



SAXAVORD

UK SPACE PORT

ACP-2017-79

Permanent ACP Safety

Assessment

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1. Executive Summary

This safety assessment and argument has concluded that provided all Safety requirements defined in Appendix B are implemented and managed by the SaxaVord Range Safety Manager within the SMS, that:

- All Hazards have been mitigated to ALARP
- The impacts to airspace users in terms of required rerouting are extremely limited given the airspace analysis and planned duration of launches to be covered by the DA application
- The design is modular and meets the representative launch profile concepts of both orbital and sub-orbital profiles

2. Introduction

This document provides the safety assessment of the permanent airspace reservation design submitted under Airspace Change Proposal (ACP) (ACP-2017-79) through the UK Civil Aviation Authority's (CAA's) ACP portal.

Shetland Space Centre Limited (trading as and hereinafter referred to as "SaxaVord Spaceport" (SaxaVord)) seeks to conduct vertical launch operations for orbital and sub-orbital activities from SaxaVord Spaceport on Lamba Ness, Unst.

A suitable permanent airspace reservation of defined dimensions is required to ensure the safety of other airspace users from SaxaVord launch activities, and to ensure the safety of SaxaVord launch activities from other airspace users. The airspace reservation would be activated for specified periods before, during and after nominated launch activities and would extend from surface to unlimited.

This safety assessment provides the argument and evidence that the design will meet appropriate ALARP standards.

2.1 Site Description.

SaxaVord Spaceport will provide a vertical launch spaceport, including all launch site licenses, launch pads, and support services for both commercial and government launchers.

The launch site is in Unst, Shetland, Scotland, on the eastern part of the Lamba Ness peninsula. This unpopulated location provides outstanding access to appropriate orbits while minimizing any possible exposure to people. Figure 1 below shows the basic site layout at the time of writing this document.

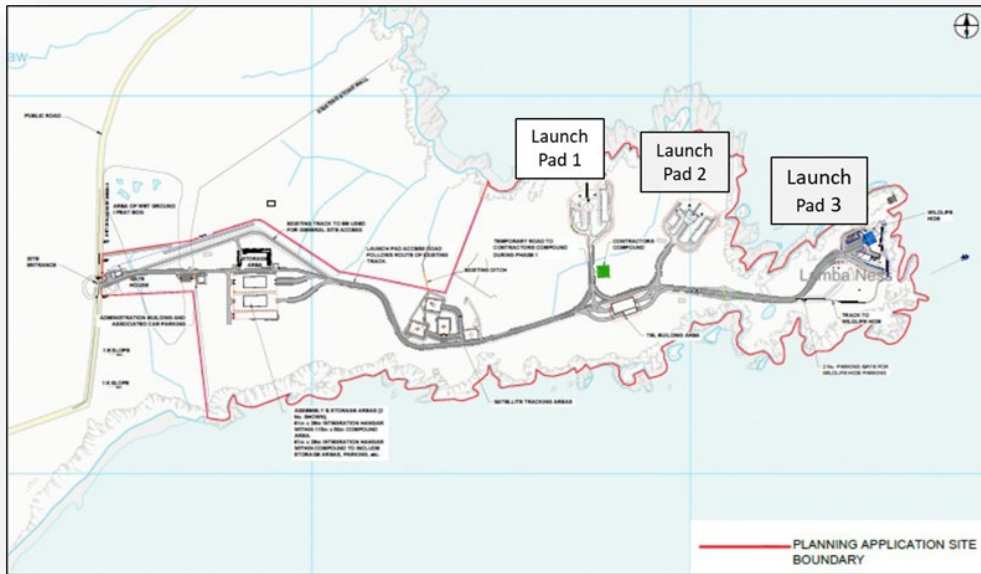


Figure 1 The SaxaVord Space Port Site Layout¹

There are three planned launch pads: Launch Pad 1, Launch Pad 2, and Launch Pad 3. The table below lists the latitude and longitude of each launch pad. The data references coordinates that are based on WGS 84. WGS (World Geodetic System) 84, a well- recognized reference system and geodetic datum for locating items. This is the reference system for Global Positioning Systems (GPS) that are in common use.

Launch Point Locations (WGS 84)				
Launch Pad Designation	Latitude Decimal	Latitude DDDMMSS.ssss	Longitude Decimal	Longitude DDDMMSS.ssss
Launch Pad 1 Launch point	60.818781°	0604907.6116 N	-0.775071°	0004630.2556 W
Launch Pad 2 Launch point	60.818416°	0604906.2976 N	-0.770009°	0004612.0324 W
Launch Pad 3 Launch point	60.817777°	0604903.9972 N	-0.761313°	0004540.7268 W

In this safety assessment all three launch pads are included as capable of launching the maximum-sized vertical launch vehicle that is licensed for launch at SaxaVord. Most launches will be smaller than the maximum-sized vehicle (see Section 4). The safety assessment also considers both orbital and sub-orbital launches.

