NLA INTERNATIONAL

SAXAVORD UK SPACE PORT NAVIGATIONAL RISK ASSESSMENT 2024

ORBITAL AND SUB-ORBITAL ROCKET LAUNCHES

NLA INTERNATIONAL

SAXAVORD UK SPACE PORT

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GLOSSARY

AIS Automatic Identification System. The Automatic Identification System is an automated, autonomous tracking system which is extensively used in the maritime world for the exchange of navigational information between AIS-equipped terminals. Static and dynamic vessel information can be electronically exchanged between AIS-receiving stations (onboard, ashore or satellite). Since December 2004, the International Maritime Organisation (IMO) requires all passenger vessels, as well as all commercial vessels over 299 Gross Tonnage (GT) that travel internationally, to carry a Class A AIS transponder (which transmits and receives AIS data) while smaller vessels can also be equipped with a Class B AIS transponder. This decision came as a result of the 2002 SOLAS (Safety of Life at Sea) agreement's relative mandate.

ALARP As Low As Reasonably Practicable. ALARP is a fundamental concept in UK health and safety law. Alongside the requirements in the Act, it applies to all activities within the scope of the Health and Safety at Work Act 1974 (HSWA). It is widely adopted within engineering good practice and across many sectors as a proportionate approach to safety risk management.

AOI Areas of Interest. These are the sea areas in which the Saxa Range is situated, and which has been studied to determine maritime activity. The AOI straddles a combination of international waters, and both the Exclusive Economic Zones (EEZ) and/or Territorial Waters (TTW) of the adjacent nations of the U.S., Canada, Greenland, Norway, Iceland, the Faroe Islands and the UK.

Boundary Boats. Saxa will employ commercial vessels to undertake both Range Safety and rocket recovery duties; Saxa has used the generic title of Boundary Boats for both services.

CAA Civil Aviation Authority. The UK’s aviation and space industry regulator.

CCG Canadian Coast Guard. The Canadian Coast Guard is a special operating agency of Fisheries and Oceans Canada and owns and operates the federal government's civilian fleet providing key maritime services to Canadians.

CCIP Continuous Computed Impact Point. The CCIP is a predicted point of impact found from the launch platform's movement, the target's movement, gravity, rocket launch velocity, rocket drag, and other factors that can be entered, such as wind, weather, humidity, barometric pressure. The last CCIP is the final point of impact before the launch vehicle reaches orbital status.

CAOFA Central Arctic Ocean Fisheries Agreement. The CAOFA is in place to prevent unregulated fishing in the high seas portion of the central Arctic Ocean through the application of precautionary conversation and management measures.

COLREGS Collision Regulations. COLREGs is the International Regulations for Preventing Collisions at Sea 1972 (as amended). A set of navigation rules to be followed by ships and other vessels at sea to prevent collisions between two or more vessels.

Debris Dispersion Radius is the area around a point of impact on the sea surface of a rocket or its debris, or rocket fairings and stages.

EEZ Exclusive Economic Zone. An EEZ, as prescribed by the 1982 United Nations Convention on the Law of the Sea, is an area of the sea in which a sovereign state has special rights regarding the exploration and use of marine resources, including energy production from water and wind. It stretches from the outer limit of the territorial sea (12 nautical miles from the baseline) out to 200 nautical miles from the coast of the state in question.

Exclusion Area or Zone. Part of a hazard area to which entry by any vehicle, ship, aircraft, or other craft, individual or domestic animal is excluded (as defined by the Space Industry Regulations 2021). Also known as an Overflight Exclusion Zone (FAA) and a Launch Exclusion Zone (Saxa).

FAA Federal Aviation Administration. The FAA is the regulator of all U.S. civil aviation activities, including management of air traffic in U.S. airspace.

FPSO Floating Production Storage and Offloading vessel. A FPSO is a floating vessel near an offshore oil field where oil is processed and stored until it can be transferred to a tanker.

FTS Flight Termination System. A system within a space rocket that, when activated (by mission control), will terminate the rocket’s flight by triggering a small explosion within the rocket to self-

destruct, and combust the rocket propellent and altitude, therefore minimising the debris that falls back to earth.

GMDSS Global Maritime Distress and Safety System. GMDSS is A maritime communication system for all types of vessel-to-vessel and vessel-to-shore communication, including routine communications as well as emergency and distress messages.

HEO Highly Elliptical Orbit. A HEO is a highly eccentrical orbit with a low perigee (the point of orbit closest to the Earth) altitude of under 1,000 km and a high apogee (the point farthest from the earth) altitude of over 35,756 km. The 'Highly Elliptical' term refers to the shape of the ellipse and the eccentricity of the orbit. A HEO follows the curve of an ellipse.

HMCG Her Majesty's Coastguard. HMCG is a section of the Maritime and Coastguard Agency responsible for the initiation and co-ordination of all maritime search and rescue within the UK Maritime Search and Rescue Region. This includes the mobilisation, organisation and tasking of adequate resources to respond to persons either in distress at sea, or to persons at risk of injury or death on the cliffs or shoreline of the UK. From 2015 it also took responsibility for land-based search and rescue helicopter operations.

HSE Health and Safety Executive. The body responsible for the regulation and enforcement of workplace health, safety and welfare, and for research into occupational risks in England and Wales and Scotland.

IDA Impact Dispersion Area. An area, defined by an impact dispersion radius, around the impact (splash down) point on the sea surface of a rocket or its debris, or rocket fairings and stages. The IDAs (measured in nautical miles of the radius) of rocket separation stages and fairings will be promulgated by Saxa ahead of any launches through Temporary Notices to Mariners.

IMO International Maritime Organisation. The IMO is a specialised agency of the United Nations responsible for measures to improve safety and security of international shipping and to prevent pollution from ships. It is also involved in legal matters, including liability and compensation issues and the facilitation of international maritime traffic.

JMOCC Joint Maritime Operations Coordination Centre. The JMSC's Operations Centre, which provides 24/7 monitoring of UK waters. Utilising a staff drawn from across government it can swiftly identify maritime security incidents and enable the effective coordination of the UK's aerial and at-sea assets to respond.

JMSC Joint Maritime Security Centre. The JMSC is the multi-agency organisation responsible for ensuring the UK maintains its understanding of the UK maritime domain and develops the cross-government coordination frameworks to respond to threats to security, law and order, and the marine environment.

