
# Regulation & Legislation Workstream Plenary Event #7

Foot Anstey LLP, 2 Glass Wharf, Bristol, BS2 0FR

**Bristol|** 17th October 2019

# LAUNCH UK

## Welcome and introductions

**Colin Macleod|** UK Space Agency

# About today

**Aim:** To continue our series of regular engagement events

- Industry speakers who led the Regulatory Development studies will present the key outputs and share the findings with the wider community.
- We will provide an overview of US-UK Technology Safeguards Agreement and Risk
- We are happy to take Q and A throughout the day

*The small print: No part of the discussions held (unless otherwise noted) should be taken as a reflection of developing or future government policy or legislation, and any decisions taken by any individual or organisation on the basis of any information they hear or see at these meetings are taken at their own risk*

# Agenda

**09:30 – 10:00 – Arrival and registration**

**10:00 – 10:15 – Welcome and Introductions**

**10:15 – 12:45 - Regulatory Development Studies (*invited industry speakers)**

**12:45 – 13:30 – Networking lunch**

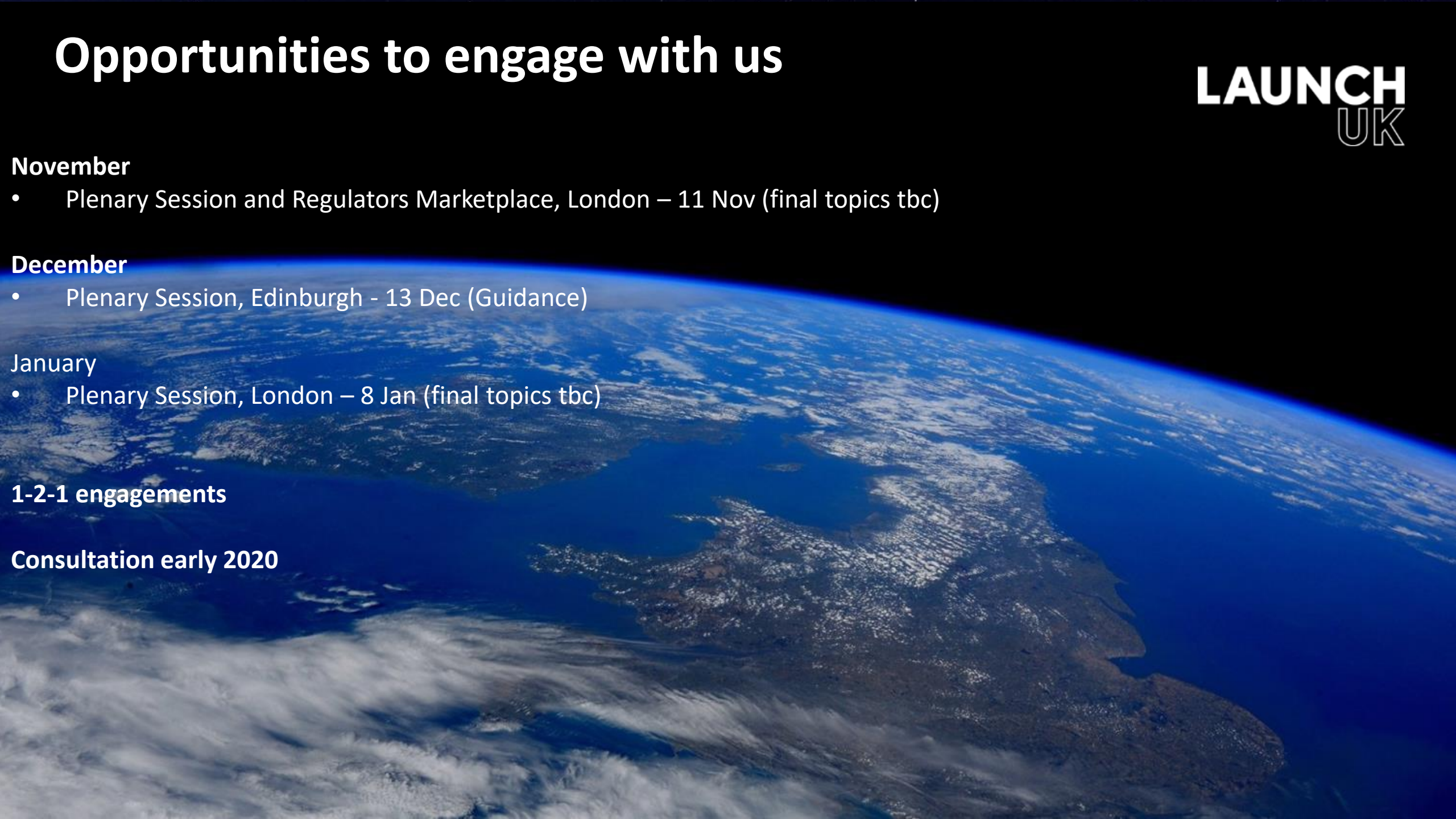
**13:30 – 14:15 – US-UK Technology Safeguards Agreement**

