



# Best Practicable Environmental Option

BPEO-RFA

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# 1 Background

Rocket Factory Augsburg (RFA) was founded in 2018 with the vision to enable data generating business models in space to better monitor, protect and connect the Earth. Against this background, the company's goal is to offer launch services of up to 1.300kg into low Earth orbits and beyond at unmatched prices. With this, RFA wants to reduce the launch costs in the space industry and to democratize access to space. The RFA ONE launch system combines two key competitive advantages: A customer-focused service with precise in-orbit delivery and a high degree of mission flexibility through its Redshift OTV; at a highly competitive price; made possible by superior staged combustion technology, low-cost structures and usage of industrial components.

RFA offers its services at a very competitive price, which results from serial production and use of standardized components from the automotive, oil and energy industries. In addition, RFA ONE uses the highly efficient, oxygen-rich staged-combustion engine "Helix" for its propulsion. RFA is the first in the European Union and one of the few private companies worldwide that have developed this very complex but efficient and sustainable engine cycle.

With its competitive pricing, high flexibility and customer-focused services, RFA can offer a globally unique and disruptive access to Earth orbit and beyond.

RFA wishes to launch its new small launcher, RFA ONE, from the Launch Pad 1C at SaxaVord Spaceport on Shetland. From UK soil, RFA intends to fly its maiden and operational launches to polar and sun-synchronous orbits.

In line with this goal, RFA seeks a marine licence, to deposit in the marine environment the first and second stage as well as the fairing of RFA ONE, for a launch scheduled between the 1<sup>st</sup> of August 2024 and the 31<sup>st</sup> of July 2025. The Best Practicable Environmental Options (BPEO) is part of RFA's Marine license application.

This document has been structured with the goal of creating a self-contained document that could summarize any marine and transboundary information associated to the launch operations of RFA. It first introduces the area of interest affected by the launch of RFA One, then presents the jettisoned objects during the launch of the rocket. After this technical introduction, an overview of the regulatory compliance which framed the marine and transboundary effects is presented. Following the tailoring of the marine and transboundary effects. Finally, the document details the justification of operational best practices in the frame of the assessment on environmental effects and other maritime stakeholders.



## 2 Area of interest

RFA One will be launched from SaxaVord Spaceport, located in the northernmost island of Shetland, in Scotland. The launcher follows a nominal sun-synchronous trajectory, which takes off vertically at T+0. The first stage burns for 175 seconds and is then jettisoned at an altitude of roughly 70km. The second stage is ignited after stage separation and burns during 315 seconds and is jettisoned after the burn, at an altitude of roughly 160km. During the flight of the second stage, the fairing is released at T+240 seconds after lift-off at an altitude of roughly 110 km. The third stage of the launcher will be orbital, therefore no expected impact on earth is presented in the frame of the Marine License.

The Hazard areas associated to the jettisoning events of Stage 1, fairing, and Stage 2 are rectangular boxes for which the coordinates in latitude and longitude are given in Table 2-1:

	Stage 1	Fairing	Stage 2
Coordinate A	67.042°, -6.979°	69.185°, -9.418°	71.908, -140.231°
Coordinate B	67.428°, -4.276°	69.633°, -6.378°	73.646, -152.626°
Coordinate C	65.433°, -2.634°	67.075°, -3.840°	84.424, -99.869°
Coordinate D	65.076°, -5.158°	66.673°, -6.609°	80.503, -91.836°

**Table 2-1: Coordinates of the hazard areas**

## 3 Jettisoned objects

Launch sequence described in section 2 highlight three jettisoning events, for the first stage, the fairing and the second stage. It is expected to have the stages falling back to earth by natural effect of gravity. The impact assessment is based on the worst-case parameters, using a Rochdale envelope assessment. Thus, the effects of thermal ablation during the re-entry of the jettisoned objects are not considered

The vehicle parameters expected to fall back on earth are described Table 3-1

Parameter	Stage 1	Stage 2	Payload Fairing
Max height (m)	21.0	5.2	8.0
Max diameter (m)	2.1	2.1	2.1 - 3.3
GLOW (kg)	75,000		
Dry mass (kg)	5000	1000	200
materials present	Carbon Composite, Stainless Steel, Lithium-ion Batteries, Aluminum, Nickel, Copper, Plastics, Zirconium, Titanium	Carbon Composite, Stainless Steel, Lithium-ion Batteries, Aluminum, Nickel, Copper, Plastics, Zirconium, Titanium	Carbon Composites, Lithium-ion Batteries, Aluminium, Cork, Stainless Steel, Aluminium, Copper Alloy Titanium, Plastics
Propellant and other gases	LOx, RP1, Helium	LOx, RP1, Helium	N/A