JNCC Joint Nature Conservation Committee. The JNCC is the public body that advises the UK Government and devolved administrations on UK-wide and international nature conservation.

JRCC Joint Rescue Coordination Centre. JRCC is a rescue coordination centre responsible for both aeronautical and maritime search and rescue operations.

JTEPS Joint Tactical Exercise Planning Staff. An organisation within the UK MoD predominantly staffed by Royal Navy personnel. JTEPS principal output is to plan and run the bi-annual Joint Warrior series of military exercises that take place in the maritime, land and air environments.

Kts Knots. A unit of speed equal to one nautical mile per hour.

Launch Area. Launch Area is a FAA definition pertaining to the construct of a flight corridor and categorised as a portion of a flight corridor from the launch point to a point 100nm in the direction of the flight azimuth. It is not classified as a Restricted Area or Exclusion Zone but sits within the overall Hazard Area.

LEOP Launch Early Operations Phase. The LEOP is one of the most critical phases of a mission, where spacecraft operations engineers take control of the satellite after it separates from the launch vehicle up to the time when the satellite is safely positioned in its final orbit.

LEZ Launch Exclusion Zone. Part of a hazard area to which entry by any vehicle, ship, aircraft, or other craft, individual or domestic animal is excluded during the launch and flight of a launch vehicle.

DPI Drilling and Production Island. A fixed oil platform on a man-made ‘gravel’ island.

LV Launch Vehicle. A LV or carrier rocket is a rocket-propelled vehicle used to carry a payload from earth's surface to space, usually to earth orbit or beyond.

MAIB Marine Accident Investigation Branch. The MAIB is a section of the Department for Transport which investigates marine accidents involving UK vessels worldwide and all vessels in UK territorial waters.

Marine Scotland. The Marine Scotland Directorate is a directorate of the Scottish Government. Marine Scotland manages Scotland's seas and freshwater fisheries along with delivery partners NatureScot and the Scottish Environment Protection Agency.

MARPOL International Convention for the Prevention of Pollution from Ships.

MCA Maritime and Coastguard Agency. The agency responsible for the regulation of the UK maritime industry, prevention of the loss of life on the coast and at sea. The MCA produces legislation and guidance on maritime matters and provide certification to seafarers. Through HMCG, it provides a 24-hour maritime search and rescue service around the UK coast and international search and rescue. The MCA is responsible for the safety of navigation outside of port limits, as a coastal State under the International Maritime Organization’s (IMO) International Convention for the Safety of Life at Sea, 1974 (SOLAS). The MCA also has responsibilities under the Merchant Shipping Act 1995.

MCTS Marine Communications and Traffic Services. A safety and navigation-related services for vessels, boaters and fishers provided by the Canadian government.

MDA Maritime Domain Awareness. MDA is defined by the International Maritime Organisation as ‘the effective understanding of anything associated with the maritime domain that could impact the security, safety, economy, or environment’. The maritime domain is defined as all areas and things of, on, under, relating to, adjacent to, or bordering on a sea, ocean, or other navigable waterway, including all maritime-related activities, infrastructure, people, cargo, and vessels and other conveyances.

MPA Marine Protected Area. MPAs are defined geographical areas of the marine environment established and managed to achieve long-term nature conservation and sustainable use.

MRCC Maritime Rescue Coordination Centre. A MRCC is a rescue coordination centre responsible for maritime search and rescue operations.

MSI Maritime Safety Information. Navigational and meteorological warnings, meteorological forecasts, and other urgent safety-related information broadcast to ships.

NASA National Aeronautics and Space Administration. NASA is a U.S. government agency that is responsible for the civil space programme, research and science and technology related to air and space.

NAVAREAS Navigational Areas. The maritime geographic areas in which various governments are responsible for navigation and weather warnings.

NAVTEX Navigational Telex. NAVTEX is an international automated medium frequency direct-printing service for delivery of navigational and meteorological warnings and forecasts, as well as urgent maritime safety information (MSI) to ships.

NAVWARNS Navigational Warnings. NAVWARNs are broadcast warnings promulgated by the Worldwide Navigational Warnings Service (WWNWS) to provide rapid dissemination of information critical to navigation and the safety of life at sea. Navigational Warnings contain information about persons in distress, or objects and events that pose an immediate hazard to navigation.

NCMPA Nature conservation MPAs (NCMPAs) are regions of the seas and coasts where wildlife is protected from damage and disturbance.

NMIC National Maritime Information Centre. The NMIC is part of the JMSC, the purpose of which is to provide a mechanism for the UK's civilian and military maritime and law enforcement focused organisations to fuse intelligence, data and capabilities.

NPFMC North Pacific Fishery Management Council. The North Pacific Fishery Management Council is one of eight regional councils established by the Magnuson-Stevens Fishery Conservation and Management Act in 1976 to manage fisheries in the 200-mile Exclusive Economic Zone.

NORDEG Northern Canada Vessel Traffic Services Zone Regulations. NORDEG splits Canadian waters into zones for management and regulation.

NRA Navigational Risk Assessment. Navigation (Marine) Risk Assessments identify and assess the hazards and risks affecting vessel navigation, before considering current controls to mitigate risks and further controls that could be adopted to minimise risk as low as reasonably practicable (ALARP).

NTMs Notices to Mariners**.** A NTM advises mariners of important matters affecting navigational safety, including new hydrographic information, changes in channels and aids to navigation, and other important data. UK Admiralty NTMs, produced by the UK Hydrographic Office, contain all the corrections, alterations and amendments for the UKHO's worldwide series of Admiralty charts and publications. NTMs come in various forms, including daily, weekly, cumulative, annual, and Temporary & Preliminary. Temporary and Preliminary Notices are issued when the information will only be valid for a short period of time or needs to be promulgated quickly and a normal chart correction would take too long to prepare and distribute..

OREI Offshore Renewable Energy Installations. An offshore wind farm is an example of a OREI.

Range. A range is a zone (or zones) consisting of a volume of airspace and area of land and/or sea, in relation to which warnings, restrictions or exclusions are put in place. Establishing a range will be critical to the safe operation of spaceflight activities. Saxa has determined that a Range ('Hazard Area' in MCA/SIR terminology) will be nominally defined as an area extending no greater than between 330° to 030° to a range from Lamba Ness of 900nm, which is an area 1.1 million km². The entire Range will encompass a wide area of sea and airspace with finite chunks (polygons) used for each launch. Launch types and trajectories will determine the size and shape of these polygons and therefore how much of the range space will be used for each launch.