**14:15 – 15:45 – Risk**

**15:45 – 16:00 – Summary and closing remarks**

**In 2018 UKSA openly tendered a number of studies related to Regulatory Development. These studies focused a number on a range of technical topics and sought to advance the UKSA's understanding of these key areas. The session will see representatives from the companies who led these studies present the key outputs and share the findings with the wider community. The studies are now being used as one of the inputs to the UKSA developing policy position.*

# Opportunities to engage with us



**November**

- Plenary Session and Regulators Marketplace, London – 11 Nov (final topics tbc)

**December**

- Plenary Session, Edinburgh - 13 Dec (Guidance)

January

- Plenary Session, London – 8 Jan (final topics tbc)

**1-2-1 engagements**

**Consultation early 2020**


## Regulatory Development Studies

(invited industry speakers)

# Networking lunch


**US-UK Technology Safeguards Agreement for UK Space Launch**

**Andrew Kuh**
Head of International Spaceflight Policy
UK Space Agency

# Summary

LAUNCH UK

1. Background of the Technology Safeguards Agreement (TSA)

2. Key principles and Practical Implications

3. Next Steps

# Background

- HMG is negotiating a TSA with the US Government to:
  - Ensure controls are in place to protect counter-proliferation commitments
  - Allow US spaceflight vehicles and technology to be imported/launched from UK

- US and UK, along with 33 other countries are partners in the Missile Technology Control Regime (MTCR)

- The MTCR addresses the proliferation of missiles for weapons of mass destruction (WMD) through controlling the transfer of sensitive technologies

- The MTCR controls space launch technologies but it is “not designed to impede national space programmes or international cooperation as long as programmes could not contribute to delivery systems of WMD”

- MTCR is not itself a legally binding treaty – but its objectives are realised through national legislation and regulations, and full adherence to the MTCR is an important international commitment by both the UK and US Governments

# Background

- The US Government cannot permit the transfer of Space Launch Vehicle technology to the UK
- The US recognises the ambition of US companies to launch from the UK
- In principle, the US is supportive of UK ambitions in space
- US entities must remain in control of relevant technology at all times to ensure it has not been ‘transferred’

# US Participants and Licensees

- **US Participants** effectively means any persons involved in Launch Activities who are subject to the jurisdiction and/or control of the USG.

- **UK Participants** are any persons other than US Participants who could have access to U.S. Launch Vehicles, U.S. Spacecraft, U.S. -Related Equipment, and/or U.S. Technical Data, and who are subject to the jurisdiction and/or control of the United Kingdom of Great Britain and Northern Ireland.

- **US Licensees** means any persons issued an export licence by the USG to bring U.S. Launch Vehicles, U.S. Spacecraft, U.S.-Related Equipment, and/or U.S. Technical Data to the UK for Launch Activities.

- **UK Licensees** means any persons who are identified on a relevant U.S.-issued export license and who are authorised under UK law to carry out Launch Activities.

# Segregated and Controlled Areas

- **Controlled Areas** are designated by HMG, and access is only permitted to persons authorised by HMG, USG or another government involved in Launch Activities.
  - It is up to HMG or UK Participants to control access to these areas.
  - When US launch vehicles, technology etc are present in controlled areas, they must be accompanied and monitored by US Participants

- **Segregated Areas** are designated jointly by HMG and USG and access is restricted to persons authorised by the USG. It is up to the USG or entities licensed by the USG to control access to these areas.

- ***In practice*** a controlled area could encompass most or the entirety of a spaceport site; a segregated area is likely to be a smaller zone with the controlled area, access to which is further restricted.

# Practical Implications

- There will be an increased operational overhead to accommodate launch activities with US involvement
    - Spaceports in the UK supporting launch activities involving US launch vehicles or US spacecraft will need to provide segregated and controlled areas
    - Security requirements will be stipulated for each, to make sure access is restricted to the correct category of person
    - Unimpeded access and monitoring for the relevant authorised persons will also be required
    - When not in segregated areas, U.S. Launch Vehicles, U.S. Spacecraft and/or U.S.-Related Equipment must be accompanied by U.S. Participants during the conduct of Launch Activities, including during transfer to launch pad.
        - This does not necessarily preclude non-U.S. Participants undertaking certain tasks

# Practical Implications

- Some obligations flowing from the TSA may need to be captured in secondary legislation.

