Department for Transport

UK Civil Aviation Authority

Virgin Orbit UK Mission

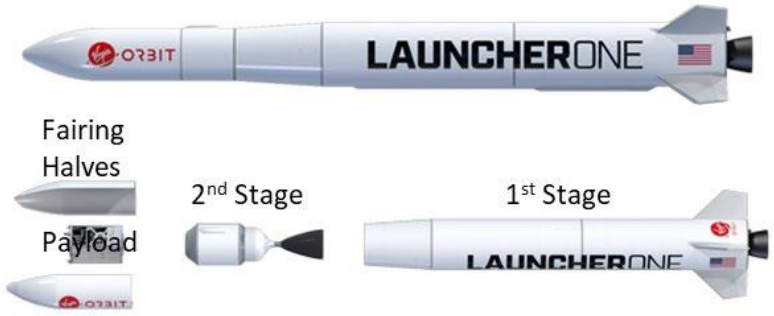
from

Spaceport Cornwall

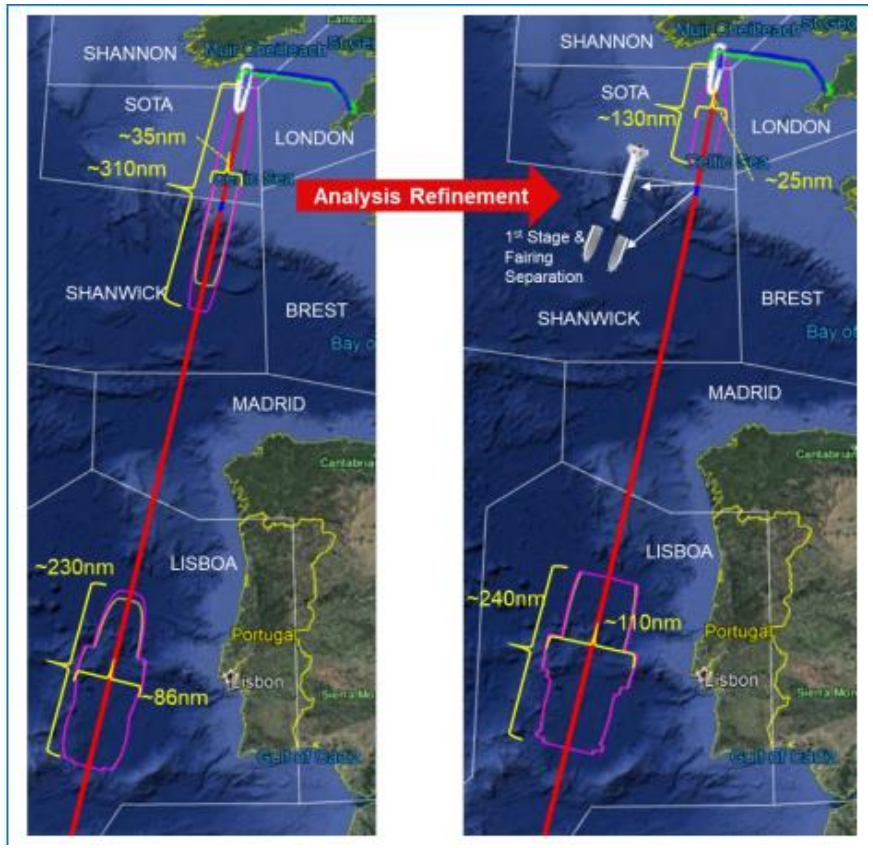
- Paul Cremin (DfT) & Colin Scott (CAA)

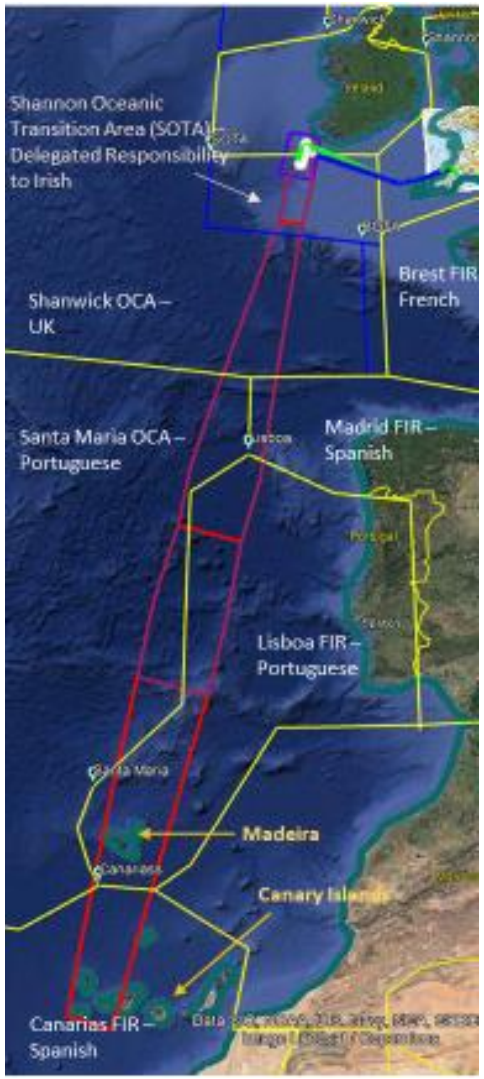
- May 2024

- Virgin Orbit used LauncherOne (L1) to provide Low Earth Orbit (LEO) deployment service for small satellites.
- L1 had a total payload capacity of 300 kilograms (kg) for Sun Synchronist Orbit and 500 kg for equatorial orbit.
- L1 is a two-stage rocket with a clamshell fairing.
- The first stage and fairing separated prior to orbit and fall back to Earth.
- Virgin Orbit used an air-launched rocket system consisting of L1 and Cosmic Girl, a 747-400 equipped to carry and deploy L1 using a custom pylon mounted to the 747's existing non-functioning fifth engine underwing mount.