2.2 Representative Launch Profiles Basis

The Spaceport and its launch pads are designed to launch a wide range of vehicles. While all launches are vertical launches (as opposed to horizontal, aircraft-style launches), there are many different sizes and designs. This safety assessment uses an orbital and suborbital representative launch profile based on “representative launch vehicles” as an approved aspect of analysis based on

Section 36 (8) of the UK's *Space Industry Regulations 2021* and as defined in REF 1. This information leads to the following summary of the main characteristics of the representative launch profiles.

- Both Orbital and Sub-orbital LVs are provided for.
- Orbital launches cover the vertical launch period until such point that the Flight safety analysis considers the safety risk requirement to be met.
- Sub-orbital launches cover the launch and return to the surface.

Launch profiles used in this safety assessment are further detailed in Appendix A.

2.3 Risk Management and Hazard Identification Process

In line with the SaxaVord SMS (REF 2) the safety process complies with the Risk Management and Hazard Identification procedures as depicted below. REF 5 provides the outputs of the Hazard Identification and Risk mitigation strategies to achieve ALARP. Safety requirements established from this process are detailed in Appendix B

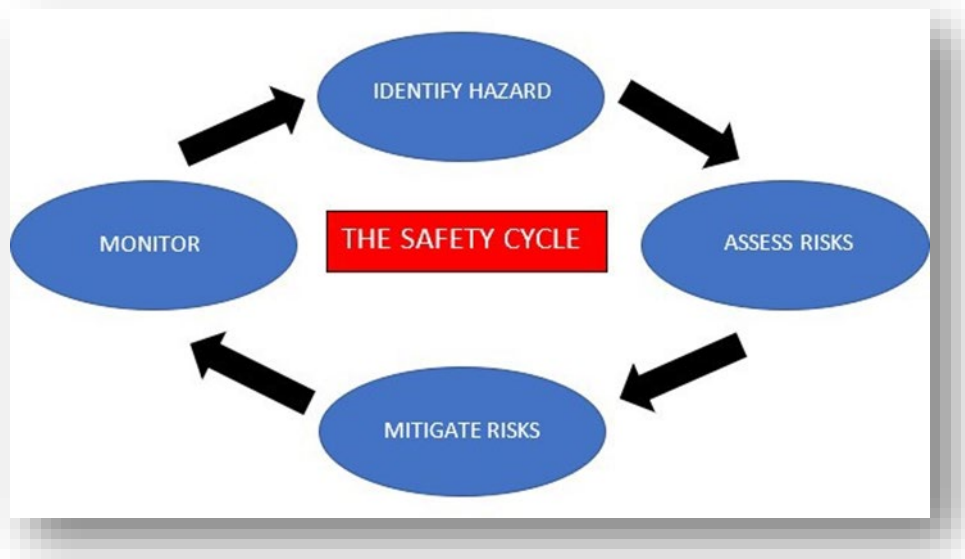


Figure 2 SaxaVord SMS Safety Lifecycle

The risk management process in this assessment includes both a quantified and qualified approach to meeting ALARP.

[Redacted text block]

[Redacted text block]

[REDACTED]

[REDACTED]

3. Safety Argument

The safety argument follows a typical GSN based methodology and is designed to also place the DA Safety assessment into context of the overall Saxa spaceport Operation. The structure for argument is based on the SIR (The illustration below highlights the overall argument 0 is to ensure that the operation achieves an integrated safe objective. However, the DA is only related to the Range operation (marked in Orange) with safety management systems applicable for the Spaceflight and Spaceport operators outside the scope of this document.