Terminal Velocity (m/s)	170	80	40
propellant left upon re-entry	600 kg	60 kg	N/A
	<p>It has been assumed that the worst-case amount of propellant to be used for launch will not exceed 22,700 kg.</p> <p>The amount of propellant in the RFA ONE Launch Vehicle at launch will be precisely measured so that the minimum amount is used to meet the launch requirements. All fuel is expected to be used during the launch. However, there is the possibility that some fuel will remain upon re-entry of the stage(s). The effects of these have been assessed as a precautionary measure.</p>		
Likely fate	<p>It is anticipated that significant sections of the RFA ONE Launch Vehicle and associated composite materials will burn up in the atmosphere resulting in debris components.</p> <p>The first stage will enter the marine environment intact after launch. The fairing halves and the second stage may fragment whilst returning to Earth and lead to debris entering the marine environment. The third stage is planned to enter orbit.</p> <p>The worst-case scenario would be to assume that the RFA ONE Launch Vehicle components do not burn up and instead enter the marine environment.</p>		

**Table 3-1: Summary RFA ONE launch Vehicle parameters**

The hazard areas [1] are included in the Navigational Risk Assessment, in the frame of the Marine License

## 4 Regulatory Compliance

The Assessment of Environmental Effects (AEE) [2] has been produced under the Space Industry Act 2018 as transposed into The Space Industry Regulations 2021. It has been informed using:

- Guidance to the Regulator on Environmental Objectives Relating to the Exercise of its Functions under the Space Industry Act 2018;
- Guidance for the Assessment of Environmental Effects 2021.

The launch aspect of Scotland's space sector is emergent in nature. As such developments occur only on land, the space sector has not been considered in marine planning policy such as Scotland's National Marine Plan (SNMP) [3]. Despite not being considered as a specific activity in the SNMP, policies are included in the SNMP that may need consideration when assessing the Proposed Project. In order to address this potential, the SNMP policies have been screened to determine which of the policies are of relevance to the Project. In addition to the policies in SNMP, the Shetland Local Development Plan [4] has also been reviewed to determine if any policies exist that may be relevant to the Proposed Project. The Shetland Plan outlines several policies that must be considered in applications for new developments.

The results of policy review and screening process indicate that the following policies are of relevance to the marine environment and the Proposed Project:

Policy ID	Policy Text
GEN 1	<i>There is a presumption in favour of sustainable development and use of the marine environment when consistent with the policies and objectives of this Plan.</i>
GEN 2	<i>Sustainable development and use which provides economic benefit to Scottish communities is encouraged when consistent with the objectives and policies of this Plan.</i>
GEN 3	<i>Sustainable development and use which provides social benefits is encouraged when consistent with the objectives and policies of this Plan.</i>
GEN 4	<i>Proposals which enable coexistence with other development sectors and activities within the Scottish marine area are encouraged in planning and decision-making processes, when consistent with policies and objectives of this Plan.</i>
GEN 5	<i>Marine planners and decision makers must act in the way best calculated to mitigate, and adapt to, climate change.</i>
GEN 6	<i>Development and use of the marine environment should protect and, where appropriate, enhance heritage assets in a manner proportionate to their significance.</i>
GEN 7	<i>Marine planners and decision makers should ensure that development and use of the marine environment take seascape, landscape and visual impacts into account.</i>
GEN 8	<i>Developments and activities in the marine environment should be resilient to coastal change and flooding, and not have unacceptable adverse impact on coastal processes or contribute to coastal flooding.</i>
GEN 9	<i>Development and use of the marine environment must:</i> <i>(a) Comply with legal requirements for protected areas and protected species.</i> <i>(b) Not result in significant impact on the national status of Priority Marine Features.</i> <i>(c) Protect and, where appropriate, enhance the health of the marine area.</i>
GEN 11	<i>Developers, users and those accessing the marine environment must take measures to address marine litter where appropriate. Reduction of litter must be taken into account by decision makers.</i>
GEN 12	<i>Developments and activities should not result in a deterioration of the quality of waters to which the Water Framework Directive, Marine Strategy Framework Directive or other related Directives apply.</i>
GEN 13	<i>Development and use in the marine environment should avoid significant adverse effects of man-made noise and vibration, especially on species sensitive to such effects.</i>
GEN 14	<i>Development and use of the marine environment should not result in the deterioration of air quality and should not breach any statutory air quality limits.</i>
GEN 15	<i>Marine and terrestrial plans should align to support marine and land-based components required by development and seek to facilitate appropriate access to the shore and sea.</i>
GEN 17	<i>All marine interests will be treated with fairness and in a transparent manner when decisions are being made in the marine environment.</i>
GEN 18	<i>Early and effective engagement should be undertaken with the general public and all interested stakeholders to facilitate planning and consenting processes.</i>
GEN 19	<i>Decision making in the marine environment will be based on sound scientific and socio-economic evidence.</i>