Timeline and Airspace Evolution





Assessment Mtg July 2021
- Target launch date – Jun 2022

V1 of ACP submission Jan 2022
- No target launch date

V2 of ACP submission Mar 2022
- Target launch date 15 Jul to 15 Sep 2022

V3 of ACP submission May 2022
- Target launch date 15 Aug to 13 Nov 2022

V4 of ACP submission Sep 2022
- Target launch date 29 Oct 2022 to 6 Jan 2023

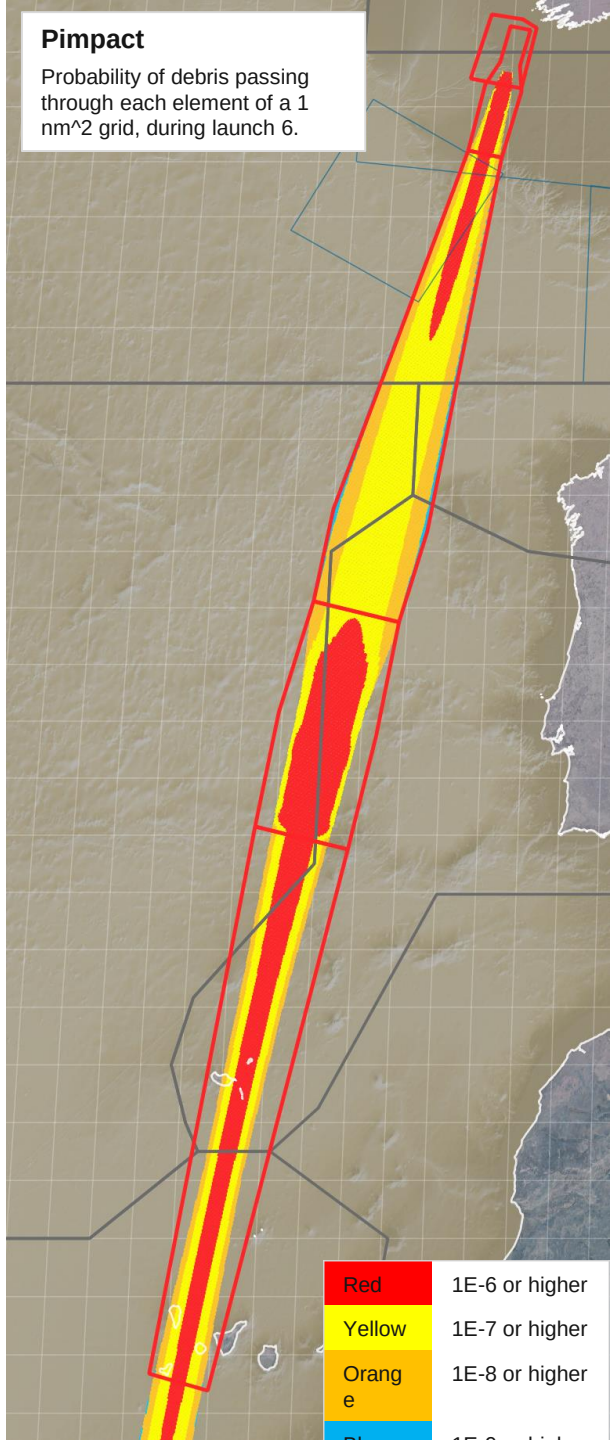
VO Launch: Air Risk Computation

US CFR 417 (re Pcasualties red regions):

(4) A launch operator must establish any aircraft hazard areas necessary to ensure the probability of impact (P_i) with debris capable of causing a casualty for aircraft does not exceed 1×10^{-6}.

FAA ICAO SASP Acceptable Level of Risk (ALR) draft guidelines (re Pcasualties yellow regions):

"3.3.2 The upper limit of the individual risk of ALR is 1E-7 probability of fatality per flight during a launch operation. This means that an acceptable airspace must ensure that no aircraft is exposed to a fatality probability of greater than 1E-7 from a hazard associated with a commercial space launch."