- It is likely that additional safeguards will be stipulated in conditions attached to US export licences: the US Government will assess each case individually when assessing applications for export licensing.

- Technology Transfer Control Plans (TTCP) are likely to be needed in respect of all U.S. export licences.
  - The TSA is designed to make the process of defining and agreeing a TTCP more straightforward, since certain conditions and obligations are already set out
  - The level of detail in a TTCP may still be quite extensive, depending on the specifics of the proposed activities

# TSA – Next Steps

- UK and US expect to conclude text in the coming months
- TSA expected to be signed by both parties early 2020
- TSA is viewed by Government as a Treaty which means following signature it will be subject to ratification by Parliament
- Initial negotiating position was informed by discussion with industry and approved by Ministers.
- We believe the TSA will remain within the terms of the mandate we agreed and will meet the requirements of both parties, protecting technology while minimising undue overhead for operators in the UK.

# TSA – Points of Contact

Any specific questions can be addressed to:


Andrew Kuh
Head of International
Spaceflight Policy

Andrew.Kuh@ukspaceagency.gov.uk

Sarah Palmer-Pearce
International Spaceflight Manager
USA & RoW

Sarah.Palmer-Pearce@ukspaceagency.gov.uk

# Questions


# Risk

**Oliver Turnbull & Robert Garner|** UK Space Agency

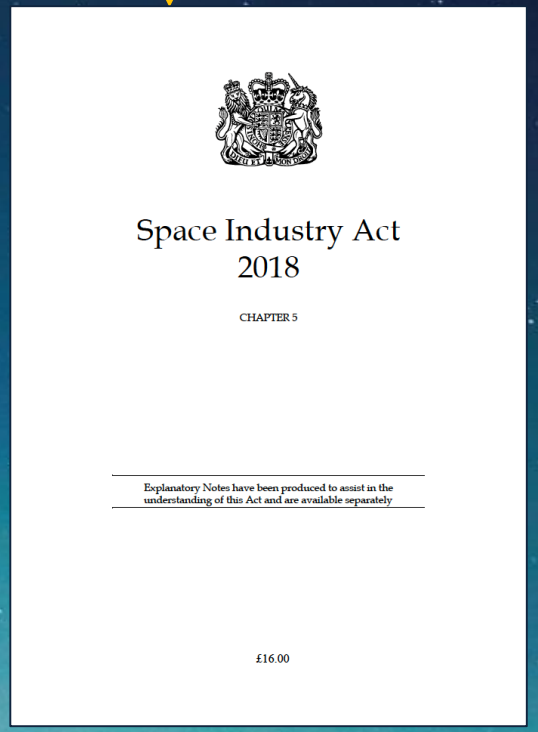
# Agenda

- What we've said before
  - Safety legislation
  - Safety case & ALARP
  - Review of previous statements about individual risk (IR)
- What we're saying today
  - Existing metrics (US & UK)
  - Launch as a discrete event
  - Societal concerns
  - Risks to Marine and Air Traffic
- What we're going to say in the future

# Previous Statements

LAUNCH UK

2018 2019 2020 2021 2022



Space Industry Act
2018

CHAPTER 5

Explanatory Notes have been produced to assist in the understanding of this Act and are available separately

£16.00

**9 Grant of operator licences: safety**

(1) The regulator must not grant an application for an operator licence unless satisfied that the requirements in subsections (2) to (4) are met.

(2) The applicant must have carried out an assessment of the risks to the health and safety of individuals who are to take part in a prescribed role or capacity in the activities to be authorised by the licence (a "risk assessment").

(3) The risk assessment must meet prescribed requirements.

(4) As regards risks to the health, safety and property of persons not within subsection (2)—

(a) the applicant must have taken all reasonable steps to ensure that those risks are as low as reasonably practicable;

(b) the level of those risks must be acceptable.

(5) Regulations may make provision about—

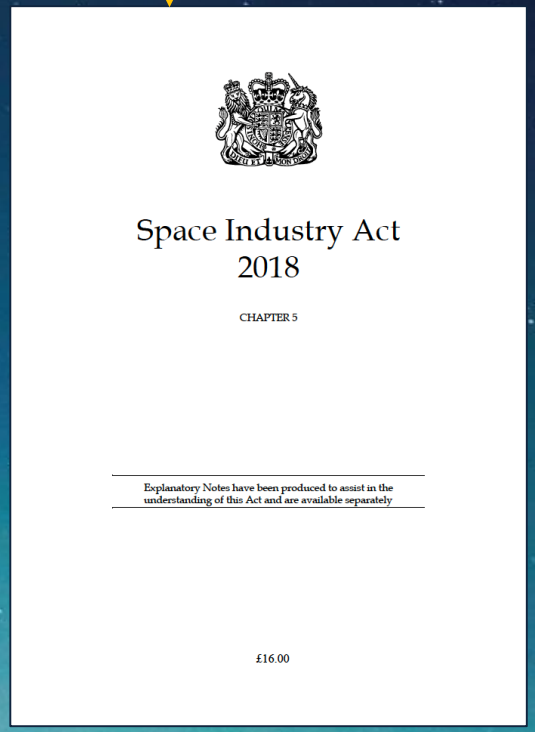
(a) matters to be taken into account, and other requirements to be met, in carrying out risk assessments;

(b) steps to be taken under subsection (4)(a);

(c) how acceptable levels of risk are to be determined for the purposes of subsection (4)(b).