Range Control Licence. The regulators will issue a range control licence for the provision of range control services by commercial entities, including tracking, surveillance and boundary control.

RFMO. Regional Fisheries Management Organisations. RFMOs are international organisations establishing binding measures for conservation and sustainable management of highly migratory or straddling fish species.

RNLI Royal National Lifeboat Institution. The RNLI is the largest charity that saves lives at sea around the coasts of the UK, the Republic of Ireland, the Channel Islands, and the Isle of Man, as well as on some inland waterways.

ScotWind is a Crown Estates programme to lease areas of the seabed around Scotland for wind farm developments.

SIRMP Shetland Islands Regional Maritime Plan. The aim of the SIRMP is to manage the marine environment in Shetland in a sustainable way to have clean, healthy, safe, productive and diverse seas, managed to meet the long-term needs of nature and the people.

Space Launch Hazard Area. The area where the licensee's range control services consist of or include identifying a volume of airspace or an area or areas of land or sea falling within the designated range (a 'hazard area') which require restrictions, exclusions or warnings for keeping the area clear at relevant times of: (a) persons or things that might pose a hazard to the operator's spaceflight activities; and (b) persons or things to which the operator's spaceflight activities might pose a hazard (as defined by the Space Industry Regulations 2021).

Space Launch Restricted Area. A part of a hazard area to which entry is restricted to authorised individuals whose presence is necessary for carrying out of spaceflight activities or for performance of duties in connection with such activities (as defined by the Space Industry Regulations 2021).

Splash Down Area. The predicted area in which the debris or components or payload contact with the sea surface.

SOLAS The International Convention for the Safety of Life at Sea. SOLAS is an international maritime treaty that sets minimum safety standards in the construction, equipment and operation of ships. The convention requires signatory flag states to ensure that ships flagged by them comply with at least these standards.

SOPs Standard Operating Procedures. A detailed set of instructions for a vessels crew to perform tasks.

SPA Special Protection Area. A SPA is a designation under the European Union Directive on the Conservation of Wild Birds. Under the Directive, Member States of the European Union (EU) have a duty to safeguard the habitats of migratory birds and certain particularly threatened birds.

SQEP Suitably Qualified and Experienced Person.

STCW The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers. STCW sets the minimum qualification standards for masters, officers and watch personnel on seagoing ships and vessels. It was adopted in 1978 at the IMO and entered into force in 1984. The convention was significantly amended in 1995 and 2010 and entered force in 2012.

SRR Search and Rescue Regions.

SSO Sun Synchronous Orbit. SSO is a particular kind of polar orbit. Satellites in SSO, travelling over the polar regions, are synchronous with the Sun, meaning that they are synchronised to always be in the same ‘fixed’ position relative to the Sun and therefore always visit the same spot each day at the same local time.

TSB The Transportation Safety Board of Canada. The TSB is an independent agency that advances transportation safety by investigating occurrences in the air, marine, pipeline and rail modes of transportation.

TTW Territorial Waters. As defined by the 1982 United Nations Convention on the Law of the Sea, TTW is a belt of coastal waters extending at most 12 nautical miles from the baseline (usually the mean low water mark) of a coastal state.

UNCLOS United Nations Convention on the Law of the Sea**.** Also called the Law of the Sea Convention or the Law of the Sea Treaty, UNCLOS is an international agreement that establishes a legal framework for all marine and maritime activities.

UK Space Industry Act 2018 (SIA). The SIA establishes the provisions for a regulatory framework to support commercial spaceflight activities at spaceports in the UK.

UK Space Industry Regulations 2021 (SIR). The SIR provides the legislative framework to regulate the UK space industry, covering licencing, compliance, monitoring, safety and security aspects of commercial spaceflight activities, spaceports and range control services in the UK.

USCG United States Coast Guard. The USCG, as the fifth military service of the U.S., manages 6 major operational mission programmes: maritime law enforcement, maritime response, maritime prevention, marine transportation system management, maritime security operations and defence operations.

VMS Vessel Monitoring System. Allows a vessel to be automatically located and identified through the system by transmitting position data every 2 hours when at sea.

VTS Vessel Traffic Service. A VTS is a marine traffic monitoring system established by harbour or port authorities.

Vulnerable Marine Ecosystems. VMEs constitute areas that may be vulnerable to impacts from fishing activities.

Warning Zone. A part of a hazard area to which entry is not restricted but which is subject to a requirement to provide a warning notice in accordance with Regulation 51 of the Space Industry Regulations 2021 (as defined by the Space Industry Regulations 2021.

WWNWS World-Wide Navigation Warning Service. A co-ordinated global service for the promulgation of navigational warnings.

WZ. WZ is the prefix for a radio navigational warning.

1. Introduction

Background

1.1. **SaxaVord UK Spaceport (Saxa)** (formerly Shetland Space Centre Ltd) was formed in 2017 and is building a multi-use spaceport for vertical launch operations on the island of Unst, Shetland. The spaceport comprises launch pads and associated infrastructure allowing for a launch cadence ramping up to 30 launches per year over the course of several years. The spaceport will support the launch of small satellites into Polar, Sun Synchronous (SSO) and Highly Elliptical Orbits (HEO). The spaceport will include a ground segment for: telemetry and tracking (T&T); launch early operations phase (LEOP) operations; and data acquisition. There will also be a rocket range and the provision of range control services to enable spaceflight activities to take place.

1.2. Unst is the most northerly of the 16 inhabited islands that form the Shetland archipelago - the headland lies at 60.8ºN with no land between it and the North Pole. This makes the 160-hectare headland suitable for a small rocket launch site, with relatively unobstructed and direct access into orbit.