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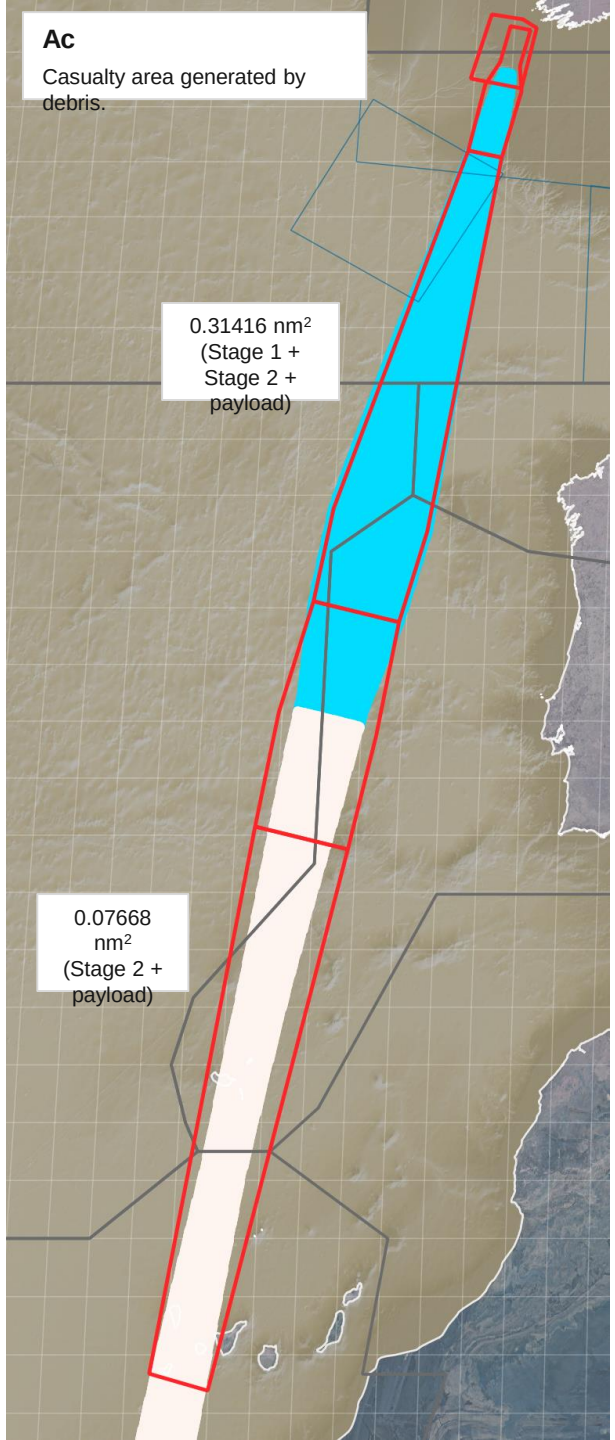

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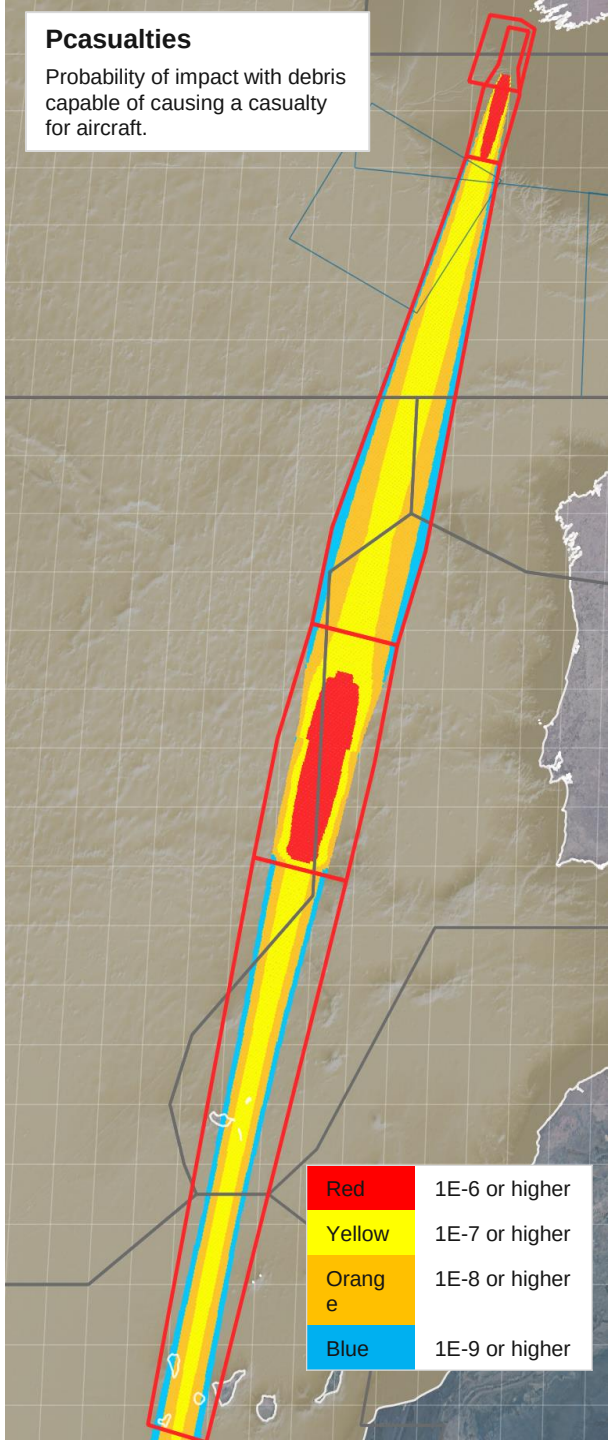