# Previous Statements

2018 | 2019 | 2020 | 2021 | 2022



Space Industry Act
2018

CHAPTER 5

Explanatory Notes have been produced to assist in the understanding of this Act and are available separately

£16.00

**10 Grant of spaceport licence**

The regulator must not grant an application for a spaceport licence unless satisfied that—

(a) the applicant has taken all reasonable steps to ensure that risks to public safety arising from the operation of the spaceport are as low as reasonably practicable, and

(b) any prescribed criteria or requirements are met.

# Previous Statements

2018 — 2019 — 2020 — 2021 — 2022


OFFICIAL
20 March 2018

HEALTH & SAFETY LABORATORY

Spaceports: keeping people safe

Author:
Ron Macbeth

Report Number:
PE06415/8
20 March 2018

HSL: HSE's Health and Safety Laboratory

Enabling a Better Working World

- Focus on spaceports
- Risk to local population
  - Risk from ground hazard(ous operations) that are unique to spaceflight
  - Risk from flight
- Identified IR per annum as an appropriate metric

# Safety Case – Purpose & Outcomes

LAUNCH UK

2018 2019 2020 2021 2022

- Outcome-focussed regulation -> a case for safety
- An accessible structured argument, supported by evidence that is intended to demonstrate that the risks from an operation are reduced to ALARP
- Used for particularly hazardous activities where the potential consequences are a major loss of life, damage to the environment or significant public concern
- Mechanism by which the duty holder demonstrates they've reduced the risks to ALARP
- Clearly sets out the trail from safety claims -> arguments -> evidence
- Provides an opportunity for a duty holder to think through the risks and how to mitigate them

# Safety Case – Form & Approach

LAUNCH UK

2018 — 2019 — 2020 — 2021 — 2022

- Logical, hierarchal set of documents signposting to supporting evidence
- Living document, updated to reflect changes and used as an ongoing operational and training tool
- Should be set within a risk management framework with a safety policy and safety management system
- Reasonable steps when compiling a safety case:
  - Identifying the hazards
  - Evaluating the risks
  - Putting measures in place
  - Working together

# Hazard vs. Risk Measures

LAUNCH UK

2018 — 2019 — 2020 — 2021 — 2022

## Hazard Measures

- Conditional expected casualty, $CE_C$ (FAA proposed regulations)

## Risk Measures

- Individual risk (hypothetical person) of fatality per annum, IR
- Individual risk, probability of casualty per mission, $P_C$
- Individual risk, probability of a hypothetical fatality per mission, $P_C$
- Expected casualties per mission, $E_C$

# US Metrics

2018 — 2019 — 2020 — 2021 — 2022

- 417.07 **Public risk criteria –** "the casualty expectation must not exceed $1 \times 10^{-6}$ per launch from each hazard"
- 417.07 **Public risk criteria** – "the risk to any individual member of the public does not exceed a casualty expectation of 1 × 10–6 per launch for each hazard"
- 417.23 **Debris Hazard Areas** – defined by "individual casualty contour that defines where the risk to an individual would exceed an expected casualty ($E_C$) criteria of 1 × 10 –6 if one (hypothetical) person were assumed to be in the open"…

# US Metrics

2018 — 2019 — 2020 — 2021 — 2022

- 417.07 **Public risk criteria –** "the casualty expectation must not exceed $1 \times 10^{-6}$ per launch from each hazard"

$$E_{C_{ijk}} = probability_{failure} * probability_{impact} * no._{fragments} \sum_{l=1}^{l=N_{pops}} probability_{casualty} * no._{people}$$

Probability of debris generating event $k$

Probability of impact for debris class $i$ and population centre $j$

Probability of casualty for fragment class $i$, population centre $j$

# US Metrics

2018 — 2019 — 2020 — 2021 — 2022

- 417.07 **Public risk criteria** – "the risk to any individual member of the public does not exceed a casualty expectation of 1 × 10−6 per launch for each hazard"

$$E_{C_{ijk}} = {p_k}^{failure} {p_{ij}}^{impact} N_{F_i} \sum_{l=1}^{l=N_{pops}} {p_{ijl}}^{casualty} N_{P_{jl}}$$

