



Department  
for Transport

# EMERGING TECHNICAL REQUIREMENTS FOR A UK SPACEPORT





This presentation is based on the understanding of the DFT and CAA as of 6 November 2015. It should be noted that Government policy and our work are subject to ongoing development in a fast-moving technological environment. Technical and other requirements for a UK Spaceport are therefore subject to a number of factors and uncertainties that could cause them to change. No reliance should therefore be placed on any aspect of this presentation, and it should not be assumed the final requirements for a UK Spaceport will be as set out here.



## Outline

- ▶ Emerging requirements
  - ▶ Background to phase 2 (post government review)
  - ▶ Spaceport considerations – **James Eales**
  - ▶ ATM and Airspace considerations – **Andy Sinclair**
- ▶ Areas of further work
- ▶ Based on our current knowledge – things will change!



## Background to CAA's Phase 2 work

- ▶ Government (DfT) funded Section 16 task
- ▶ Includes (but is not limited to):
  - ▶ Implement the recommendations in the Technical Review
  - ▶ Development of a Technical Specification
  - ▶ Develop a Regulatory and operational framework for horizontal launch sub-orbital spaceplane operations
  - ▶ Working in partnership with UKSA and MOD



## Scope

- ▶ A to A, horizontal launch, sub-orbital flights
  - ▶ Space tourism /spaceflight experience
  - ▶ Micro gravity experimentation
- ▶ Satellite launch
- ▶ Vertical launch is not in scope of CAA's work



## Different requirements

<b>Sub-orbital A to A</b>	<b>Satellite launch</b>
Crew and spaceflight participants on board	Launch vehicle has crew but satellite launch is un-manned
Defined airspace close to spaceport	Potentially larger defined flight corridor of airspace some distance from spaceport
All parts of the spaceflight system return in tact	Expendable sections of spaceflight system
No flight termination function	Flight termination function
Likely to be classified as 'aircraft' throughout flight	Portion of flight will involve launch to orbit



## In scope – Concept X





## In scope – Concept Y







## In scope – Concept Z





## Aviation and space are fundamentally different

Aviation	Horizontal launch sub-orbital spaceflight
Mature industry	Emerging industry
Aviation is one of the safest modes of transport	Spaceflight involves a higher level of risk
90,000 daily flights	Limited number of licensed launches in the US since 1989 – Limited number of UK licensed launches overseas
Low altitude – within the national airspace system	High altitude with the intent to exit and re-enter the earth's atmosphere
Airports – 50 EASA certified / 80 UK licensed / numerous un-licensed	10 licensed spaceport sites in the US
Passengers and crew expectation of high level of safety	Spaceflight participants and crew may have to accept a higher level of risk
Integrated licensing and certification programme – design / airworthiness / flight crew / maintenance	In the US the licensing regime is primarily to protect 3 <sup>rd</sup> parties
Large safety database on all aspects of aviation	Minimal data and limited number of launches – especially horizontally launched spaceplanes



## Regulatory frameworks that could be used for horizontal launch spaceplane operations

### ▶ Existing

- ▶ FAA Office of Commercial Space Transportation (FAA AST)
- ▶ Other States

### ▶ Potentially in the future

- ▶ ICAO
  - ▶ EASA
- ▶ UKSA provides licensing for satellite launch (not from UK)



## Regulatory principles

- ▶ As a baseline, align with FAA AST where appropriate
- ▶ Collaborative development with FAA AST
- ▶ Permissive regulatory framework
- ▶ Capable of adapting to technical developments
- ▶ Generic UK regulation (not site or operator specific)



## FAA AST

### ▶ Pros

- ▶ Established framework
- ▶ US Spaceplane operators familiar
- ▶ Established a good working relationship with FAA AST

### ▶ Cons

- ▶ Initially developed for vertical launch
- ▶ Different concept to commercial aviation regulatory approach
- ▶ Different legal system



## FAA AST – different approach

- ▶ Spaceplane operations are licensed rather than vehicle certification
- ▶ Vehicles classified as suborbital launch vehicles rather than aircraft
- ▶ Primarily to protect uninvolved general public
- ▶ Part 400 series
  - ▶ Part 420 – Licence to operate a launch site
  - ▶ Part 431 – Launch and reentry of a reusable launch vehicle
  - ▶ Part 433 – Licence to operate a reentry site
  - ▶ Part 437 – Experimental permits