Stakeholders

Sponsors

- Virgin Orbit
- Spaceport Cornwall
- Newquay Airport

International Stakeholders

- Ireland
- Spain
  - 12 Agencies
- Portugal
  - 16 Agencies
- France
- ICAO – NAT SPG
- Eurocontrol

Other Stakeholders

- NATS
  - Prestwick
  - AMC
  - NOTAM Office
- NATMAC
- Airline Operators

UK Government

- BEIS
- DfT
- MoD
  - 78 Sqn (Swanwick)
  - MoD Boscombe Down
  - DAATM
- UKSA
- HMCG

FAA

- Commercial Space Transportation
- Air Traffic Organisation

CAA

- Space Team
  - Licencing and Oversight
  - Mission Safety Analysts
  - Policy
- ATM
- AR
  - Technical
  - Engagement
  - Environment
  - Utilisation
- OGC

COORDINATION – ATM Alignment Mtgs

FAA ALR CONCEPT

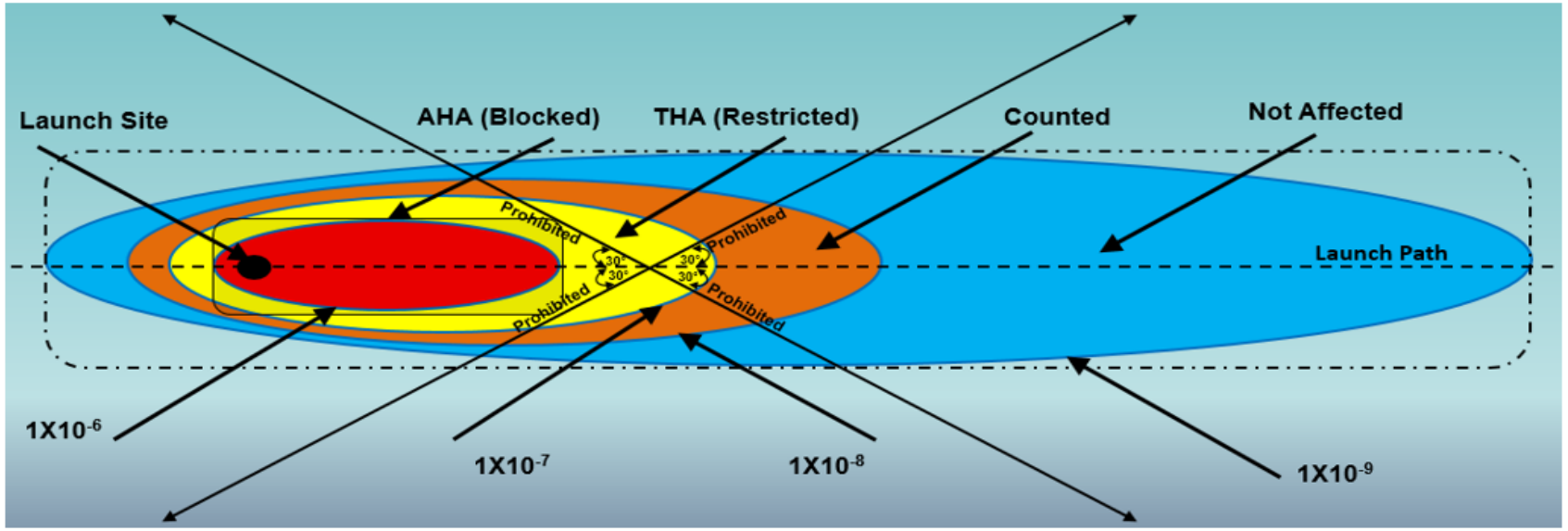
ALR Conditions, Limits, and Restrictions

Individual Risk Limit

- Consequence: Fatality
- Limit: 1E-7 per flight

Collective Risk Limit

- 95 % probability no additional fatal accident in 80 years
- 1 fatal accident every 1,600 years
- 6,412 total flights per year in 1E-8 contour
- 128 launches per year