Mission $E_C$ for the population centre $j$

$$P_{C_j} \sim \frac{E_{C_{Pop\ j\ (Total)}}}{no._{Pop_j}}$$

Number of people in the population centre $j$

# US Metrics

2018 — 2019 — 2020 — 2021 — 2022

- 417.23 **Debris Hazard Areas** – defined by "individual casualty contour that defines where the risk to an individual would exceed an expected casualty ($E_C$) criteria of $1 \times 10^{-6}$ if one (hypothetical) person were assumed to be in the open"…

- Measured per mission
- Similar to the typical measure of risk used in the UK…

# IR to a Hypothetical Person

2018 — 2019 — 2020 — 2021 — 2022

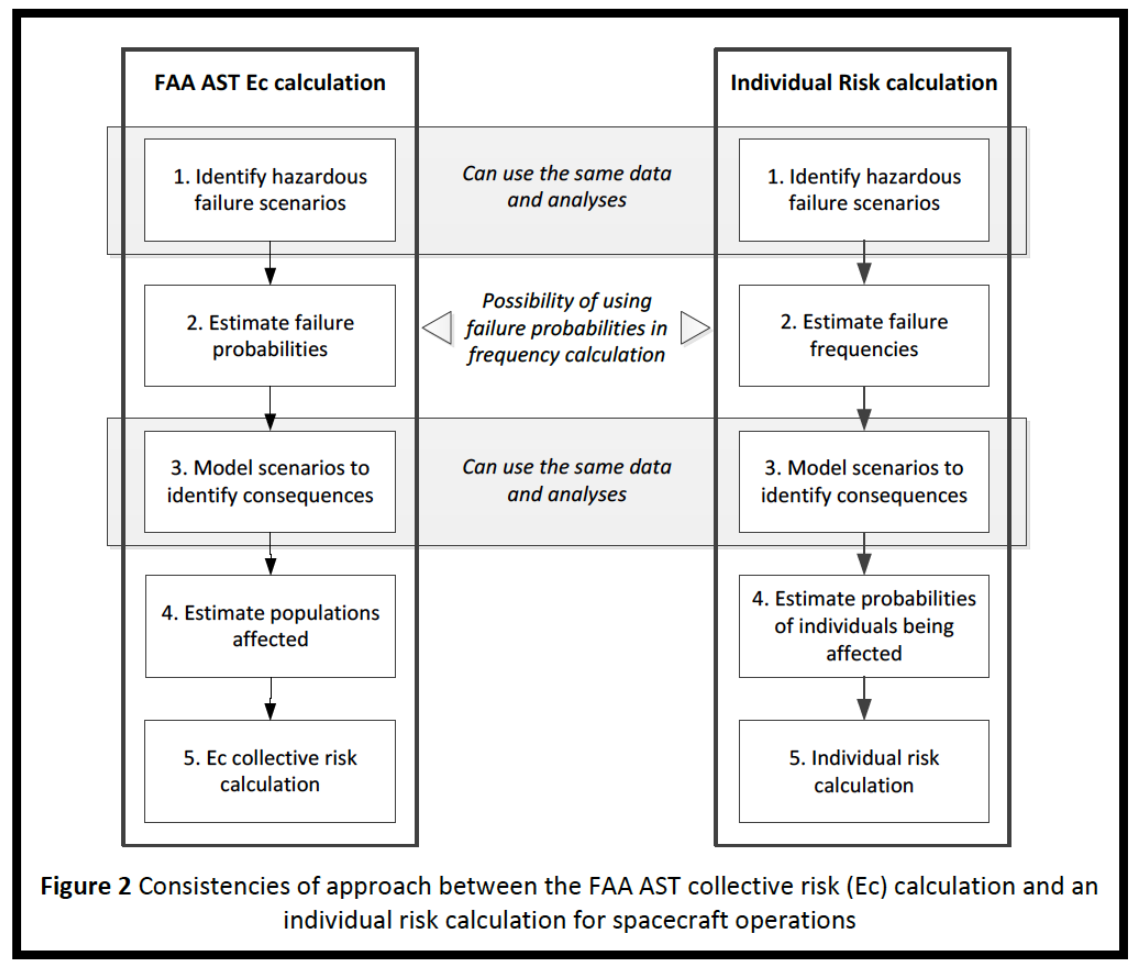



**Figure 2** Consistencies of approach between the FAA AST collective risk (Ec) calculation and an individual risk calculation for spacecraft operations