GEN 20	<i>Adaptive management practices should take account of new data and information in decision making, informing future decisions and future iterations of policy.</i>
GEN 21	<i>Cumulative impacts affecting the ecosystem of the marine plan area should be addressed in decision making and plan implementation.</i>
FISHERIES 1	<p><i>Taking account of the EU's Common Fisheries Policy, Habitats Directive, Birds Directive and Marine Strategy Framework Directive, marine planners and decision makers should aim to ensure:</i></p> <ul style="list-style-type: none"> <li>- <i>Existing fishing opportunities and activities are safeguarded wherever possible.</i></li> <li>- <i>An ecosystem-based approach to the management of fishing which ensures sustainable and resilient fish stocks and avoids damage to fragile habitats.</i></li> <li>- <i>Protection for vulnerable stocks (in particular for juvenile and spawning stocks through continuation of sea area closures where appropriate).</i></li> <li>- <i>Improved protection of the seabed and historical and archaeological remains requiring protection through effective identification of high-risk areas and management measures to mitigate the impacts of fishing, where appropriate.</i></li> <li>- <i>That other sectors take into account the need to protect fish stocks and sustain healthy fisheries for both economic and conservation reasons.</i></li> <li>- <i>Delivery of Scotland's international commitments in fisheries, including the ban on discards.</i></li> <li>- <i>Mechanisms for managing conflicts between fishermen and/or between the fishing sector and other users of the marine environment.</i></li> </ul>
FISHERIES 2	<p><i>The following key factors should be taken into account when deciding on uses of the marine environment and the potential impact on fishing:</i></p> <ul style="list-style-type: none"> <li>- <i>The cultural and economic importance of fishing, in particular to vulnerable coastal communities.</i></li> <li>- <i>The potential impact (positive and negative) of marine developments on the sustainability of fish and shellfish stocks and resultant fishing opportunities in any given area.</i></li> <li>- <i>The environmental impact on fishing grounds (such as nursery, spawning areas), commercially fished species, habitats and species more generally.</i></li> <li>- <i>The potential effect of displacement on: fish stocks; the wider environment; use of fuel; socio-economic costs to fishers and their communities and other marine users.</i></li> </ul>
FISHERIES 3	<p><i>Where existing fishing opportunities or activity cannot be safeguarded, a Fisheries Management and Mitigation Strategy should be prepared by the proposer of development or use, involving full engagement with local fishing interests (and other interests as appropriate) in the development of the Strategy. All efforts should be made to agree the Strategy with those interests. Those interests should also undertake to engage with the proposer and provide transparent and accurate information and data to help complete the Strategy. The Strategy should be drawn up as part of the discharge of conditions of permissions granted.</i></p> <p><i>The content of the Strategy should be relevant to the particular circumstances and could include:</i></p> <ul style="list-style-type: none"> <li>- <i>An assessment of the potential impact of the development or use on the affected fishery or fisheries, both in socio-economic terms and in terms of environmental sustainability.</i></li> <li>- <i>A recognition that the disruption to existing fishing opportunities/activity should be minimised as far as possible.</i></li> <li>- <i>Reasonable measures to mitigate any constraints which the Proposed Project or use may place on existing or proposed fishing activity.</i></li> <li>- <i>Reasonable measures to mitigate any potential impacts on sustainability of fish stocks (e.g., impacts on spawning grounds or areas of fish or shellfish abundance) and any socio-economic impacts.</i></li> </ul> <p><i>Where it does not prove possible to agree the Strategy with all interests, the reasons for any divergence of views between the parties should be fully explained in the Strategy and dissenting views should be given a platform within the Strategy to make their case.</i></p>
WILD FISH 1	<i>The impact of development and use of the marine environment on diadromous fish species should be considered in marine planning and decision-making processes. Where evidence of impacts on salmon and other diadromous species is inconclusive, mitigation should be adopted where possible and information on impacts on diadromous species from monitoring of developments should be used to inform subsequent marine decision making.</i>
OIL & GAS 4	<i>All oil and gas platforms will be subject to 9 nautical mile consultation zones in line with Civil Aviation Authority guidance.</i>
OIL & GAS 5	<i>Consenting and licensing authorities should have regard to the potential risks, both now and under future climates, to oil and gas operations in Scottish waters, and be satisfied that installations are appropriately sited and designed to take account of current and future conditions.</i>
OIL & GAS 6	<i>Consenting and licensing authorities should be satisfied that adequate risk reduction measures are in place, and that operators should have sufficient emergency response and contingency strategies in place that are compatible with the National Contingency Plan and the Offshore Safety Directive.</i>
TRANSPORT 1	<p><i>Navigational safety in relevant areas used by shipping now and in the future will be protected, adhering to the rights of innocent passage and freedom of navigation contained in UN Convention on the Law of the Sea (UNCLOS). The following factors will be taken into account when reaching decisions regarding development and use:</i></p> <ul style="list-style-type: none"> <li>- <i>The extent to which the locational decision interferes with existing or planned routes used by shipping, access to ports and harbours and navigational safety. This includes commercial anchorages and defined approaches to ports.</i></li> <li>- <i>Where interference is likely, whether reasonable alternatives can be identified.</i></li> <li>- <i>Where there are no reasonable alternatives, whether mitigation through measures adopted in accordance with the principles and procedures established by the International Maritime Organization can be achieved at no significant cost to the shipping or ports sector.</i></li> </ul>
TRANSPORT 3	<i>Ferry routes and maritime transport to island and remote mainland areas provide essential connections and should be safeguarded from inappropriate marine development and use that would significantly interfere with their operation. Developments will not be consented where they will unacceptably interfere with lifeline ferry services.</i>
TRANSPORT 6	<i>Marine planners and decision makers and developers should ensure displacement of shipping is avoided where possible to mitigate against potential increased journey lengths (and associated fuel costs, emissions, and impact on journey frequency) and potential impacts on other users and ecologically sensitive areas.</i>