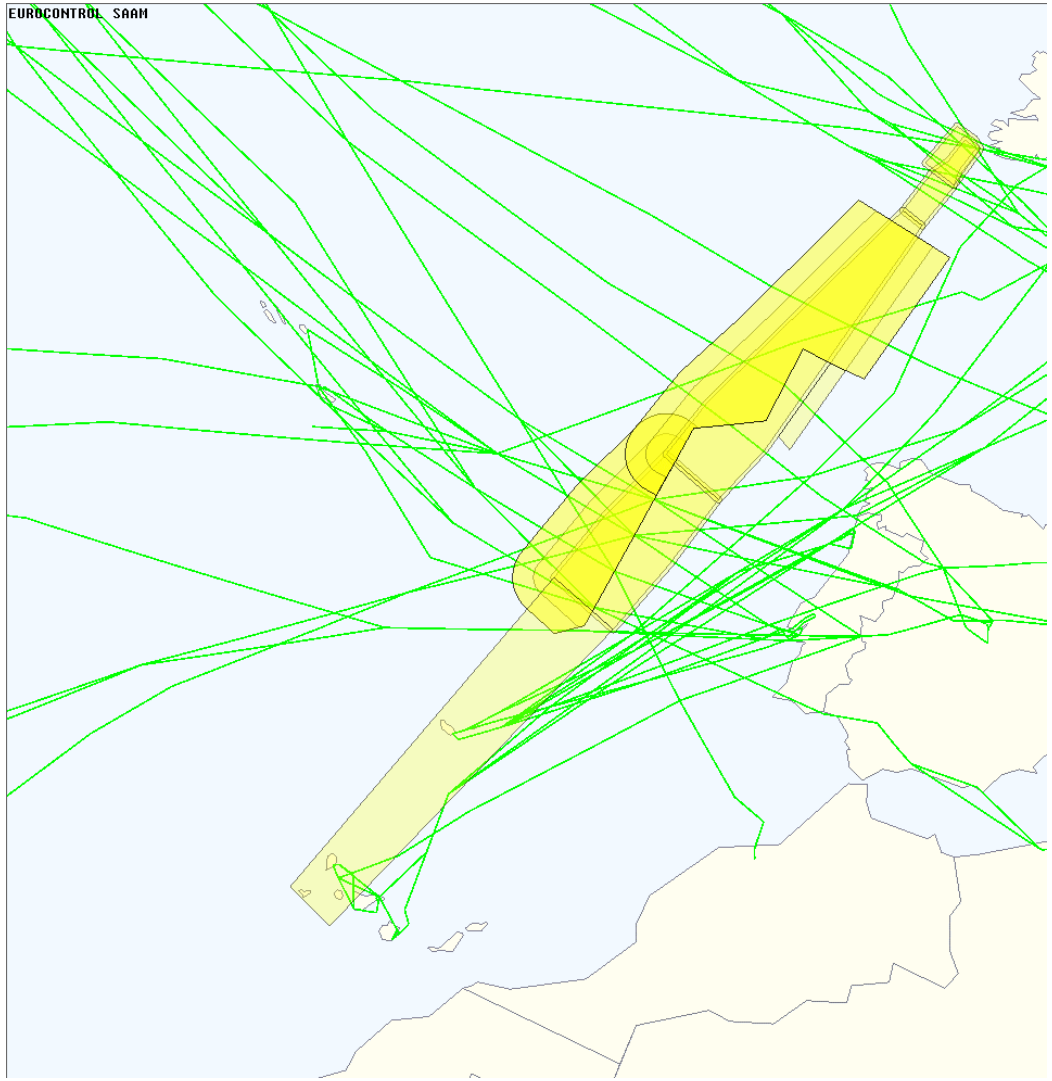
ALR Operational Requirements in 1E-7 Contour

- At least 30 degrees between the flight and launch vehicle path
- No parallel routes, loitering, holding
- No ATC service to airports