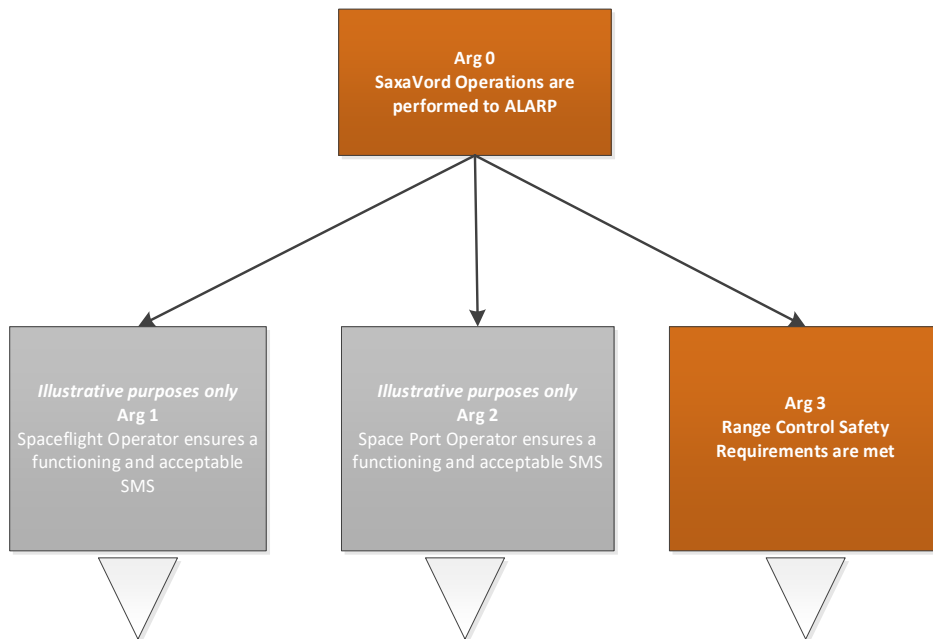


Figure 3 DA Safety in context of overall SaxaVord Operations

Breaking Argument 3 down further the DA scope is further identified as a specific part of SIR Part 6 Chapter 4 where the requirements define the need for the range and hazard area to be defined and implemented.

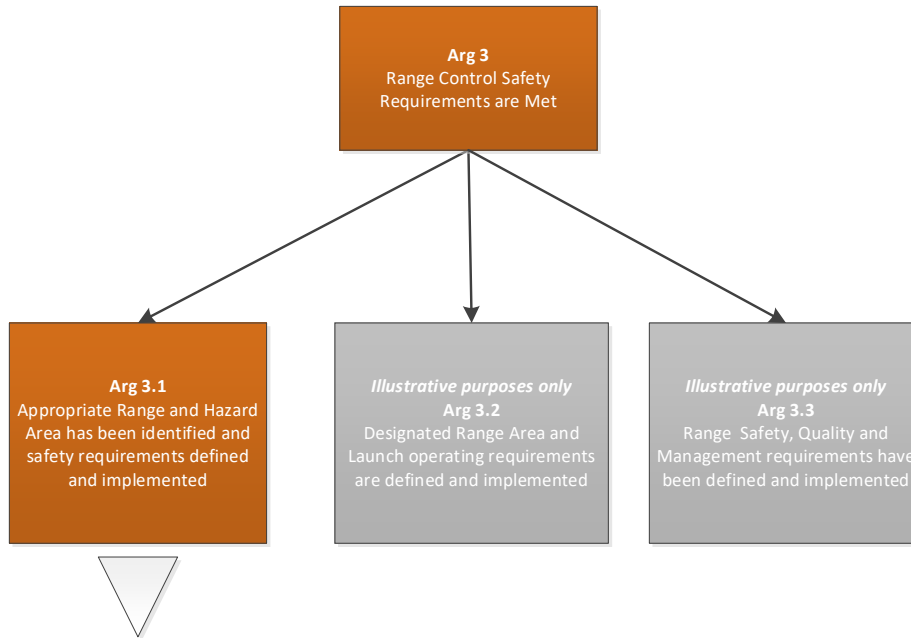


Figure 4 DA Safety in context of SaxaVord Range Control SMS

Under Argument 3.1 the Safety Assessment logical flow becomes considerably more detailed. Each section below is further explained in the following text.