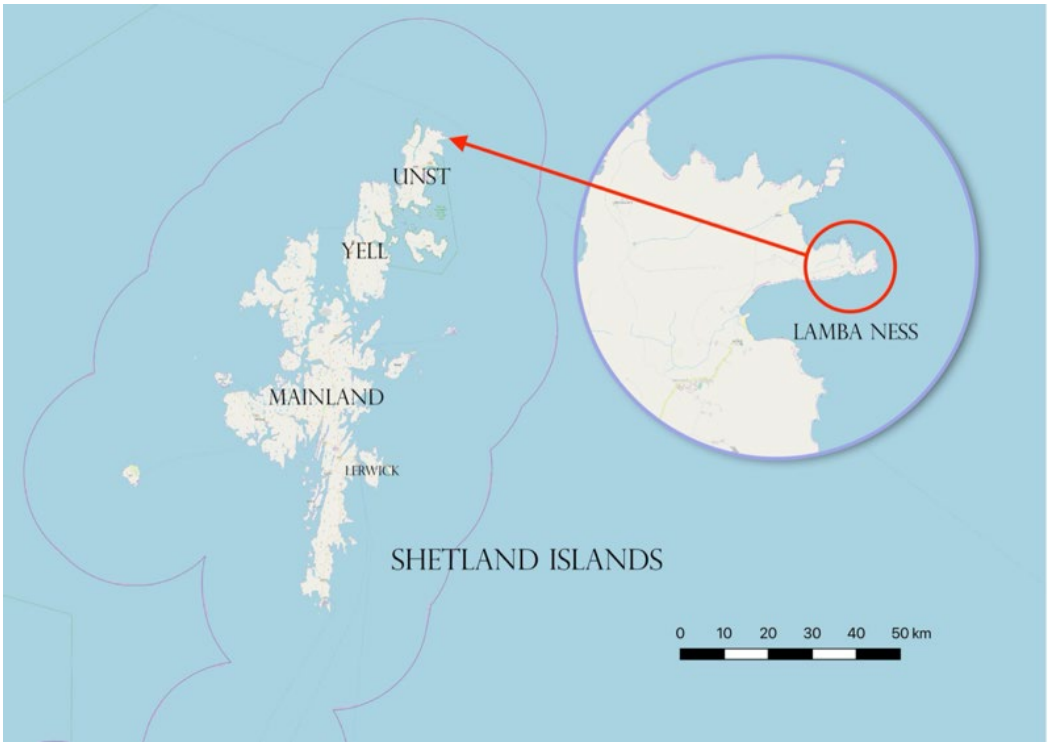

Figure 1: Location of Saxa UK Spaceport

1.3. **NLA International (NLAI)** champions the implementation of Blue Economy solutions by enabling the utilisation of innovative technologies, tools and processes to create sustainable ocean environments for the people and economies that depend upon them. NLAI works on projects around the world, providing a conduit to suppliers of innovation to access wider markets, raising awareness of Blue Economy potential and inspiring engagement of current stakeholders and future generations. NLAI has wide-reaching experience in maritime domain awareness.

Scope of Work

1.4. Spaceflight activities have the potential to impact the marine environment through two primary channels: through the development of spaceports along coastal areas or through vertical and horizontal launch operations[1]. The latter may result in components of the launch vehicle being jettisoned into national and/or international waters during launch operations. Jettisoned objects

[1] Maritime & Coastguard Agency 'Spaceflight Activities: Risk Mitigation for Shipping, Navigation and Emergency Response, para 1.1.3', draft dated 4 Nov 21.

have the potential to cause both direct and indirect impacts on the marine environment, activities and users, which could extend well beyond the launch activity timeframe, including but not limited to:

1.4.1. Direct strike from jettisoned objects with persons, marine wildlife, vessels (or other craft), or offshore installations and infrastructure.

1.4.2. Marine pollutants from jettisoned objects.

1.4.3. Floating debris impacting shipping and safe navigation.

1.4.4. Changes to seabed topography reducing vessel under keel clearance.

1.4.5. Re-routing of vessel traffic to avoid a Space Launch Hazard Area.

1.4.6. Coastal activities (e.g. kayaking, fishing, walking).

1.5. NLAI has been commissioned by Saxa to undertake a Navigational Risk Assessment (NRA) in support of its marine licence application for the launch, and where required, recovery, of orbital and sub-orbital rockets. The NRA will consider the effects of launch and recovery operations on surface marine navigation within the specified launch and recovery areas for the proposed orbital and sub-orbital rocket activity, plus the wider impact on the maritime community within what is defined as the Saxa Range. The NRA assesses the launch and recovery phases of orbital and sub-orbital rockets and identifies appropriate mitigation measures. It must be noted that this NRA does not consider the risks associated with air traffic.

1.6. While the NRA is designed to analyse risk for a number of different rocket types that may launch from Saxa, it will specifically address the orbital launch of the Rocket Factory Augsburg (RFA) NOM ONE Launch Vehicle (LV) scheduled to launch later in 2024 in a window of 1 August – 30 September.

1.7. The NRA will cover and include:

1.7.1. Description of the Marine Environment.

1.7.2. Description of SaxaVord UK Spaceport launch operations.

1.7.3. Data Sources and Vessel Traffic Analysis.

1.7.4. Hazard Identification.

1.7.5. Risk Analysis and Assessment.

1.7.6. Risk Controls.

1.7.7. Risk Tolerability Statement.

Legislation and Guidance

1.8. **The UK Space Industry Act 2018 (SIA)**. SIA establishes the provisions for a regulatory framework to support commercial spaceflight activities at spaceports in the UK. A significant aspect of this structure are the regulations governing the launch of spacecraft. A key change is the transfer of the spaceflight regulator role from the UK Space Agency to the Civil Aviation Authority (CAA). The CAA is therefore responsible for all SIA regulatory functions.

1.9. **UK Space Industry Regulations 2021 (SIR)**. SIR provides the legislative framework to regulate the UK space industry, covering licencing, compliance, monitoring, safety and security aspects of commercial spaceflight activities, spaceports and range control services in the UK.

1.10. **The United Nations Convention on the Law of the Sea (UNCLOS)** Part Two Section One (General Provisions), Section Two (Limits of the Territorial Sea), Section Three (Innocent Passage in the Territorial Sea), Section Four (Contiguous Zone); Part Three Section Two (Transit Passage), Section Three (Innocent Passage), Section Five (EEZ), Section Six (Continental Shelf), Section Seven (High Seas); Part Eleven, Section Two, Article 146 (Preservation of Human Life).

1.11. **Marine (Scotland) Act 2010** and associated Delegation of Functions (Regional Marine Plan for the Scottish Marine Region for the Shetland Isles) Direction 2016. The policy framework is

in line with Scotland's National Marine Plan (2015) and is used to assess marine development applications for marine licences (by Marine Scotland), works licences and marine planning applications (by Shetland Islands Council).