## FAA AST – Who needs an FAA AST licence?

- ▶ A citizen of the United States must obtain a licence:
  - ▶ To launch a launch vehicle outside the United States
  - ▶ To re-enter a re-entry vehicle outside of the United States
  - ▶ To operate a launch site outside of the United States



## Development of a technical specification for a spaceport

- ▶ Current EASA certification or UK licensing requirements
- ▶ FAA AST requirements in Part 420 – Licence to operate a launch site
- ▶ Known facilities and operational requirements of spaceplane operators





## EASA aerodrome certification or UK aerodrome licensed?

- ▶ Recommendation in Government sponsored Technical Review
- ▶ Potentially captured in ANO articles
  - ▶ 207 – Requirement to use a licensed or Government aerodrome
  - ▶ 208 – Flights which must use licensed or Government aerodrome
    - Sub-orbital spaceplanes likely to be classified as aircraft
    - Spaceflight participants (commercial aspect)
  - ▶ 211 – Licensing of aerodromes
  - ▶ Schedule 12 – Information contained in aerodrome manual
- ▶ Spaceport Licence may be issued



## EASA aerodrome certification or UK aerodrome licensed?

- ▶ EASA aerodrome – certified against EU Commission regulation No. 139 / 2014 (12 February 2014)
- ▶ UK licensed aerodrome – CAP 168 licensing of aerodromes
- ▶ ICAO annex 14 – Aerodrome design and operation



## Information required from a spaceplane operator includes (but is not limited to)

- ▶ Declared distances required
- ▶ Physical size of aircraft (wing span and outer main gear wheel span)
- ▶ Minimum Pavement Classification Number (PCN)
- ▶ Non instrument v instrument runway
- ▶ Rescue & Fire Fighting (RFF) category of any proposed vehicle
- ▶ Operational requirements (nominal and non nominal)
- ▶ Weather limitations or night flying (not currently anticipated)
- ▶ Fuel / oxidiser / other requirements
- ▶ Any other information necessary to conduct operations safely



## Current aerodrome requirements that may need to be reviewed

- ▶ Oversight programme
- ▶ Review the basis and any limitations on which original certificate or licence issued
- ▶ Safety Management System
- ▶ Management of change
- ▶ Review procedures related to fire hazards
- ▶ Personnel / training requirements
- ▶ Review of aerodrome manual



## Current aerodrome requirements that may need to be reviewed (continued)

- ▶ Runway safety
- ▶ Condition of the manoeuvring area
- ▶ Wildlife programme
- ▶ MOR and safety reporting
- ▶ Security requirements



## Key considerations – runway physical characteristics

- ▶ Runway length
- ▶ Code E or code F aircraft
- ▶ Runway width
- ▶ Taxiway widths
- ▶ Runway shoulders
- ▶ Runway strip
- ▶ Runway end safety area





## Key considerations – Runway and taxiway surfaces



**Asphalt v concrete  
Hazards?**





## Key considerations – Runway centreline lighting

- ▶ Nose wheel skid
- ▶ Possible light fitting damage
- ▶ Compatibility
- ▶ Potential to fit ultra flush light fittings







## Key considerations – Runway operations

- ▶ Sterile runway
  - ▶ Glide operation
  - ▶ Potentially up to 2 hours
  
- ▶ PAPI lights
  - ▶ Operating procedures





## Key considerations – RFFS provision

- ▶ Rescue and fire fighting category
- ▶ Oxidiser enhanced fires
- ▶ Personnel training
- ▶ Key stakeholders
- ▶ Egress from vehicles
- ▶ Close cooperation with spaceplane operator required