NH 2	<p>"Where there is good reason to suggest that a species protected under the Wildlife and Countryside Act 1981 (as amended), Annex IV of the Habitats Directive or Annex 1 of the Birds Directive is present on site, or may be affected by a Proposed Project, the Council will require any such presence to be established. If such a species is present, a plan should be provided to avoid or mitigate any adverse impacts on the species, prior to determining the application.</p> <p>Planning permission will not be granted for development that would be likely to have an adverse effect on a European Protected Species unless the Council is satisfied that:</p> <ul style="list-style-type: none"> <li>• The development is required for preserving public health or public safety or for other imperative reasons of overriding public interest including those of a social or economic nature and beneficial consequences of primary importance for the environment; and</li> <li>• There is no satisfactory alternative; and</li> <li>• The development will not be detrimental to the maintenance of the population of the European Protected Species concerned at a favourable conservation status in their natural range.</li> </ul> <p>Planning permission will not be granted for development that would be likely to have an adverse effect on a species protected under Schedule 5 (animals) or 8 (plants) of the Wildlife and Countryside Act 1981 (as amended) unless the Council is satisfied that:</p> <ul style="list-style-type: none"> <li>• Undertaking the development will give rise to, or contribute towards the achievement of, a significant social, economic or environmental benefit; and</li> <li>• There is no satisfactory solution.</li> </ul> <p>Planning permission will not be granted for development that would be likely to have an adverse effect on a species protected under Schedules 1, 1A or A1 (birds) of the Wildlife and Countryside Act 1981 (as amended), unless the Council is satisfied that:</p> <ul style="list-style-type: none"> <li>o The development is required for preserving public health or public safety; and</li> <li>o There is no other satisfactory solution.</li> </ul> <p>Applicants should submit supporting evidence for any development meeting these criteria, demonstrating both the need for the development and that a full range of possible alternative courses of action have been properly examined and none found to acceptably meet the need identified.</p> <p>The Council will apply the precautionary principle where the impacts of a Proposed Project on natural heritage are uncertain but potentially significant. Where development is constrained on the grounds of uncertainty, the potential for research, surveys or assessments to remove or reduce uncertainty should be considered."</p>
NH 3	<p>"Development will be considered against the Council's obligation to further the conservation of biodiversity and the ecosystem services it delivers. The extent of these measures should be relevant and proportionate to the scale of the development.</p> <p>Proposals for development that would have a significant adverse effect on habitats or species identified in the Shetland Local Biodiversity Action Plan, Scottish Biodiversity List, UK Biodiversity Action Plan, Annexes I and II of the Habitats Directive, Annex I of the Birds Directive (if not included in Schedule 1 of the Wildlife and Countryside Act) or on the ecosystem services of biodiversity, including any cumulative impact, will only be permitted where it has been demonstrated by the developer that;</p> <ul style="list-style-type: none"> <li>• The development will have benefits of overriding public interest including those of a social or economic nature that outweigh the local, national or international contribution of the affected area in terms of habitat or populations of species; and</li> <li>• Any harm or disturbance to the ecosystem services, continuity and integrity of the habitats or species is avoided or reduced to acceptable levels by mitigation." </li></ul>
NH 7	<p>"Development will only be permitted where appropriate measures are taken to protect the marine and freshwater environments to an extent that is relevant and proportionate to the scale of development. Development adjacent to a watercourse or water body must be accompanied by sufficient information to enable a full assessment of the likely effects.</p> <p>Where there is potential for the development to have an adverse impact the applicant/developer must demonstrate that:</p> <ul style="list-style-type: none"> <li>• There will be no deterioration in the ecological status of the watercourse or water body;</li> <li>• It does not encroach on any existing buffer strips and that access to these buffer strips has been maintained; and</li> <li>• Both during the construction phase and after completion it would not significantly affect: <ul style="list-style-type: none"> <li>o Water quality flows in adjacent watercourses or areas downstream</li> <li>o Natural flow patterns and sediment transport processes in all water bodies or watercourses."</li> </ul> </li> </ul>
HE 4	<p>"Scheduled monuments, designated wrecks and other identified nationally important archaeological resources should be preserved in situ, and within an appropriate setting. Developments that have an adverse effect on scheduled monuments and designated wrecks or the integrity of their settings should not be permitted unless there are exceptional circumstances.</p> <p>All other significant archaeological resources should be preserved in situ wherever feasible. Where preservation in situ is not possible the planning authority should ensure that developers undertake appropriate archaeological excavation, recording, analysis, publication and archiving in advance of and/ or during development."</p>