1.12. **The Merchant Shipping (Safety of Navigation) Regulations 2002** implements the Safety of Life at Sea (SOLAS) Convention Chapter V (Safety of Navigation) 2002. This applies to all vessels on all voyages, therefore for the purposes of this document 'sea lanes' are considered to be IMO-adopted routeing measures and potentially other sea routes transited by all vessel types.

1.13. **International Regulations for Preventing Collisions at Sea** (COLREGS) 1972/78, as implemented in the UK through Marine Shipping Notices (IMO, 1972/78).

1.14. **Spaceflight Activities: Risk Mitigation for Shipping, Navigation and Emergency Response** is a document produced by the MCA providing guidance on MCA and UK Hydrographic Office requirements for space launch activities in the UK.

1.15. **MGN 654 (M+F) Safety of Navigation: Offshore Renewable Energy Installations (OREIs)** – Guidance on UK Navigational Practice, Safety and Emergency Response is a MCA document that address the navigational and emergency response impacts of OREIs proposed for UK sites.

1.16. **Methodology for Assessing Marine Navigational Safety & Emergency Response Risks of Offshore Renewable Energy Installations V3.1** is a document produced in 2023 by the MCA as a methodology for assessing the marine navigational safety & emergency response risks of offshore renewable energy installations.

1.17. **The Principles and Guidelines for the Spaceflight Regulator in Assessing ALARP and Acceptable Risk 2021** is a Civil Aviation Authority (CAA) document to support consistent and transparent decision-making by the regulator's staff by setting out the principles that underpin the regulator's view on acceptable levels of residual risk and providing guidelines on judging whether a licence applicant has met the requirements to reduce risks to ALARP.

1.18. **The Shetland Islands Regional Marine Plan (amended 2021)** reflects the requirements for regional marine planning under the Marine (Scotland) Act 2010 and associated Delegation of Functions (Regional Marine Plan for the Scottish Marine Region for the Shetland Isles) Direction 2016. The policy framework is in line with Scotland's National Marine Plan (2015) and will be used to assess marine development applications for marine licences (by Marine Scotland), works licences and marine planning applications (by Shetland Islands Council), and leases by Crown Estate Scotland.

1.19. **Code of Federal Regulations Title 14 Chapter 3 – Commercial Space Transportation** contains the U.S. codified Federal laws and regulations pertaining to aeronautics, air transportation/aviation, and space exploration, including areas overseen by the FAA and NASA.

1.20. **The Canada Shipping Act 2001** is the umbrella for maritime activities and regulations.

1.21. **The Central Arctic Ocean Fisheries Agreement** is designed to prevent unregulated fishing in the high seas portion of the central Arctic Ocean through the application of precautionary conservation and management measures as part of a long-term strategy to safeguard healthy marine ecosystems and to ensure the conservation and sustainable use of fish stocks.

1.22. **The IMO International Code for Ships Operating in Polar Waters** (or the Polar Code) is a binding, mandatory international standard for commercial ships and passenger vessels (500 tonnes and larger) operating in Antarctic and Arctic waters.

1.23. **Marine and Coastal Access Act 2009** is an act of Parliament created to introduce a new marine planning system designed to bring together the conservation, social and economic needs of the UK's seas.

Data Sources

1.24. To understand maritime patterns of life this report has utilised multi-source information, including Automatic Identification System (AIS) data, including from:

1.24.1. Starboard Maritime Intelligence.

1.24.2. Windward Intelligence.

1.24.3. Keplr.GI.

1.24.4. Emu Analytics.

1.24.5. European Atlas of the Seas.

1.24.6. IHS Markit.

1.24.7. Global Fishing Watch.

1.24.8. Marine Scotland National Marine Plan Interactive (NMPI).

1.24.9. UK Marine Accident and Investigation Branch.

1.24.10. The Royal National Lifeboat Institution.

1.24.11. Canadian Coast Guard.

1.24.12. U.S. Coast Guard.

1.24.13. 4C Offshore.

1.24.14. Norskpetrolium Interactive Map.

1.24.15. North Sea Transition.

1.24.16. Authority Interactive Energy Map.

1.24.17. IMO Global Integrated Shipping Information System.

1.24.18. UK Hydrographic Office Admiralty Charts.

Consultation and Stakeholder Engagement

1.25. In completing this NRA a full and comprehensive stakeholder engagement process was undertaken. The purpose of the stakeholder engagement and consultation was to:

1.25.1. Apprise of the existence, intent and mode of operations of Saxa.

1.25.2. Ascertain the stakeholders' involvement and responsibilities within the AOI.

1.25.3. When dealing with industry, understand their use of the sea, and any potential impacts Saxa may have on their livelihood and/or commercial operations.

1.25.4. Establish a network and relationships that Saxa can utilise on an enduring basis.

1.25.5. Provide the stakeholder community with a voice, and in particular give them the opportunity to raise concerns and issues.

Risk Techniques

1.26. There are a wide range of risk assessment techniques available, and the selection of the techniques should be:

1.26.1. Proportionate to the scale of the project and the magnitude of the risk.

1.26.2. Acceptable to Government.

1.26.3. Techniques and tools appropriate to aspects of specific developments include:

1.26.3.1. No action.

1.26.3.2. Expert judgement.

1.26.3.3. Qualitative assessment.

1.26.3.4. Quantitative assessment.

1.26.3.5. Simulations.

1.26.3.6. Trials.

1.26.3.7. Analysis of real-word situation.

1.26.4. To provide a risk assessment this NRA has used a combination of:

1.26.4.1. Expert judgement.

1.26.4.2. Qualitative and quantitative assessments.

1.26.4.3. Analysis of real-world situation.

Areas of Interest

1.27. This NRA covers a significant ocean area; therefore, analysis of the marine environment is divided into two regions: Arctic Ocean/Beaufort Sea AOI and the Nordic Seas[2] AOI. Each region will be analysed individually to determine the extent of human activity in each AOI.

2. AOI 1 – ARCTIC OCEAN/BEAUFORT SEA

The Maritime Environment

2.1. The Arctic Ocean/Beaufort Sea AOI covers an area of around 600,000nm², extending east from the western limit of the U.S. EEZ along the Alaskan and Canadian north coasts and north to 85° north, as illustrated in Figure 2.