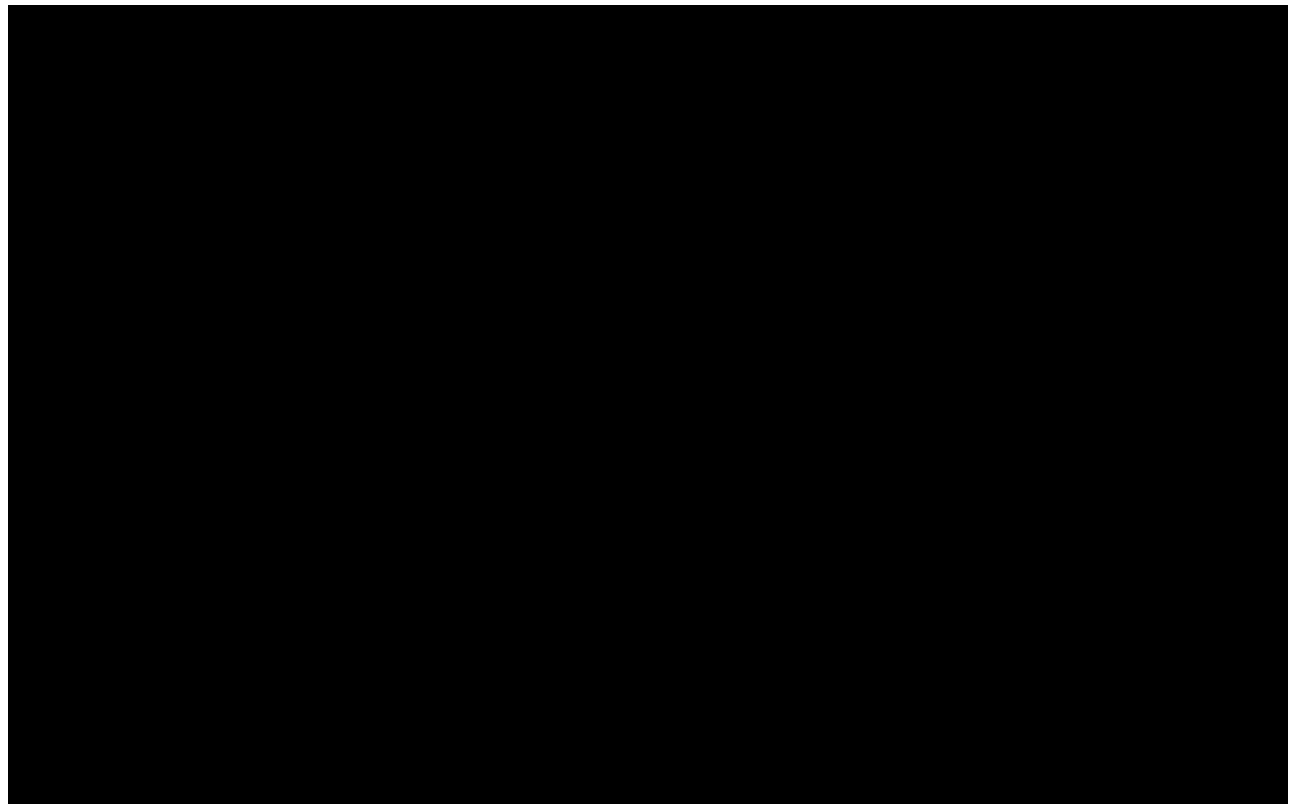


Figure 5 DA Safety in context of the specific safety aspects of the Range Hazard Area

The Argument 3.1 figure above has three distinct areas:

- Purple Source area (dashed box): provides the SIR mapping of elements that are required to be

used as part of the definition of the volume of airspace of Interest.

- Blue Arguments Arg 3.1.1 and 3.1.3: These are respectively the source input of the volume of airspace of interest application for the Safety Assessment and the Safety requirement output to the Range SMS for ongoing management and monitoring.
- Orange Arg 3.1.2: this is the scope of the assessment where areas identified for both Exclusion and Warning (as defined in the SIR) are grouped as 'Danger areas' for the purpose of the ACP.

Argument 3.1.2 is detailed below. This is where the argument concludes on evidentiary components. The logic is that once those evidences are provided to prove the connected safety posture then the top level argument is met. The table after the GSN image provides the direction for where in this assessment the evidence is discussed or presented.