**Table 4-1: Policies considered in the Marine and Transboundary effect assessment**

## 5 Marine & Transboundary Effects

### 5.1 Introduction.

This chapter considers the marine and transboundary effects of the launch of RFA ONE (the launch). Transboundary effects of the launch are significant environmental effects that may arise in a different country as a consequence of the launch.

The majority of the potential environmental effects are expected at or near the launch. However, RFA ONE Launch Vehicles will also splashdown in Exclusive Economic Zone (EEZ) and international waters and potentially interact with the marine environment. The scope of the transboundary effects chapter is therefore concerned with assessment of the marine environmental effects of returning RFA ONE Launch Vehicle stages or debris arising. Therefore, this chapter considers the potential marine receptors present within the effects range of the predicted impact points from returning RFA ONE Launch Vehicles.

The UK Government has consulted with the governments of countries where the stages or fairings are predicted to land, to come to an agreement to allow stages to fall in their waters.

The Federal Aviation Administration (FAA) [5] methodology will be applied to define an exclusion zone for each of the hazard area, in the vicinity in the launch site and the jettisoned objects. For these, a Notice to Mariners will be published, with the exact areas dependent upon individual launches.

### 5.2 Baseline Conditions

The baseline conditions are described in terms of their water quality, biodiversity and humans/human activities for the EZI. Parameters included in the assessment are water quality, biodiversity and human activities.

Receptor	Taken Forward
<b>Water and Sediment quality</b>	
Contaminants	Yes
Microplastics	Yes
<b>Biodiversity</b>	
Physical features	No
Plankton	Yes
Benthic species	Yes
Fish and shellfish	Yes
Marine ornithology	Yes
Marine megafauna	Yes
Marine protected area	Yes
<b>Human/human activities</b>	
Shipping and navigation	Yes



Oil and gas infrastructure	No
Cables and pipelines	Yes
Military	Yes
Other sea users	No
Socioeconomics/tourism	No
Marine archaeology	Yes
Commercial fisheries	Yes

**Table 5-1: Receptors taken forward in the assessment**

## 5.3 Potential Effects

A series of effect pathways on the marine environment have been identified as a result of the return of launch vehicles to Earth. Table 5-2 summarizes the effect pathways to be considered for the launch.