- **Definition:** *"Individual risk is a measure of risk over time to a hypothetical individual at a given location from exposure to a hazard."*
- Typically measured per annum rather than per event in the UK (O&G, nuclear, chemical etc)
- Uses largely the same process as an expected casualty calculation

# Launch as a Discrete Event


- Launch is a transient activity, it occurs over a short time period and the exposure of people is very small
- A person close to a launch site is at risk not just for one mission, but (potentially) for all missions & activities

# Launch as a Discrete Event

2018 — 2019 — 2020 — 2021 — 2022

- Launch is a transient activity, it occurs over a short time period and the exposure of people is very small
- A person close to a launch site is at risk not just for one mission, but (potentially) for all missions & activities

$$IR\ per\ annum \sim \sum_{scenario=1}^{N} Failure\ Rate\ per\ year * Probability_{fatality|scenario}(hazard\ scenario, population, sheltering) * \frac{t}{T_{year}}$$

Probability of Failure ← historical failure rates, FTA, FMECA etc

$$where\ N = number\ of\ Major\ Accident\ Scenarios$$

# Launch as a Discrete Event

2018 — 2019 — 2020 — 2021 — 2022

- Launch is a transient activity, it occurs over a short time period and the exposure of people is very small
- A person close to a launch site is at risk not just for one mission, but (potentially) for all missions & activities

$$IR\ per\ annum \sim \sum_{scenario=1}^{N} Failure\ Rate\ per\ year * Probability_{fatality|scenario}(hazard\ scenario, population, sheltering) * \frac{t}{T_{year}}$$

Probability of Failure ← historical failure rates, FTA, FMECA etc

$where\ N = number\ of\ Major\ Accident\ Scenarios$

Casualty expectation ← Flight Safety Analysis

# Launch as a Discrete Event


- Launch is a transient activity, it occurs over a short time period and the exposure of people is very small
- A person close to a launch site is at risk not just for one mission, but (potentially) for all missions & activities

$$IR\ per\ annum \sim \sum_{scenario=1}^{N} Failure\ Rate\ per\ year * Probability_{fatality|scenario}(hazard\ scenario, population, sheltering) * \frac{t}{T_{year}}$$

Probability of Failure ← historical failure rates, FTA, FMECA etc

$where\ N = number\ of\ Major\ Accident\ Scenarios$

Casualty expectation ← Flight Safety Analysis

Exposure

# Launch as a Discrete Event

2018 — 2019 — 2020 — 2021 — 2022

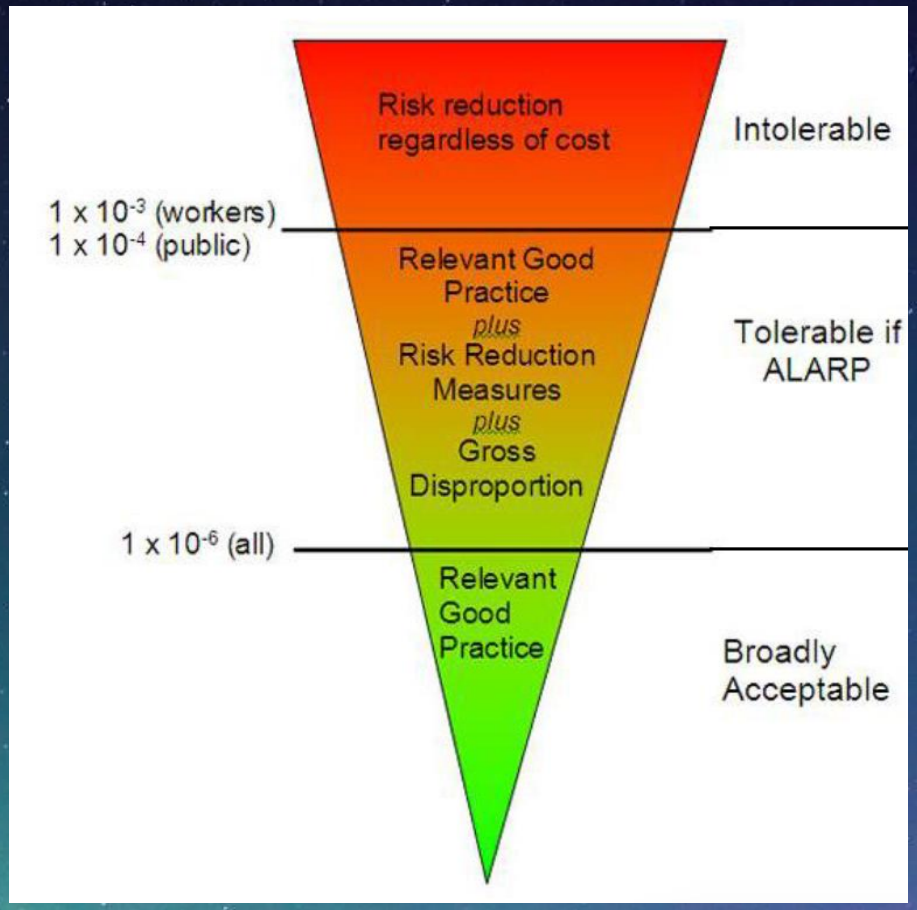
- Exposure
  - $t \leq 60s$
  - $T \approx 86400 * 365.25 \approx 31.5 \times 10^6$
  - $t/T \approx 2 \times 10^{-6}$