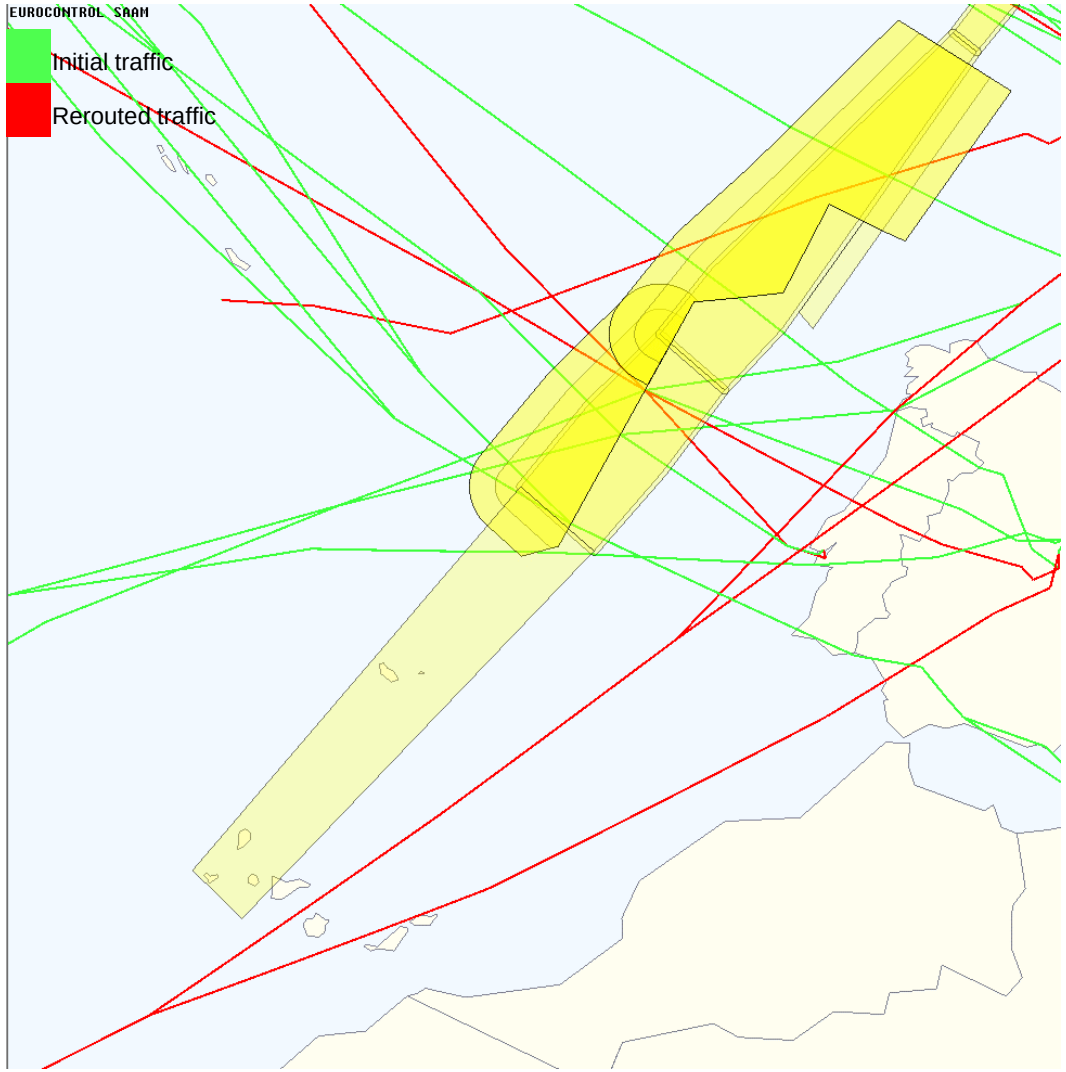
Traffic Impacted

- Traffic forecast for 09 Jan 2023

Day/Date		Traffic crossing TDAs EUVIRGIN (20:00-01:30 UTC)
Monday	09/01/2023	60



Rerouting between 20:00 and 01:30



- Initial traffic crossing EUVIRGIN ► 60
- Rerouted traffic to avoid EUVIRGIN ►23
- No rerouting solution found ► 37

List of rerouted flights

ADEP	ADES	Aircraft	Callsign	EOBD	EOBT
LFPG	KMEM	MD11	FDX5277	09-01-2023	19:51:00
LIMC	KMEM	B77L	FDX7	09-01-2023	19:15:00
LPAZ	EGTK	CL60	VLZ381A	09-01-2023	17:46:00
KGSP	EDFH	B744	GTI4711	09-01-2023	17:30:00
KEWR	WSSS	A359	SIA21	09-01-2023	15:10:00
KFLL	EGGW	GLEX	VXS4	09-01-2023	14:10:00
KCVG	EDDK	B763	ABX957	09-01-2023	19:00:00
MHLM	LEMD	B788	AEA016	09-01-2023	18:05:00
LFPG	KJFK	B773	AFR008	09-01-2023	18:45:00
LPPT	KEWR	A21N	TAP203	09-01-2023	19:05:00
EGLL	SBGR	A359	BAW247	09-01-2023	21:25:00
KJFK	OTHH	B772	QTR33Y	09-01-2023	15:15:00
KIAD	OMDB	A388	UAE232	09-01-2023	15:45:00
LFPG	MMMX	B77L	AFR6720	09-01-2023	19:20:00
KJFK	LTFM	A333	MNB601	09-01-2023	15:35:00
KDFW	OMDB	B772	UAE1CA	09-01-2023	17:45:00
LFPG	MMMX	B789	AMX004	09-01-2023	22:15:00
EGLL	SKBO	B788	AVA121	09-01-2023	21:55:00
LEMD	SCEL	B789	LAN705	09-01-2023	22:50:00
MMUN	LTFM	B789	THY189	09-01-2023	15:05:00
KMIA	LTFM	B789	THY13T	09-01-2023	16:15:00
LFPG	SCEL	A359	AFR406	09-01-2023	22:35:00
KJFK	OEJN	B773	SVA020	09-01-2023	19:15:00

Traffic with no rerouting solution found (37 Flights)

GCLA (La Palma); **GCTS** (Tenerife South); **GCLP** (Gran Canaria); **GCXO** (Tenerife North)