The effects of direct strike on vessels have been screened out. There is no pathway for effect due to the standard operating procedure of implementing a Notice to Mariners and an exclusion zone around the RFA ONE Launch Vehicle.

Impact	significance
Effects on Water, Sea Ice, and Sediment Quality, and Ecological Receptors from Fuel Spillage	No likely significant effect
Effects on Water, Sea Ice, and Sediment Quality, and Ecological Receptors from Metal Corrosion and Toxic Contamination	No likely significant effect
Effects on Water, Sea Ice, and Sediment Quality, and Ecological Receptors from Debris and Microplastics (Including Ingestion)	No likely significant effect
Smothering of Marine Organisms, Habitat Alteration (Including Reef Effects) and Habitat Loss via Deposition of Material on the Seabed or Sea Ice	No likely significant effect
Direct Strike	No likely significant effect
Acoustic Disturbance (including Underwater Noise) from the Impact of the Jettisoned Objects Hitting the Sea Surface or Sea Ice	No likely significant effect
Thermal Effects of Jettisoned Objects	No likely significant effect
Visual Disturbance	No likely significant effect
Displacement of Fish	No likely significant effect
Damage to Human Infrastructure (Subsea Cables/Pipelines)	No likely significant effect
Interference with Military Exercise Areas	No likely significant effect
Impacts to Vessel Navigation Including Floating Debris, Changes to Topography and Re-routing of Vessel Traffic	No likely significant effect
Damage to Marine Archaeology/Shipwrecks	No likely significant effect

**Table 5-2: Impacts considered for the impact assessment**

## 5.4 Cumulative Assessment

The cumulative assessment aims to determine the potential for effects of the Proposed Project to combine with other 'reasonably foreseeable projects and plans'. Reasonably foreseeable projects can comprise projects that are planned but not yet operational, be they under construction, or under approval for construction. Projects and plans that are

fully implemented and in operation are not considered under the cumulative assessment as they will have been considered under the baseline environment.

All reasonably foreseeable plans and projects that have the potential to act cumulatively with the marine effect pathways associated with the Proposed Project are presented in Table 5-2. Plans and projects have been identified for offshore wind, marine renewables, oil and gas, and subsea cables. With regard to the sectors of military, recreation and tourism, and disposal sites, no proposed plans or projects have been identified.

Table 5-3 details which of the effect pathways included in the assessment are applicable to each of the projects or plans. The pathways which have the potential to act cumulatively between the Proposed Project and the reasonably foreseeable projects and plans have been taken forward in the assessment.

Plan/Project	Description	Location	Stage
Hywind Tampen Floating Offshore Wind Farm	The Hywind Tampen is being developed by Equinor ASA in Norwegian waters. The windfarm capacity is 88 MW and will comprise floating turbines.	Norway, adjacent to the south-east corner of the EZI	Pre-construction
Celtic Norse Subsea Cable	The Celtic Norse cable will be ready for service in 2022. It connects Grindavik, Iceland, Killala, Ireland, Caithness, Scotland, and Øysanden, Norway. It is approximately 2,000 km in length and is owned by Eidsiva Energi, NTE, and TrønderEnergi.	Norway, Iceland, Scotland, crossing the southern part of the EZI	Pre-construction
UK Offshore Licensing Round for Oil and Gas	There have been several UK Offshore Licensing rounds for Oil and Gas in recent years, most recently the 32 <sup>nd</sup> Offshore Licensing Round in 2019. These licensing rounds have included blocks and partblocks in the EZI. It is likely that a proportion of these recently licensed blocks will be developed, either by drilling exploration wells, undertaking seismic surveys, or field development planning.	West of Shetland, FaroeShetland Basin, East Shetland Platform	Exploration and Pre-development
Norway Offshore Licensing Round for Oil and Gas	Similar to the UK, Norway also undertakes licensing for its offshore oil and gas blocks. The latest announcement of new blocks up for award in pre-defined areas was in June 2020. Blocks awarded in previous rounds may be developed in the future	Norwegian waters of the EZI. Examples of overlapping blocks are Licence 933 and 993	Exploration and Pre-development
Faroese Licensing Round for Oil and Gas	Similar to the UK, the Faroe Islands also undertakes licensing rounds for its offshore oil and gas blocks. In 2019 the 5 <sup>th</sup> Faroese Licensing Round occurred, in conjunction with the UK's 32 <sup>nd</sup> Licensing Round. The blocks on offer were near to the boundary of the UKCS. There is therefore potential for future oil and gas exploration and production in these blocks.	Faroese waters of the EZI, specifically in the south-west of the EZI near the border with the UKCS	Exploration and Pre-development
Jan Mayen oil exploration	There has been interest in the potential oil and gas reserves of Jan Mayen. Although there have been no recent updates on progress (in the last five years), there is the potential that exploration and production activities could occur in the future.	Jan Mayen EEZ of the EZI	Exploration and Pre-development
Faroe Islands marine renewable energy	Minesto have signed an agreement to install two tidal kites in Faroese waters. Site development is in progress; installation of the first kite happened in Q2 2020, with the second unit also planned for 2020.	Faroese coastal waters, just outside the EZI	Pre-construction
Space Hub Sutherland	Space Hub Sutherland EIA report identifies Risk Assessment Study Area (area of likely debris impact zones).	Faroese coastal waters, within and just outside the EZI	Pre-construction