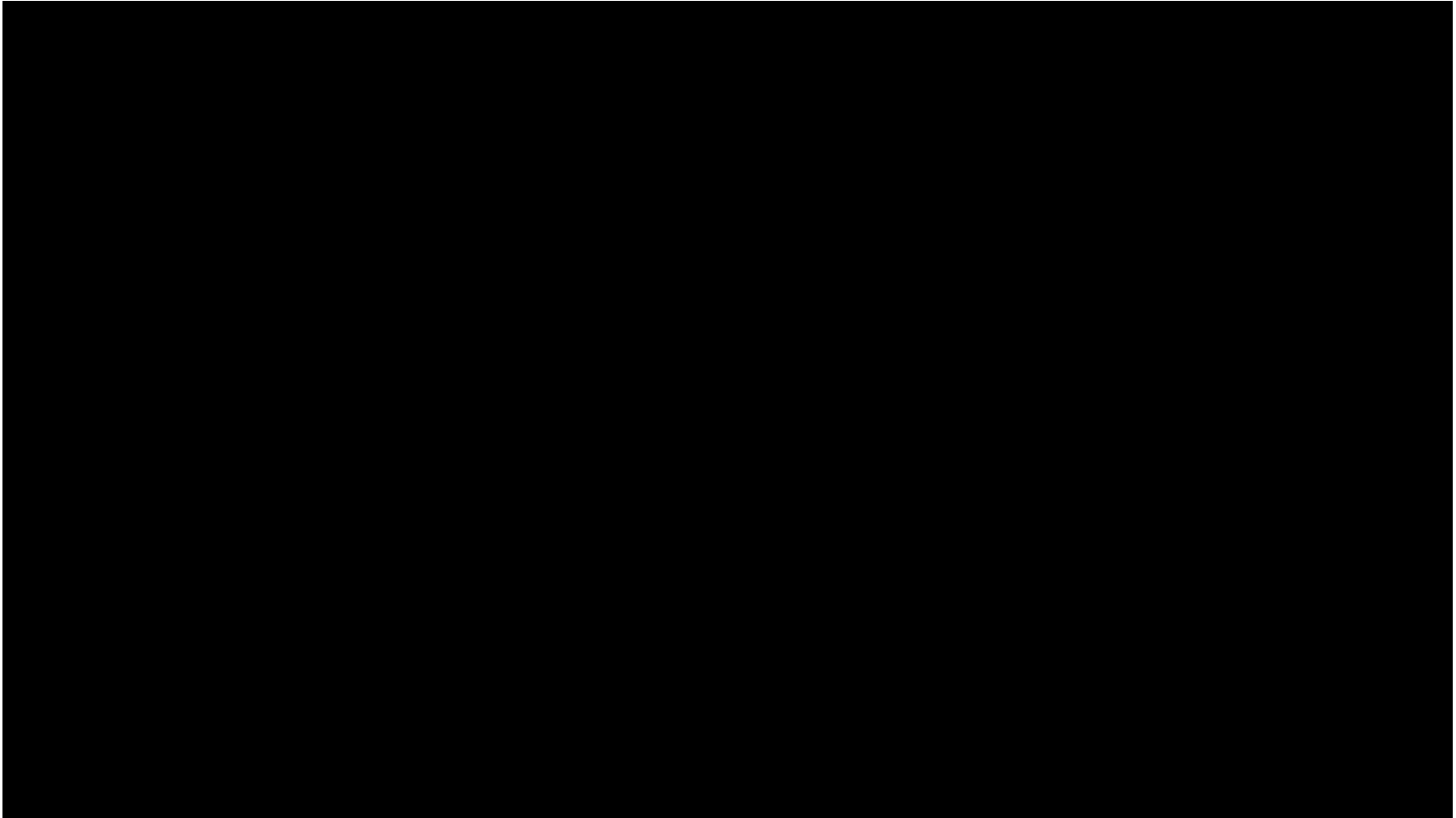


Figure 6 DA Safety Specific Argument

[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]

Table 1 SaxaVord DA Safety Argument evidence mapping

4. Safety Criteria for ALARP

The safety criteria being used to define ALARP cover both qualitative and qualitative formats. The quantitative format comes from CAP2220 and the qualitative comes from the SaxaVord SMS. Both are provided below.

4.1 Qualitative ALARP Safety Criteria

[REDACTED]

[REDACTED]		
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]

Table 2 Severity of Consequence Table

[REDACTED]		
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]

[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]

Table 3 Likelihood of Consequence Table

[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]

Table 4 Risk Severity Table

All hazards defined in REF 5 have utilised this criteria and successfully mitigated into the Acceptable region.

4.2 Quantitative ALARP Safety Criteria

As introduced in section 2.3 the quantified ALARP criteria is specifically used on the tactical launch risks related to the launch vehicles and associated potential failures during flight.

Publication CAP 2220 provides an indication of the risk levels that may be applied to a Launch Operator licence(see Figure 7).

[REDACTED]

[REDACTED]

Each Licenced Launch operator [REDACTED] is licenced by the CAA and under that licence the CAA requires a flight safety analysis. [REDACTED]

[REDACTED]

[REDACTED]