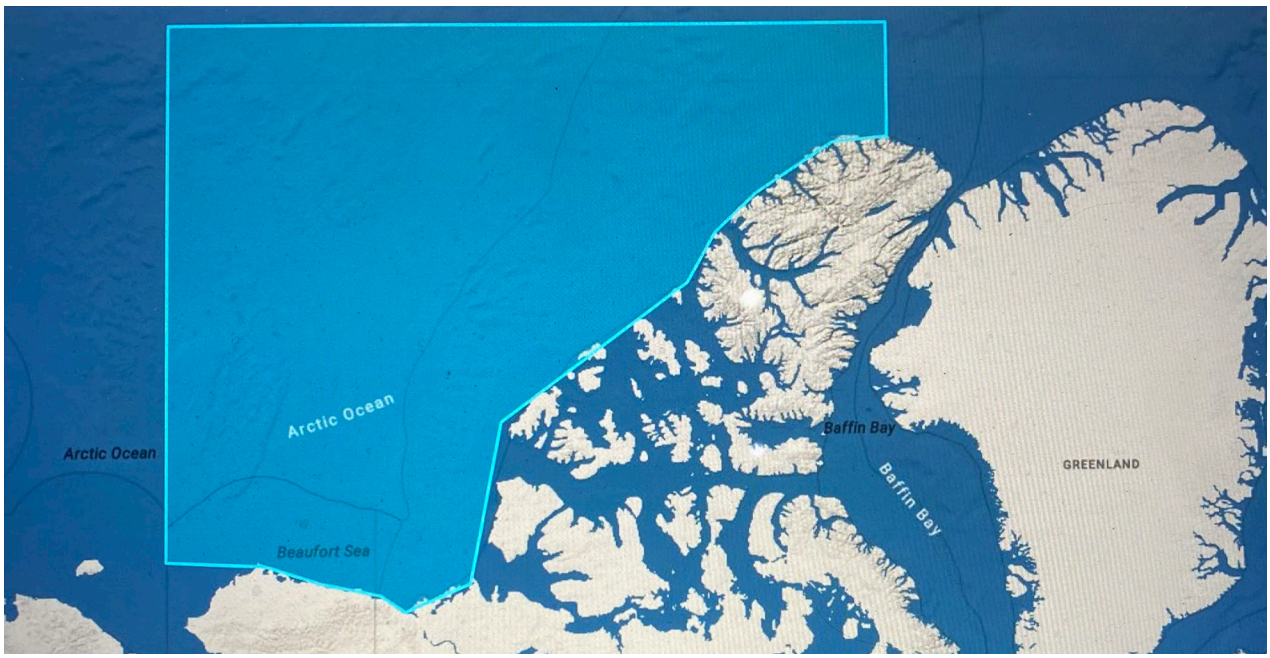

Figure 2: Arctic Ocean/Beaufort Sea AOI

2.2. The Arctic Ocean is unique in that nearly one-third of its total area is underlain by continental shelf, which is asymmetrically distributed around its circumference. Several factors in the Arctic Ocean make its physical, chemical, and biological processes significantly different from those in the adjoining North Atlantic and Pacific Oceans. Most notable is the covering ice pack, which is the sea ice cover of the Arctic Ocean and its vicinity. Despite the extent of the ice pack reducing significantly in the last 10 years, the coverage is still extensive, as shown in Figure 3.

[2] For this NRA the Nordic Seas are defined as the Greenland, Iceland and Norwegian Seas.

Figure 3: Arctic Sea Ice Coverage

2.3. Sea ice rarely forms in the open ocean below a latitude of 60° N but does occur in more southerly enclosed bays, rivers, and seas. Between about 60° and 75° N the occurrence of sea ice is seasonal, and there is usually a period of the year when the water is ice-free. Above a latitude of 75° N there is a more or less permanent ice cover.

2.4. The average Arctic Ocean and Beaufort Sea depth is 1000m. The surface water mass is nearly 330ft thick and ranges in temperature from -1.4° C in late summer to -1.8° C in winter. The subsurface water mass, formed by the waters of the Pacific Ocean and the Bering Sea flowing through the Bering Strait, is much warmer than the surface water and almost reaches the North Pole. The deep Atlantic water is the warmest of all, its temperature ranging from 0° to 1° C. The bottom water has temperatures ranging from -0.4° to -0.8° C.

Climate

2.5. The Arctic Ocean is characterised by persistent cold and relatively narrow annual temperature ranges. Winters are characterised by the polar night[3], extreme cold, frequent low-level temperature inversions, and stable weather conditions. Summers are characterised by continuous daylight (midnight sun), and air temperatures can rise slightly above 0 °C. Cyclones are more frequent in summer and may bring rain or snow. It is cloudy year-round, with mean cloud cover ranging from 60% in winter to over 80% in summer.

Currents

2.6. The two major currents in the Arctic Ocean are the Transpolar Drift and the Beaufort Gyre, illustrated at Figure 4. Transpolar Drift is a surface current that crosses the North Pole and central Arctic Ocean from Siberia to ends up in the Arctic outflow in the East Greenland Current in the western Fram Strait. The Beaufort Gyre is an ocean and ice circulation pattern in the Beaufort Sea, north of Alaska. This gyre moves in a clockwise direction, fed by an average high-pressure system that fosters anti-cyclonic winds. Ice that forms in or drifts into the Beaufort Gyre has historically remained in the Arctic ice system for years, accumulating snow and thickening each winter. Beginning in the late 1990s, the ice began melting away while in the southern parts of the gyre, before completing the circulation.

[3] Polar night is a phenomenon in the northernmost and southernmost regions of Earth where night lasts for more than 24 hours, occurring only inside the polar circles.

Figure 4: Arctic Sea Currents

Maritime Activity overview

2.7. The Arctic Ocean/Beaufort Sea AOI is a relatively quiet region for shipping and maritime traffic. The extent of the sea ice precludes routine navigation and passage for most vessels and generally only icebreakers have the capability to proceed further North than the coastal shipping routes. The main transport areas are in Northern Europe – from Iceland to the Kara Sea through the Norwegian coast – and along the coast of Alaska (USA). Cargo ships as well as government vessels, including icebreakers, account for the largest share of the traffic in the Arctic. The number of tourism-related shipping activity and private yachts is increasing. Figure 5 shows the zones of maritime activity in the Arctic.