**Table 5-3: All reasonably foreseeable plans and projects in the EZI**



Plan/Project	Fuel Spillage	Metal Corrosion	Microplastics	Disturbance/ Displacement/ Interference	Impact At Seabed	Direct Strike
Hywind Tampen Floating Offshore Wind Farm	x	✓	x	✓	✓	x
Celtic Norse Subsea Cable	x	x	✓	✓	✓	x
UK Offshore Licensing Round for Oil and Gas	✓	✓	✓	✓	✓	x
Norway Offshore Licensing Round for Oil and Gas	✓	✓	✓	✓	✓	x
Faroese Licensing Round for Oil and Gas	✓	✓	✓	✓	✓	x
Jan Mayen oil exploration	✓	✓	✓	✓	✓	x
Faroe Islands marine renewable energy	x	✓	x	✓	✓	x
Space Hub Sutherland	x	✓	✓	✓	✓	✓

**Table 5-4: Assessment of the pressures relevant to the Project to other projects for cumulative assessment**

Impact	significance
Effects on Water quality	<b>No likely significant effect</b>
Biodiversity receptors	<b>No likely significant effect</b>
Human and Human Activities	<b>No likely significant effect</b>

**Table 5-5: Impacts considered for the cumulative impact assessment**

## 5.5 Conclusion on marine & transboundary effects

Negligible risk has been determined for all receptors screened into this assessment for in combination effects from the Proposed Project with reasonably foreseeable plans and projects. Therefore, the project presents no likely significant effect on the environment and other stakeholders.

## 6 Justification of best practices

### 6.1 Tailoring of the hazard area

The hazard areas have been identified according to Appendix B of Part 450 of the FAA [5], due to its inherent advantages in regulatory compliance, expert oversight, and standardized risk assessment.

In the process of identification of hazard areas for Marine License, the emphasis has been put on inherent risks to populations, infrastructures and environment associated to a flight. The Marine License regulates the expected impact of the mission on the marine environment, thus non-reasonably foreseeable events such as failure before orbital insertion are not to be considered. Moreover, consideration of the entire area potentially affected until orbital insertion would result in the analysis of an area covering most of the earth, and is therefore not deemed to be As Low As Reasonably Practicable (ALARP).

A smaller area would not contain all hazardous scenarios associated to nominal operations. The launch of an orbital rocket follows a flight envelope that accounts for perturbations and uncertainties. A smaller envelope will not necessarily contain all scenarios leading to hazardous event and is therefore, not considered to be ALARP.

A wider area would result in extensive analysis, resulting in an exponential increase of time and cost to complete the Marine License for each individual launch. Neither RFA nor the relevant marine authorities would have the practical capability to analyse larger areas for each individual flight.

In addition, a larger hazard area will have a bigger impact on maritime- and air traffic for a risk with negligible likelihood. Moreover, a larger hazard area would result in an increase in the probability of a violation of the warning or exclusion zones that might be implemented as a risk mitigation measure.

Therefore, increasing the size of the hazard areas would not only be unpractical as a result of increased analysis workload and increased disturbance to maritime and air traffic, it might result in increased risk due to the higher likelihood of warning and/or exclusion zone violations.

