some areas.

Due to the degree of uncertainty surrounding how the aviation sector will develop over the next 20 years, the strategy to develop the airspace system that supports it must be flexible and adaptable to changing circumstances. The FAS needs to adopt a clear focus on the strategic drivers it aims to address and the key areas that must be considered to do this successfully. The following section sets out these drivers and considerations to ensure the efficacy of the Strategy while more detailed work will be carried out to deliver it. Unlike the European National Performance Scheme, cost has not been included as a separate strategic driver, but within an aviation industry where output is delivered by companies driven by market forces within a global market economy, cost is inevitably a context within which all the strategic drivers are delivered. In the UK some of these companies are subject to economic regulation.

The development of an airspace system that enables users to fly in more environmentally efficient ways is a key strategic driver for FAS work. The specific environmental objectives are potentially in conflict as the interactions between environmental impacts are often very complex and careful analysis is required to understand the issues.

There are a number of trade-offs that must be considered by decision makers who may find that improvements in one aspect of the environmental challenge can only be achieved at the expense of another.

The obvious set of environmental trade-offs occurs between noise, emissions and local air quality. For example, in the simplest case, flying around a densely populated area in order to minimise the number of people affected by noise would increase fuel burn and could adversely impact on some currently "tranquil" areas. FAS work also considers other less obvious interdependencies associated with the environment that may require trade-offs, including:

- Concentration versus dispersion of aircraft routes across the ground.
- The value placed on the legacy of long-standing planning system versus the benefits of change.
- The need to enhance the supply of renewable energy (on and off shore wind turbines) and the potential impact on radar, aircraft routeing and procedures.

The interdependencies between environmental impacts, demand for air travel, capacity of airspace and airports and the resilience of the overall system to a shock (such as the 9/11 terrorist attacks and the 2010 volcanic eruption in Iceland).

Environmental impacts are only one of a range of competing issues affected by the development of the UK airspace system. The consideration of environmental factors and their impact also changes depending on the phase of flight. All the environmental issues associated with the FAS, and its implementation, will be addressed in line with extant Government policy.