$$IR\ per\ annum \sim \sum_{scenario=1}^{N} Failure\ Rate\ per\ year * Probability_{fatality|scenario}(hazard\ scenario, population, sheltering) * \frac{t}{T_{year}}$$

# Launch as a Discrete Event

2018 — 2019 — 2020 — 2021 — 2022

- Exposure
  - $t \leq 60s$
  - $T \approx 86400 * 365.25 \approx 31.5 \times 10^6$
  - $t/T \approx 2 \times 10^{-6}$



# Launch as a Discrete Event

2018 — 2019 — 2020 — 2021 — 2022

- Won’t only be considering IR per annum
- At spaceports, there are longer term hazards and greater exposure -> IR per annum makes sense
- What are the alternatives?
  - IR per mission (like the US)?
  - Societal risk?

# Societal Concerns

2018 — 2019 — 2020 — 2021 — 2022

*"Societal risks must be determined when there is the potential for harm to large numbers of people. These risks may not be negligible due to the large numbers of people who may be exposed, even when each individual has minimal exposure."*

- Pitfalls in risk assessment: examples from the UK

- Accounted for by other launching states with $E_C$
- In the UK, generally addressed with other mechanisms, like Land-Use Planning or using hazard areas/distances
  - Retrospective
  - National

# Societal Concerns

2018 — 2019 — 2020 — 2021 — 2022

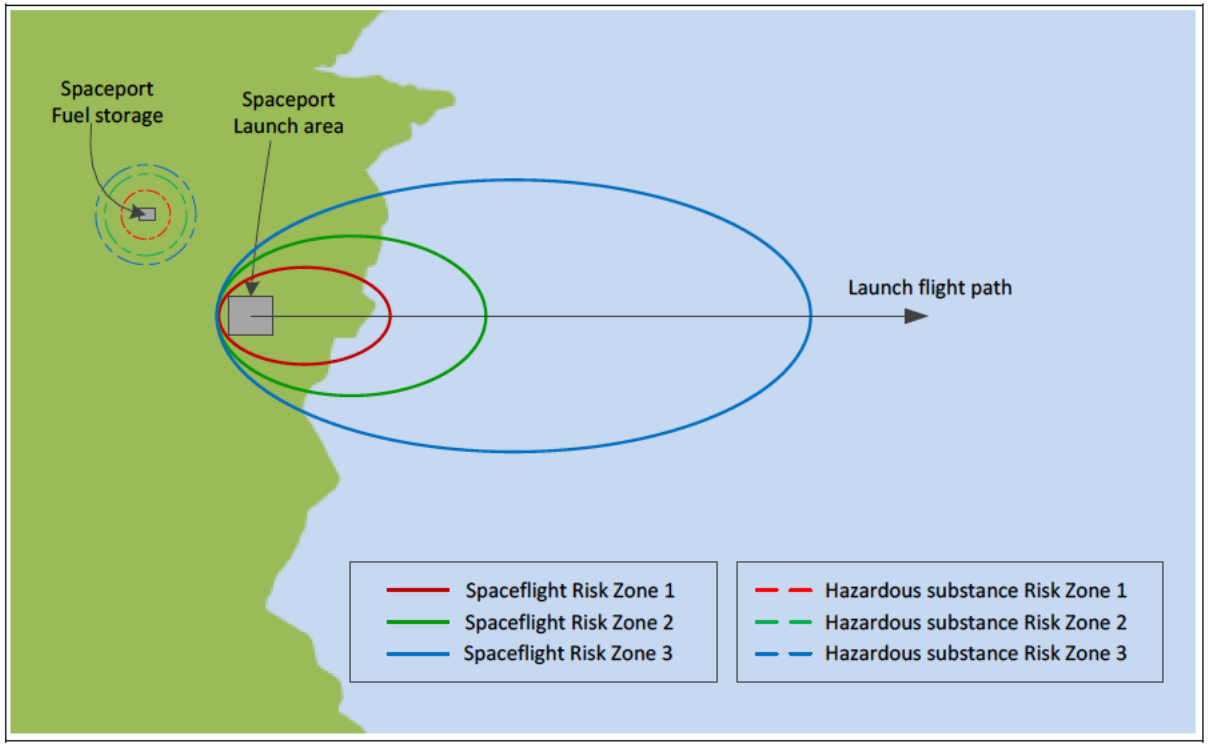



**Figure 5** Spaceport risk zones concept

***For illustrative purposes only; calculated risk zones for a launch and for a fuel depot might look completely different in shape and size.***