## Key considerations – Emergency response plan

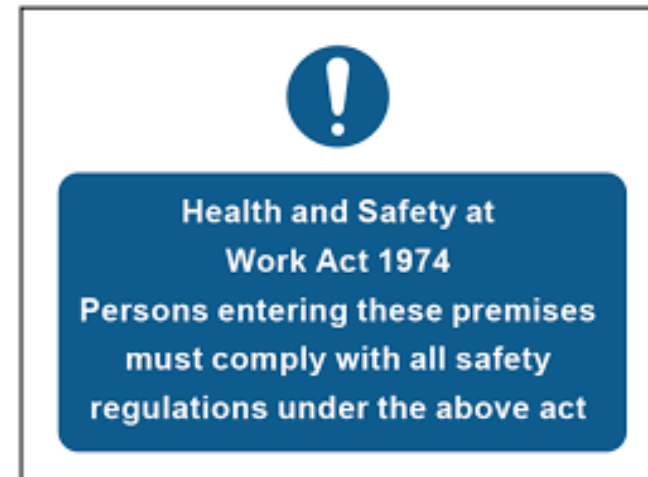
- ▶ Key stakeholders
- ▶ Local authorities
- ▶ Search and rescue
- ▶ ERP Testing





## Key considerations – Health and Safety Executive

- ▶ Health & Safety Executive
- ▶ Health & Safety at Work Act 1974
- ▶ <http://www.hse.gov.uk/>





## Key considerations – weather limitations

- ▶ Spaceplane operators have different weather operating criteria
- ▶ Key considerations include cloud cover and cross wind limits
- ▶ Met Office study has been commissioned but has not yet been finalised





## FAA AST Part 420 – Licence to operate a launch site

- ▶ Initially developed to regulate commercial vertical launch
- ▶ Covers reusable launch vehicles and expendable launch vehicles
- ▶ Primarily to protect 3<sup>rd</sup> parties on the ground



## FAA AST Part 420 – Licence to operate a launch site

- ▶ Part 420 includes:
  - ▶ Launch site location review
  - ▶ Site hazard analysis
  - ▶ Agreements with US Coast Guard and National Air Traffic
  - ▶ Licence terms and conditions
  - ▶ Control of public areas
  - ▶ Scheduling of launch operations
  - ▶ Notifications
  - ▶ Accident investigation plan
  - ▶ Records
  - ▶ Explosive siting



## FAA AST Part 420 – Launch site location review

- ▶ Demonstration of risk level
- ▶  $30 \times 10^{-6}$
- ▶ Probability of impact by the casualty area of the debris, multiplied by the population density of the region of interest
- ▶ Currently under review in US (NPRM)
- ▶ Requirement on both the spaceplane operator and a US spaceport
- ▶ Developing UK expertise
- ▶ UK requirements to be determined



### Advisory Circular

Subject: EXPECTED CASUALTY CALCULATIONS FOR COMMERCIAL SPACE LAUNCH AND REENTRY MISSIONS Date: August 30, 2000 AC No: 431.35-1  
Initiated By: AST-1 Change:

1. **PURPOSE.** This advisory circular provides an acceptable methodology for estimating the value, or upper limit of the value, of Expected Casualty  $E_0$  for commercial space launch and reentry missions.

2. **BACKGROUND.** The FAA Office of the Associate Administrator for Commercial Space Transportation (AST) is responsible for licensing commercial space launch and reentry (return from Earth orbit or outer space) operations. A principal objective of the licensing process is to limit risk to public health and safety, and safety of property, and to protect national security and foreign policy interests of the United States. Sections 415, 431 and 435 establish that, to be eligible for licensing, the launch of a launch vehicle (415.35(a)), the launch and reentry of a reusable launch vehicle (431.35(b)), or the reentry of a reentry mission (435.35) shall not exceed an expected average number of 0.00003 casualties per mission ( $E_0 \leq 30 \times 10^{-6}$ ). The purpose of the requirement is to ensure that risks to public safety presented by launch and reentry operations is limited to an acceptable level, defined in a manner consistent with acceptable launch risk at national ranges administered by the Air Force.