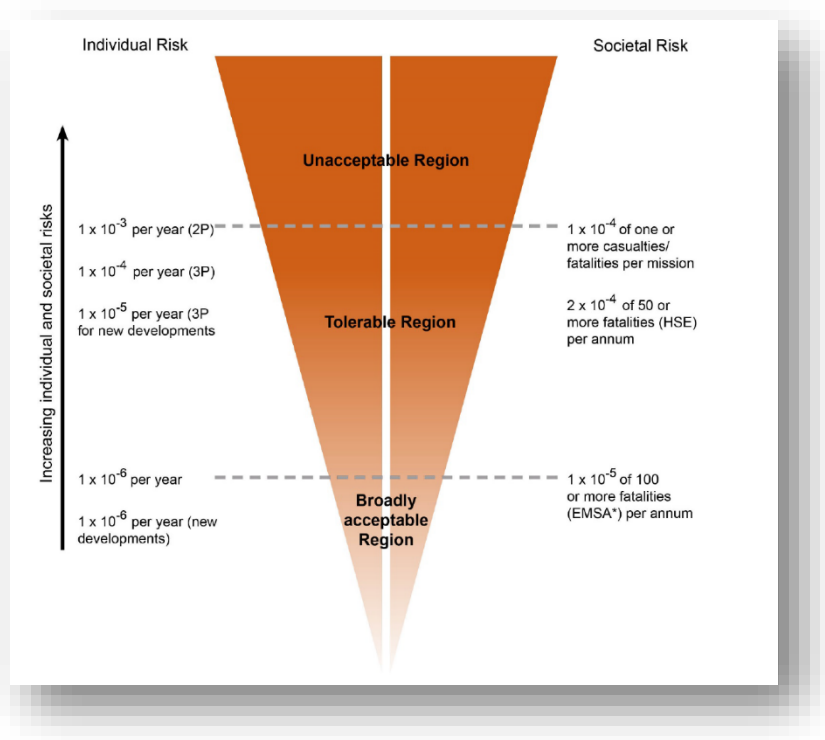


Figure 7 CAP2220 Risk regions

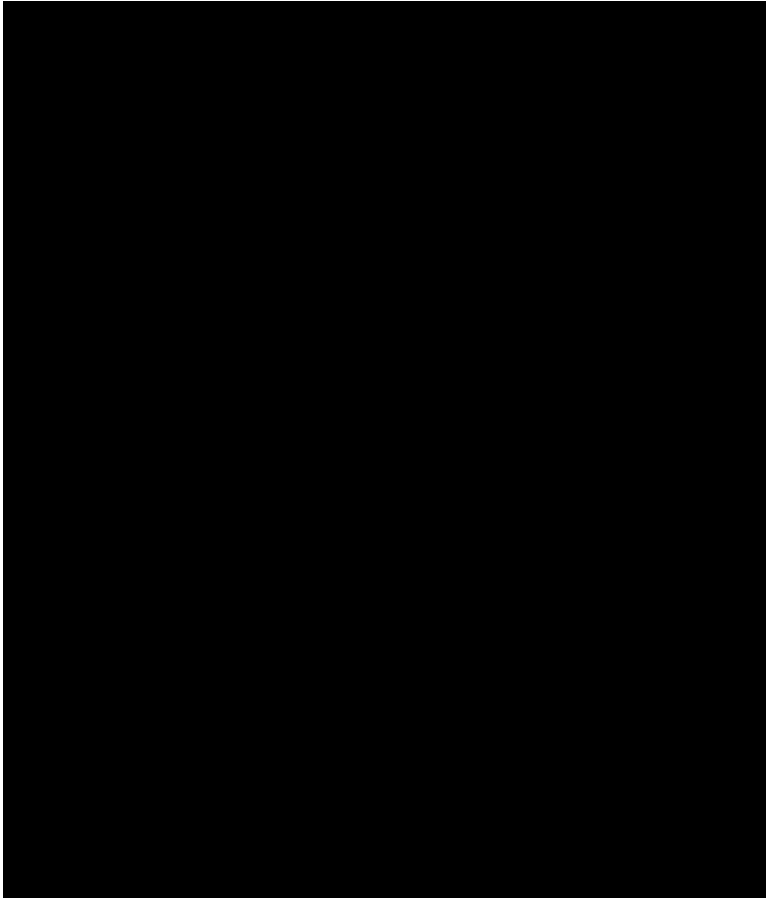
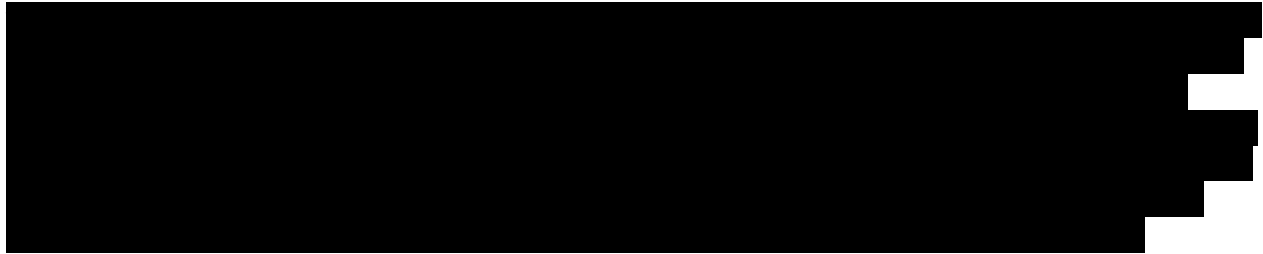
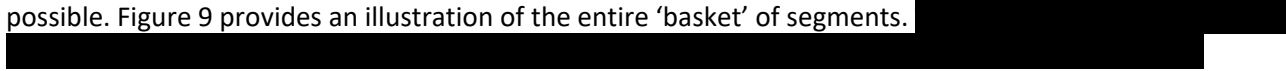


Figure 8 Danger Area Exclusion Principle

5. Airspace Design

5.1 Airspace Segmentation

Airspace segmentation allows the activated airspace volume to be selected, as advised by the launch operators flight safety analysis, to ensure the safety objectives are met but at the same time to minimise impact on airspace users. In addition, the use of internal segments enables greater granularity in selecting the most appropriate airspace volume for a given launch operation. Furthermore, refined latitudes of segments have been selected to avoid coincidence with established FIR boundary reporting points where possible. Figure 9 provides an illustration of the entire ‘basket’ of segments.