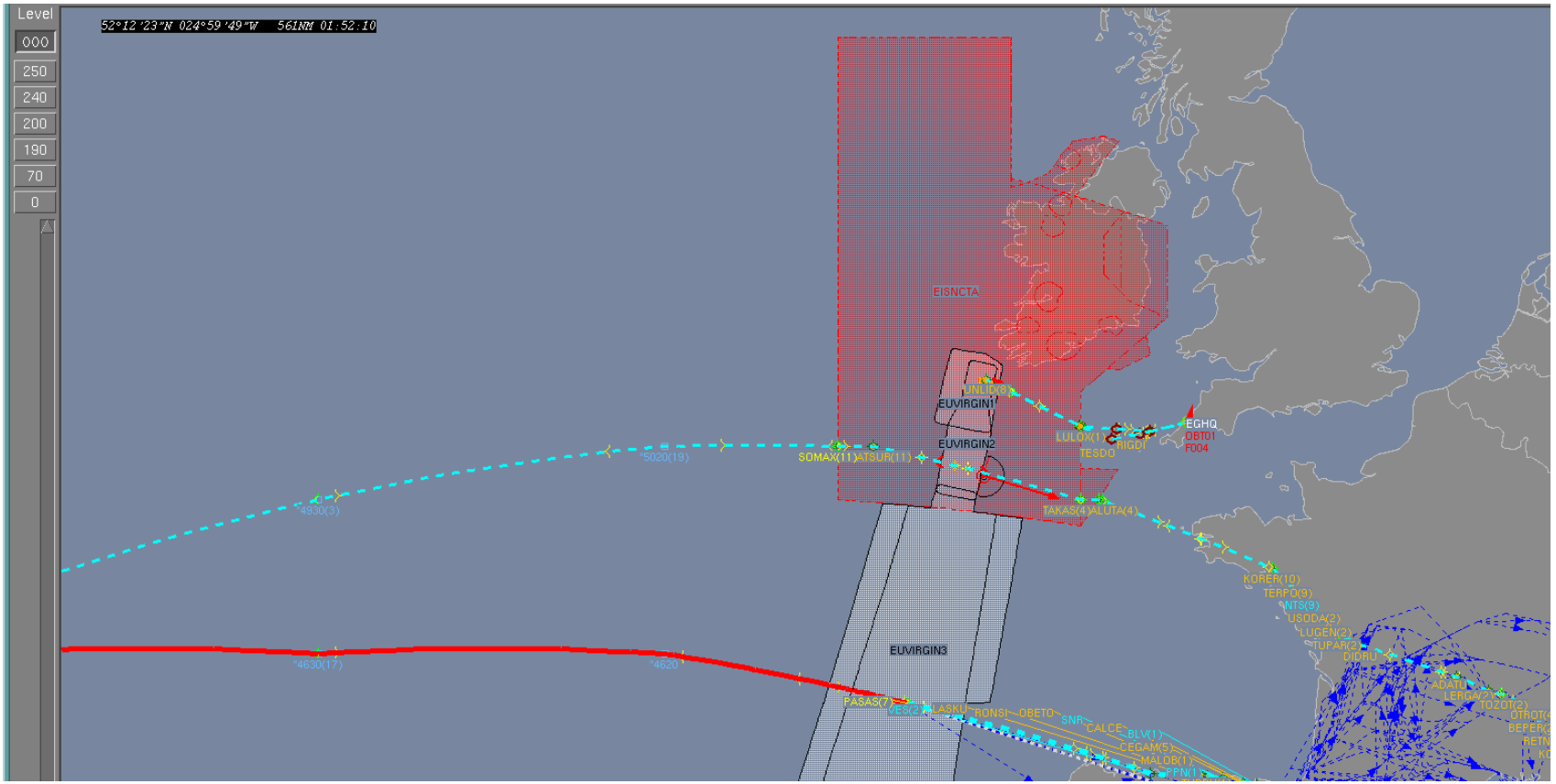
- 2 departure and 1 arrival to GCTS → to be rescheduled.
  - GCTS operational hours H24.

- Local flights (GCLA, GCTS, GCLP, GCXO) → to be rescheduled (operational hours constrain!)

  - GCLA operational hours 08:00-21:30
  - GCXO (arrivals) operational hours 07:00-23:00
  - GCXO (departures) operational hours 06:45-23:00
  - GCLP operational hours H24.