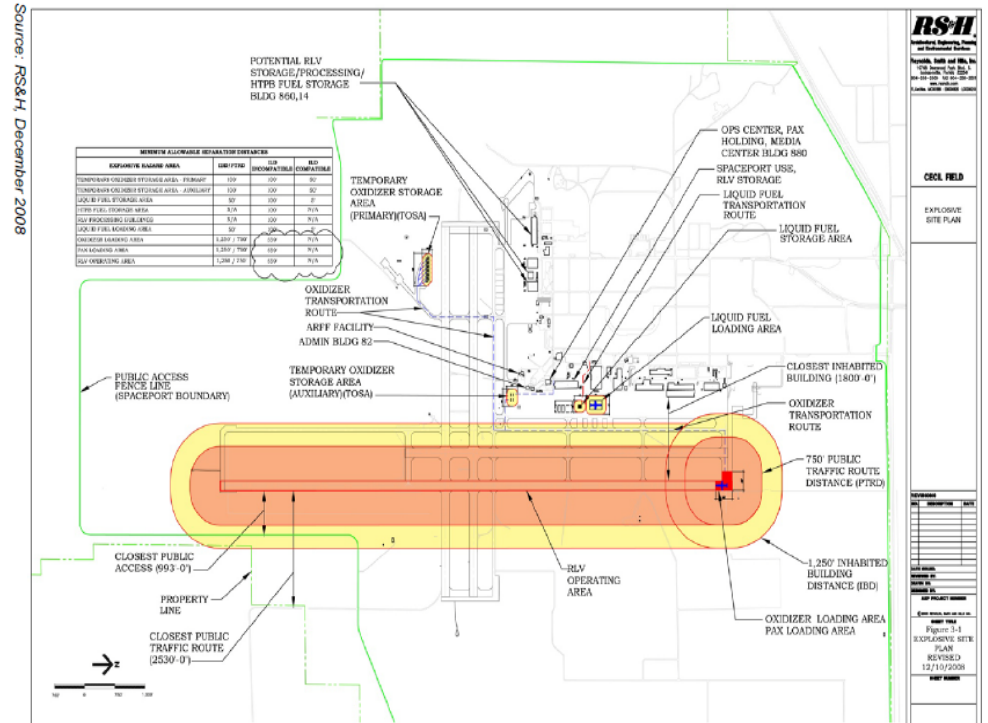
In summary, a license applicant is in compliance with sections 415.35(a), 431.35(b) or 435.35 if its expected casualty calculation utilizes the methodologies and procedures detailed in this advisory and yields an  $E_0$  of less than or equal to 0.00003. For further information: Ronald Gress, Manager, Licensing and Safety Division, (202) 267-8602.





# FAA AST Part 420 – Explosive site plan

- ▶ Fuel storage
- ▶ Oxidiser storage
- ▶ Separation of solid and liquid propellants
- ▶ Lightning protection plan





## Propellant for 1 mission

	Concept Y	Concept Z
<b>Propellant type</b>	Liquid	Hybrid
Aviation fuels	None	Jet A – 32,000lbs (4,923 gal)
Rocket fuels	Kerosene blend	HTPB CTN – 1,500lbs
Oxidisers	Liquid oxygen	Nitrous oxide – 13,500lbs (2,248 gal)
Others	Ghe, GN2	



## FAA AST Part 420 – Separation distances

- ▶ **Inhabited building distance** – minimum distance between a loaded vehicle and any inhabited building
- ▶ **Public traffic route distance** – minimum distance between a loaded vehicle and public road or railway
- ▶ **Intraline distance** – minimum distance between two explosive related buildings or sites
- ▶ Consulting with HSE to review current UK requirements



## FAA AST Separation distances – Part 420 appendix E

- ▶ Separation distances factors include:
  - ▶ Solid or liquid propellants
  - ▶ Quantity
  - ▶ Class of explosive 1.1 or 1.3
  - ▶ Propellant combinations
  - ▶ Explosive equivalent





## Spaceplane operator facilities (potential)

- ▶ Air-conditioned hangar to accommodate vehicles
- ▶ Secure to meet Export control regulations
- ▶ Payload preparation area





## Spaceplane operator facilities (potential)

- ▶ Control / communication centre for operations
- ▶ Accommodate for spaceplane operator personnel
- ▶ Customer hosting and training





## Airspace and Air Traffic Management

- ▶ Criticality of Airspace and Air Traffic Management
- ▶ Airspace
- ▶ Airspace Management
- ▶ Air Traffic Management
- ▶ Military operational notification and coordination





## Criticality of Airspace and Air Traffic Management

- ▶ Spaceplane Regulatory Review Recommendation:  
... access to airspace is a key factor which was considered as one of the selection criteria for any potential locations