# Societal Concerns

2018 — 2019 — 2020 — 2021 — 2022

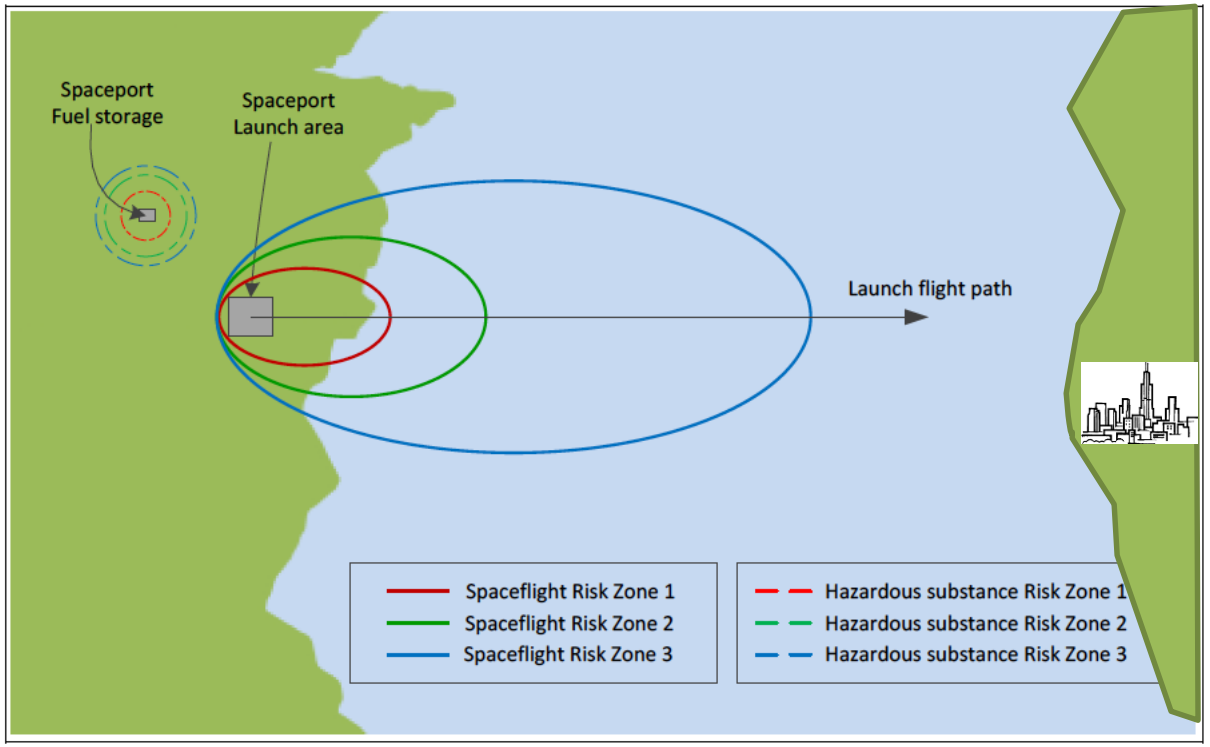



**Figure 5** Spaceport risk zones concept

***For illustrative purposes only; calculated risk zones for a launch and for a fuel depot might look completely different in shape and size.***

# Marine and Air Traffic

LAUNCH UK

2018 — 2019 — 2020 — 2021 — 2022

- FAA:
  - Probability of impact, $p_I$ - used for marine and air traffic under 417 to define hazard areas (should not exceed $1 \times 10^{-5}$)
  - Under proposed regulations, for marine, a risk calculation where the $P_c$ for a hypothetical person should not exceed $1 \times 10^{-6}$
- How to define a hazard area that reduces the risk, but is feasible to implement (and where necessary, monitor)?

# Next steps


- Account for feedback from risk plenary
- Consultation
  - Secondary Legislation
  - Guidance
- Assessment criteria
- Anything else?

# Feedback?

- What do you think?
- Do you understand the difference between individual and societal risk?
- Do you understand the difference between per annum and per mission?
- How does what we've presented align with your expectations?
- What was most useful/interesting?
- What did you least understand?
- What is your biggest concern?


## Closing remarks

**Irina Mineva|** UK Space Agency

# Thank You

https://www.gov.uk/guidance/how-we-are-promoting-and-regulating-spaceflight-from-the-uk