It is concluded that neither smaller hazard areas, nor larger hazard areas would be more practical or feature lower risk. Therefore, the hazard areas presented in this document are considered ALARP.

### 6.2 Recovery operations

Noting the conditions of the Memoranda of Understanding currently in place between the UK Government and the Governments of The Faroe Islands and Iceland respectively RFA will carry out the following activities:

- RFA will make all reasonable efforts to avoid RFA ONE launch debris falling within the territory of Iceland.
- Prior to any launch activity, RFA will provide copies of any relevant Notices to Aviators or Notices to Mariners issued for the launch activity to the Government of The Faroe Islands and the Government of Iceland.
- On the day of launch, RFA will monitor the publicly available Automatic Identification Systems (AIS) information, to ensure that no fishing activity within the territories of the Faroes Islands is placed at risk by RFA's activities.

RFA is aware of the intergovernmental agreements with Jan Mayen and Norway that there should be no dropped debris within 12 nautical miles of the coasts of both Jan Mayen and Norway and confirms that planned trajectories and drop zones will be designed such that no debris falls either over land or within 12 nautical miles of the coast. This applies both to nominal and off-nominal launches. For off-nominal launch situations the RFA ONE Launch Vehicle flight termination system could be activated prior to the RFA ONE Launch Vehicle entering any area which could result in debris falling either over land or within 12 nautical miles of the coast.

There are currently no recovery operations planned to recover first or second stages or fairings from the RFA ONE Launch Vehicle from the Icelandic EEZ or any other oceanic area. This is because recovery of stages is an expensive operation involving specialized equipment, aircraft and multiple sea craft, personnel, and logistics. RFA considers that:

- The window of operation is limited in time as the stages are designed to be passivated and sink after impact on sea.
- There are inherent risks associated with stage recovery. Factors such as unstable structures (the debris itself), adverse weather conditions and working far out at sea pose significant threats to the safety of the recovery team.
- Once at the bottom of the ocean, the stages, mainly constructed out of stainless steel, will start an artificial reef and serve as a habitat for marine life, contributing to biodiversity in the area, and no significant environmental effects have been identified in the AEE.
- The stages will be jettisoned at a minimum distance of 12 nautical miles from the nearest coastline, it is therefore very unlikely that there will be a justified demand from the public to remove it once the environmental benefits of such artificial reef have been communicated.

Therefore, it is considered that the cost and risk associated with recovery outweighs the potential benefits of removal of the debris.



## 7 Conclusion

In conclusion, the comprehensive exploration of Best Practicable Environmental Options (BPEO) has revealed a steadfast commitment to our mission of conducting safely the launch of an orbital rocket while safeguarding the marine environment and transboundary ecosystems. Through a thorough assessment of potential effects, coupled with a meticulous examination of best practices, our efforts have resulted in the mitigation of adverse impacts to levels deemed as low as reasonably practicable, and no significant effect has been reported.

The launch of an orbital rocket inherently presents risks for environment and human activities. The remote location of our activities, the quantifications of our impact combined with our awareness and willingness to mitigate these risks to as low as reasonably practicable levels have concluded to a tolerable impact of our activities on marine and transboundary ecosystems.

The Civil Aviation Authority is the governmental body which oversee the licensing application of RFA. They ensure among some the impact of the operations on safety and environment through the Safety Case [6] and the Assessment of environmental effect [2].

## A. Acronyms and Abbreviations

Acronym	Definition
AEE	Assessment of Environmental Effect
AIS	Automatic Identification Systems
ALARP	As Low As Reasonably Practicable
BPEO	Best Environmental Practicable Options
CAA	Civil Aviation Authority
EEZ	Exclusive Economic Zone
EZI	Environmental Zone of Influence
FAA	Federal Aviation Administration
GLOW	Gross Lift Off Weight
RFA	Rocket factory Augsburg
SNMP	Scotland's National Marine Plan

## B. Reference Documents

- [1] RFA, "LIC-RFA-0013-(1-0): Hazard Areas".
- [2] RFA, "LIC-RFA-0009-(4-1): Assessment of Environmental Effect".
- [3] Marine Directorate, "Scotland's National Marine Plan," 2015.
- [4] Shetland Islands Council, "The local Development Plan," 2014.
- [5] Code of Federal Regulation, "Launch Safety," in *Code of Federal Regulation*, pp. Appendix B to Part 417, Title 14.
- [6] RFA, "LIC-RFA-0007-(2-1): Safety Case".