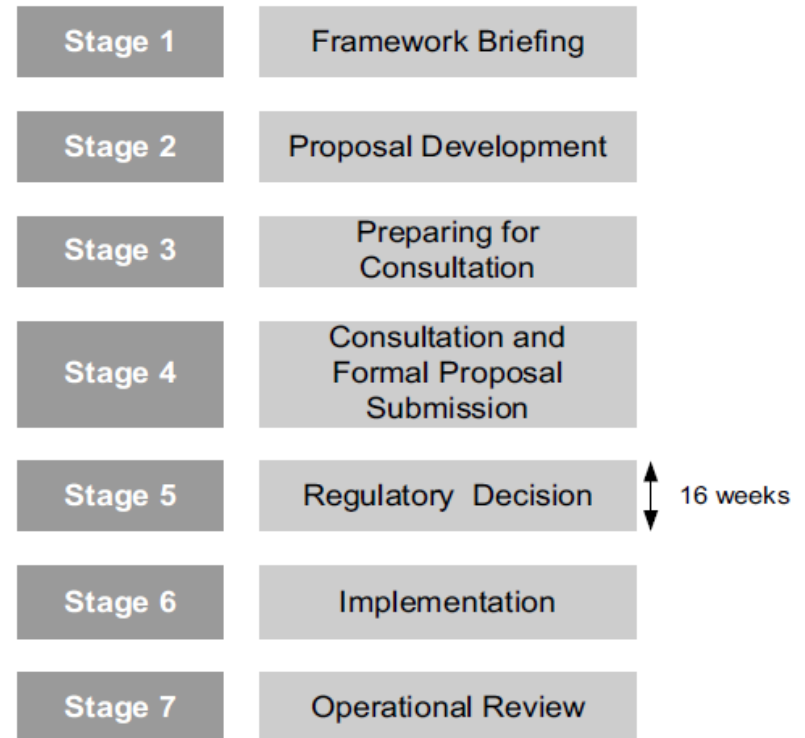
## Airspace - Segregated for spaceplane operations

- ▶ Spaceplane launches and the recovery of unpowered vehicles should take place within segregated airspace
  - ▶ To ensure the safety of all airspace users
  - ▶ To ensure the safety and integrity of the spaceplane operation
- ▶ Some operations may have the ability to comply with the Rules of the Air in certain circumstances, however, it can be anticipated that in the near term airspace segregation to support and contain spaceplane operations will be a necessary
- ▶ The UK has existing segregated airspace that may potentially be used for sub-orbital flights



## Airspace Change Proposal (ACP)

- ▶ The sponsor will be required to submit an airspace change proposal (ACP)
- ▶ An ACP is necessary to support changes to the dimensions, classification or use of UK airspace
- ▶ Airspace change process is defined in CAP 725 CAA Guidance on the Application of the Airspace Change Process





## Airspace Management (ASM)

- ▶ The ASM objective is to achieve the most efficient use of the airspace
- ▶ Whatever the airspace solution it must be integrated with existing ASM structures and procedures to:
  - ▶ ensure the integrity of the system
  - ▶ and manage the impact on the air traffic network and other airspace users



## Airspace Management (ASM)

- ▶ ASM procedures will be reviewed in anticipation of UK spaceplane operations - although no changes to ASM procedures are anticipated. This will be driven by:
  - ▶ The spaceplane operation
  - ▶ The airspace change proposal
- ▶ Impact on other airspace users (including commercial, military and general aviation)



## Air Traffic Management (ATM)

- ▶ The spaceport and spaceplane operator/s will be required to ensure appropriate ATC capabilities and procedures are in place
- ▶ The spaceport will need to work closely with the Air Navigation Service Provider regarding training requirements and co-ordination between spaceport, controlling authority and parent Area Control Centre
- ▶ Work to define operations oversight requirements is ongoing:
  - ▶ Conventional ATC radar surveillance may be required
  - ▶ Tracking of the spaceplane may be required



## Military operational notification and co-ordination

- ▶ Notification/agreement/coordination will be required with UK military for sub-orbital launch activity but are still to be determined



## Areas of further work

- ▶ US Export Controls – US State Department
- ▶ Specific spaceplane operator information – Technical Assistance Agreements (TAAs)
- ▶ FAA Office of Commercial Space Transportation (FAA AST) – US visit and collaboration
- ▶ Gain experience as the number of horizontal launch spaceplanes flights increase
- ▶ Increase flight operational safety data



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# Thank you – Questions?