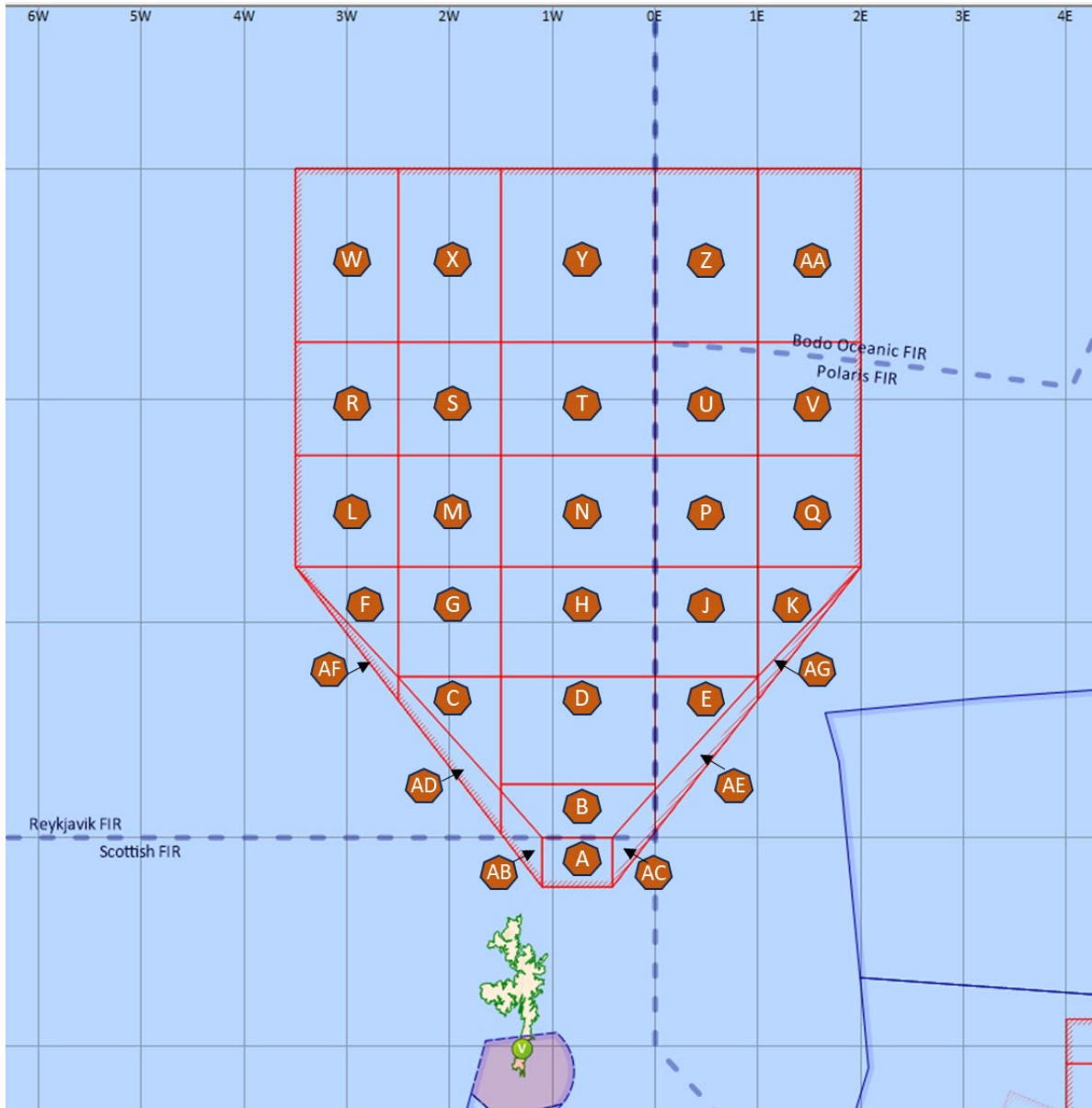


Figure 9 Segmented Airspace Design



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Appendix A. Representative Launch profile Descriptions

To enable a DA design to be established that was feasible for the potential LVs, reduces impacts on airspace Users and provides the necessary protection as per the DA application it was necessary to understand what a representative launch profiles could look like. Although this is illustrative, it does provide an indication of the duration of each event and range distances.