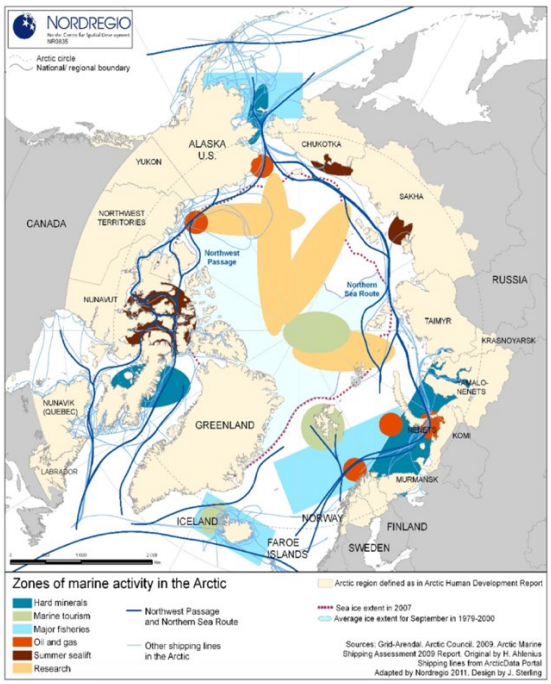

Figure 5: Arctic Zones of Maritime Activity

2.8. The Arctic shipping routes are the maritime tracks used by vessels to navigate through parts or the entirety of the Arctic. There are three main routes that connect the Atlantic and the Pacific oceans: the Northeast Passage, the Northwest Passage, and the mostly unused Transpolar Sea Route, as shown at Figures 6 & 7. These main transport corridors in the Arctic have all experienced significant growth in the maritime traffic in the recent years. The Northern Sea Route is the shortest route between Europe and the Asia-Pacific region and is competing with traditional trade lines. Between 2016 and 2017 the cargo volume in Northern Sea Route increased by nearly 40%. In the Canadian Arctic the traffic has almost tripled between 1990-2015.

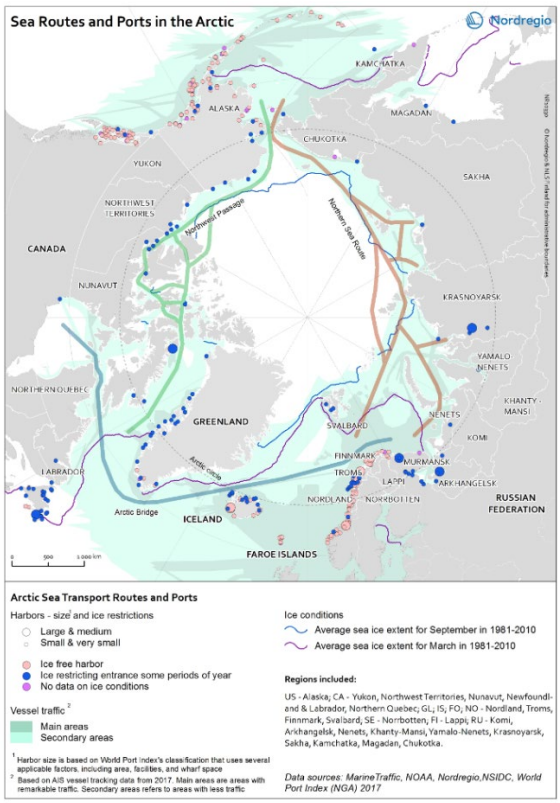

Figure 6: Arctic Shipping Routes

Figure 7: Transpolar Sea Route

2.9. The principal route through the AOI is the Northwest Passage, the sea lane between the Pacific and Atlantic Oceans through the Arctic Ocean along the Northern coast of North America via waterways through the Arctic Archipelago of Canada. The Passage is closed throughout the winter, the ice making it impassable. Although from 2007 ships were able to transit the Northwest Passage without an icebreaker escort, during the Arctic shipping season the Canadian Coast Guard operates several icebreakers in the region, offering assistance to vessels, including cruise ships, from Spring before the winter sea ice melts through to Autumn when it starts forming again.

2.10. In 2023 only 41 vessels made a complete transit of the Northwest passage (18 yacht or other private, 11 passenger voyages, 12 commercial)[4], although in addition a small number of ships also made the transit from the Bering Strait to the ports and oil terminals along the North Alaskan and Canadian coast.

2.11. Regarding the increasing maritime traffic in the Arctic, the interests of economic potential and challenging physical conditions are balancing. Even if the sea ice coverage is decreasing, the Arctic region is still a challenging environment. In the wintertime ice floes lack predictability and the conditions vary seasonally. Travelling across multiyear ice – that can be more than three metres thick – is challenging even for icebreakers which progress better across first-year ice – less than one metre thick. Icebreaker escorts in the wintertime are not only costly but are also limiting the maximum width of the vessel escorted. During the open water season the transit is often challenging due to severe storms or heavy fog that is obscuring visibility – thus leading to decreased transit speed. The lack of infrastructure in the region further complicates the transits[5].

Ice Class Ships

2.12. An ice classed ship, also known as an ice navigation vessel, refers to an internationally recognised standard of strengthening to allow it to navigate unaided through sea ice or to follow and ice breaker in more challenging conditions.

2.13. For a normal ship, the installed propulsion power of the main engine needed to obtain the required ship speed in service may be sufficient for propulsion conditions during wintertime. However, depending on the form and thickness of the ice, and thereby the ice class required, combined with the lowest ambient air temperature appearing during winter operation, some increased capabilities of the main engine may be required.

2.14. Ships with an ice class for winterisation are built with thicker hulls with stronger girders, beams, and bulkheads. How thick and how strong depends on the different ice class levels, which also specify a minimum power output. They also generally require several forms of rudder and propeller protection and strengthened propeller tips.

Icebreakers

2.15. An icebreaker is a special-purpose ship or boat designed to move and navigate through ice-covered waters and provide safe waterways for other boats and ships. The design of an icebreaker is such that it can sail through thick ice at the head of a convoy of ordinary cargo ships, clearing a waterway for them. These ships are of a double hull construction that allows them to reach polar regions and carry out research. Their scantlings[6] are increased when compared to other ordinary vessels, and the steel used in their construction is of a special grade that does not lose strength when exposed to very low temperatures.

2.16. All Arctic nations operate icebreakers, but Russia is the only country to build nuclear icebreakers. As well as providing an escort function to ships navigating the Arctic sea routes, icebreakers are used as coastguard/government vessels to service the offshore energy sector and for scientific research.