ADEP	ADES	Aircraft	Callsign	EOBD	EOBT	Arrival Date	ETA
LPPD	LPPT	A20N	TAP186Z	09-01-2023	20:40:00	09-01-2023	22:35:28
LPMA	LPPR	A320	EJU52UB	09-01-2023	20:30:00	09-01-2023	22:06:51
LPPD	LPPT	A21N	RZO128	09-01-2023	21:25:00	09-01-2023	23:22:55
LPMA	LPPT	A21N	RZO6468	09-01-2023	20:40:00	09-01-2023	21:59:05
CYUL	GMMN	B788	RAM207	09-01-2023	16:50:00	09-01-2023	23:21:25
LPPT	LPPD	B738	RYR7768	09-01-2023	20:25:00	09-01-2023	22:21:08
GCLA	GCXO	AT72	RSC6WU	09-01-2023	20:15:00	09-01-2023	20:39:12
LPPT	LPLA	A21N	TAP1823	09-01-2023	21:55:00	09-01-2023	23:58:00
LPPT	LPPD	A20N	TAP1865	09-01-2023	22:35:00	10-01-2023	00:30:33
LPPT	LPMA	A20N	TAP1687	09-01-2023	21:25:00	09-01-2023	22:43:49
LPPT	LPMA	A20N	TAP169W	09-01-2023	18:55:00	09-01-2023	20:13:49
GCLA	GCLP	AT72	RSC2ZY	09-01-2023	21:30:00	09-01-2023	22:10:41
GCXO	GCLA	AT72	RSC9EV	09-01-2023	20:25:00	09-01-2023	20:47:17
LPPR	LPMA	A320	TAP1715	09-01-2023	19:35:00	09-01-2023	21:09:33
EDDN	LPMA	B738	RYR74MN	09-01-2023	19:10:00	09-01-2023	22:55:16
GCLP	GCLA	AT72	RSC987K	09-01-2023	20:10:00	09-01-2023	20:48:43
LPMA	LPPR	A320	TAP1712	09-01-2023	22:15:00	09-01-2023	23:51:51
LEMD	MMMX	A359	IBE6409	09-01-2023	23:10:00	10-01-2023	09:31:37
LPMA	LPPT	A320	EJU69EG	09-01-2023	21:25:00	09-01-2023	22:45:03
LEMD	SPJC	B789	AEA175	09-01-2023	23:10:00	10-01-2023	10:01:42
LPMA	LPPT	A20N	TAP168G	09-01-2023	21:30:00	09-01-2023	22:49:38
LPMA	EGCC	A320	EZY28HF	09-01-2023	19:40:00	09-01-2023	23:02:10
LPLA	LPPT	A320	RZO134	09-01-2023	20:10:00	09-01-2023	22:13:29
GCLA	GCTS	AT72	RSC766	09-01-2023	20:15:00	09-01-2023	20:39:37
LPMA	LPPT	B738	RYR705Y	09-01-2023	20:15:00	09-01-2023	21:35:13
LPPR	LPMA	B738	RYR3BP	09-01-2023	19:20:00	09-01-2023	20:53:49
GCLA	GCXO	AT72	CNF468S	09-01-2023	20:30:00	09-01-2023	20:54:12
LPPT	LPMA	A320	EJU7605	09-01-2023	19:10:00	09-01-2023	20:29:19
EGKK	LPMA	A21N	WUK3585	09-01-2023	17:35:00	09-01-2023	20:42:41
KMIA	LLBG	B789	ELY018	09-01-2023	17:15:00	10-01-2023	05:19:33
LPMA	EGKK	A21N	WUK131J	09-01-2023	22:20:00	10-01-2023	01:28:33
LEMD	SPJC	B789	LPE2485	09-01-2023	23:55:00	10-01-2023	10:46:42
LEMD	SKBO	B788	AVA047	09-01-2023	23:40:00	10-01-2023	08:50:38
GCTS	EGGW	A321	WUK5930	09-01-2023	20:50:00	10-01-2023	00:41:16
GCTS	EIDW	B738	RYR3TH	09-01-2023	19:50:00	09-01-2023	23:47:09
GCLP	EFHK	A321	FIN18T	09-01-2023	23:05:00	10-01-2023	04:57:16
LEMD	GCTS	A21N	IBS3926	09-01-2023	21:10:00	09-01-2023	23:38:03

ETH 575 KORD - HAAB



- The CAA licences launch activities under the Space Industry Act (2018) **[SIA]** and the Space Industry Regulations (2021) **[SIR]**.
- The entire launch in licenced under the Space Industry Acy [**not aviation law**] – the carrier aircraft for the outward leg is treated as the first stage of the launch. After separation the Boeing 747 will revert to operations under aviation law.
- This legislation sets out seven tests that are required to be met by the applicant. Section 9 of the SIA and Part 4 of the SIR are the relevant parts for flight safety.
- A licence cannot be granted unless the CAA is satisfied that no further reasonable steps can be taken to reduce the risks to as low as reasonably practicable (ALARP) for the operations the applicant is proposing to undertake, and the remaining level of risk is acceptable.
- To make this determination, the applicant is required to submit a safety case report showing how they will manage the risks they create, including a demonstration of why further reasonable steps to reduce the risks cannot be taken.
- **Safety assessment process**
- The CAA's safety assessment is a combination of desktop review of the safety case provided by Virgin Orbit, inspections and audits, and independent analysis.
- The initial phase of the assessment reviews the safety case as a whole, establishing whether sufficient information is present to continue and identifying areas for further in-depth review.
- This is followed by a detailed review that scrutinises the safety arguments presented, focusing on Major Accident Hazards (MAHs), safety-critical systems, and the barriers and risk controls defined by the applicant.

- **Seven Tests**
  - National Security (performed by the UK Space Agency)
  - International Obligations
  - National Interest (performed by the DfT)
  - Fit & Proper
  - Financial Resources
  - Safety
  - Environment

- **Statutory Consultation and Licence Conditions**

Statutory consultees	SIA Launch / return	SIA Spaceport	SIA Range	SIA Orbital
BEIS SoS	×	×	×	✓
DfT SoS	✓	✓	✓	×
Health and Safety Executive	×	✓	×	×
Office of Nuclear Regulation	✓	✓	✓	✓
Defence Safety Authority	✓	✓	✓	✓
Appropriate persons regarding trade controls or national security	As applicable	As applicable	As applicable	As applicable

- The licence will not contain any conditions that are already set out in the SIR or whose purpose has already been covered by post-grant-of-a-licence regulations
- Conditions should be tailored to the licensed activity as required - as a result of the assessment of the applicant's licence application, from feedback from the mandatory consultees; or where there are no appropriate post-grant-of-a-licence regulations
- An explanation of the licence conditions, as required under SIR S.21(c), will be sent in a formal letter along with the licence.
- Changes to conditions on an existing licence will be kept to a minimum where there is an alternative means e.g. through the SIR Part 14 Monitoring and Oversight regime

- For this launch, the UK was the joint-launching state with the United States and under the UN Liability Convention these nations would be liable in the event of a claim.

- Both the UK and US have insurance requirements for launch operators, which will in the case of this launch be equal to $250M.