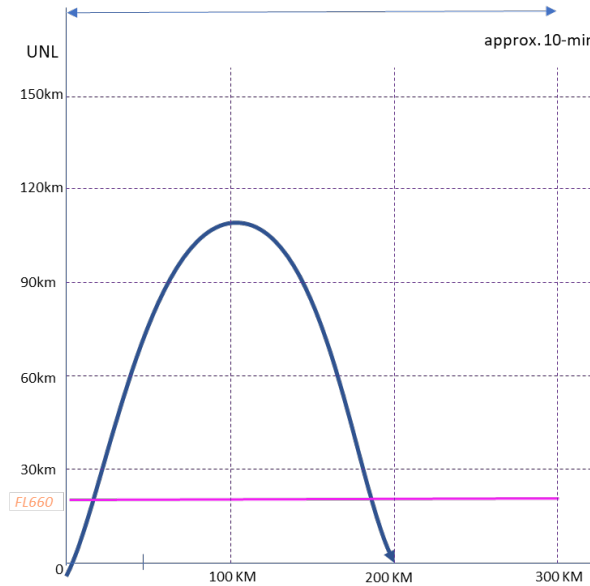


Figure 10 Sub-Orbital Representative Launch profile

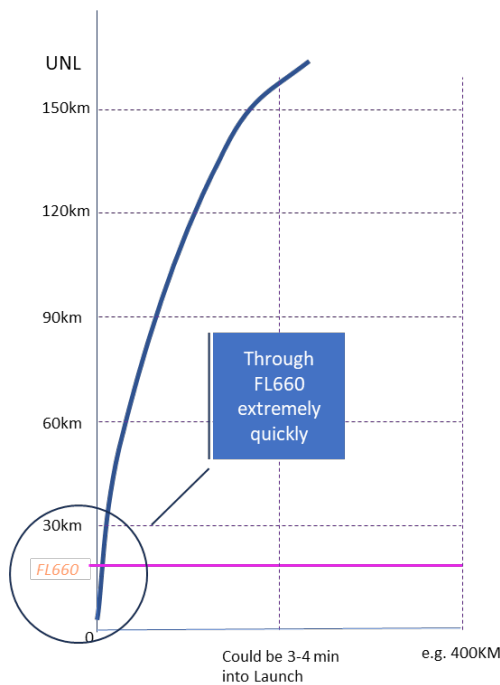


Figure 11 Orbital Representative Launch profile

[Redacted]

[Redacted]

[Redacted]

Req Reference	Requirement Description
[Redacted]	[Redacted]
[Redacted]	[Redacted]
[Redacted]	[Redacted]
[Redacted]	[Redacted]
[Redacted]	[Redacted]
[Redacted]	[Redacted]

B. 2. FHA Safety Requirements and Assumptions

[Redacted]

FHA Reference	Requirement Description
[Redacted]	[Redacted]
[Redacted]	[Redacted]
[Redacted]	[Redacted]
[Redacted]	[Redacted]
[Redacted]	[Redacted]
[Redacted]	[Redacted]
[Redacted]	[Redacted]
[Redacted]	[Redacted]

Appendix C. Launch Activation and Notification

The following information is provided to inform on the Activation and Notification plans as per Safety Requirements listed in B. 2. Co-ordination and notification of the airspace will be conducted by SaxaVord range services.

- **Publication/Promulgation.** The DA will be published/promulgated on completion of the CAP1616 ACP process.
- **Activation.** The DA will be activated by NOTAM, by SaxaVord range services.
- **Advance Notification of Launch.** SaxaVord aims to provide informal, advance notification at least 3 months before launch date (i.e. “L-3 mths”).
- **Illustrative NOTAM Notification.**
 - **NOTAM Submission.** NOTAM submission will take place through the CAA NOTAM Portal at L – 28 days
 - **Launch Date Minus 9 Days (“L-9”).** NOTAM activation with a defined, broad launch window in the order of 3 hours, although actual duration will be dictated by the requirements of the Launch operator. A launch window will be defined as a series of days and times where Launch will be attempted on Day 1 and if unsuccessful, Day 2 and so on. Once Launch is successful on Day X, subsequent reservations will be released immediately.
 - **Protecting the Launch Facilities:** the NOTAM will include a suitable activation period of the DA to protect during rocket preparation operations.
 - **L-3 Days.** Revised NOTAM with a refined launch window if possible.
 - **L-1 Day.** Potentially, a final revised NOTAM with a further refined launch window.
 - **DA Deactivation.** Will be as detailed in the NOTAM.
 - **Tactical Usage Within NOTAM Windows.** SaxaVord range services will develop coordination procedures with relevant parties to facilitate the tactical management of the airspace within published (NOTAM) launch windows.

Appendix D. References

[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]

Appendix E. Acronyms and Abbreviations

ACP	Airspace Change Proposal
ALARP	As Low As Reasonably Practicable
Aoi	Area of Interest
ATC	Air Traffic Control
FHA	Functional Hazard Analysis
GSN	Goal Structured Notation
HazLog	Hazard Log
ICAO	International Civil Aviation Organisation
LV	Launch Vehicle
LO	Launch Operator
NATS	National Air Traffic Services
SAXA	SaxaVord Spaceport
SIR	Space Industry Regulations
SMS	Safety Management System
SO	Safety Objective
SAXAVORD	Shetland Space Centre
DA	Temporary Danger Area
WGS	World Geodetic System