Fishing

2.17. With the Arctic ice pack receding year on year, commercial fishing in the Arctic Ocean has become more accessible. Because of concerns about overfishing, the north Pacific Fishery Management Council (NPFMC), one of eight regional councils[7], was established by the Magnuson-Stevens Fishery Conservation and Management Act[8] in 1976.

2.18. In 2009 the NPFMC approved a new Fishery Management Plan for Fish Resources of the Arctic Management Area (Arctic FMP). The Council's action recognised the different and

[4] https://www.spri.cam.ac.uk/resources/infosheets/northwestpassage.pdf
[5] https://nordregio.org/maps/sea-routes-and-ports-in-the-arctic/
[6] Structural frames.
[7] https://www.fisherycouncils.org/
[8] The Magnuson–Stevens Fishery Conservation and Management Act (2007) is the primary law that governs marine fisheries management in U.S. federal waters.

changing ecological conditions of the Arctic, including warming trends in ocean temperatures, the loss of seasonal ice cover, and the potential long-term effects from these changes on the Arctic marine ecosystem. More prolonged ice-free seasons coupled with warming waters and changing ranges of fish species could together create conditions that could lead to commercial fishery exploitation in the U.S. Arctic Exclusive Economic Zone (EEZ). The emergence of unregulated, or inadequately regulated, commercial fisheries in the Arctic EEZ off Alaska could have adverse effects on the sensitive ecosystem and marine resources of this area, including fish, fish habitat, and non-fish species that inhabit or depend on marine resources of the U.S. Arctic EEZ, and the subsistence way of life of residents of Arctic communities. The Arctic Management Area is illustrated in Figure 8.

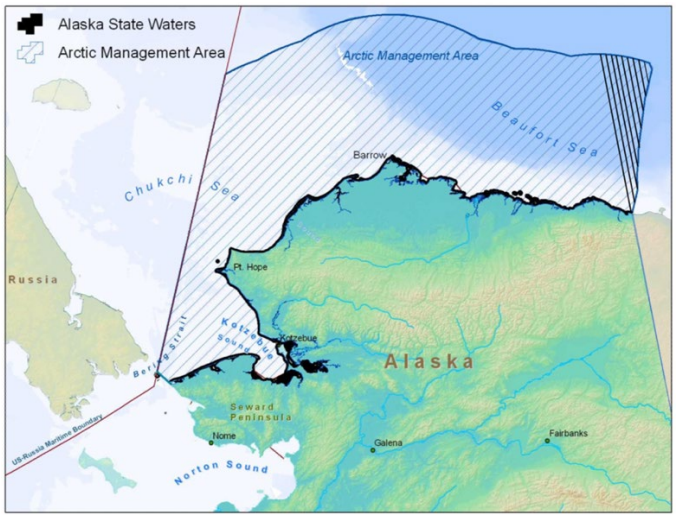

Figure 8: Arctic FMP Area

2.19. In October 2018, a new initiative for the protection of Arctic fish stocks, entitled the Central Arctic Ocean Fisheries Agreement[9] (CAOFA), was signed by ten parties, namely: Canada, Iceland, Denmark, Norway, the U.S., Russia, China, Japan, South Korea and the European Union. In June 2021, the CAOFA entered into force to prevent unregulated commercial fishing in a wide swath of the Arctic Ocean that could have caused significant harm to the marine environment. The CAOFA will last for 16 years to ensure that adequate scientific information is available that can inform decision making in relation to the viability and sustainability of any potential future fishing activities in the agreement area. The CAOFA area is shown at Figure 9.

Figure 9: CAOFA Area

[9] https://www.mofa.go.jp/files/000449233.pdf

Marine Protected Areas

2.20. Within the Arctic, different types of national Marine Protected Areas (MPAs) have been established under national legislations. The Arctic covers a number of seas under national jurisdictions as well as areas beyond national jurisdictions (high seas). High sea MPAs, known as Vulnerable Marine Ecosystems (VMEs), have been established by Regional Fisheries Management Organisations (RFMOs). Although there are around 1300 protected areas in the Arctic, most of these areas are terrestrial (1069), while 126 are coastal – defined as partially within the marine environment – and 62 are marine[10], as illustrated in Figure 10.

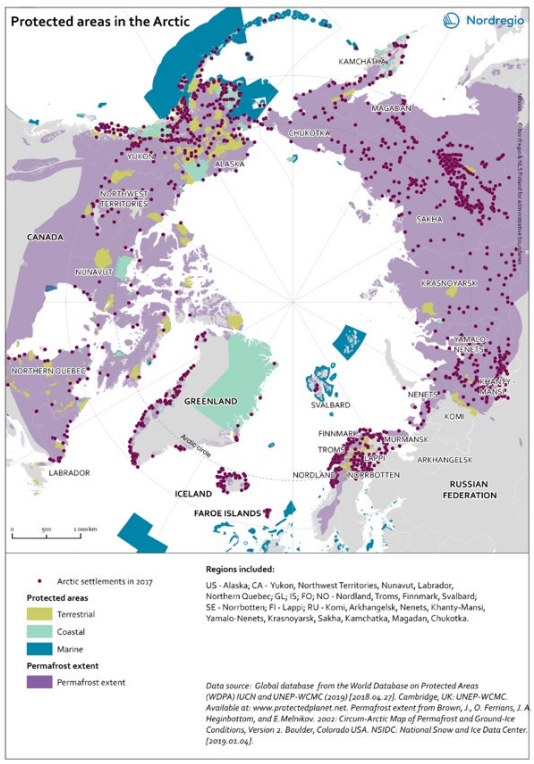

Figure 10: Protected Areas in the Arctic

2.21. There are no MPAs within the Arctic Ocean/Beaufort Sea AOI, as shown at Figure 11. However, the Canadian portion of the Beaufort Sea is governed by the Beaufort Sea Large Ocean Management Area, including the marine portion of the Inuvialuit Settlement Region, which is one of five priority areas identified for integrated ocean management planning by the Government of Canada. The Beaufort Sea Management Plan is organised around 6 thematic goals of: governance, economic, cultural, social, traditional and ecosystem.

[10] https://nordregio.org/maps/protected-areas-in-the-arctic/#:~:text=Within%20the%20northern%20circumpolar%20permafrost,environment%20%E2%80%93%20and%2062%20are%20marine.

Figure 11: MPAs in the Arctic classified according to their IUCN[11] Management Category, 2016.

2.22. There are 2 MPAs within the Beaufort Sea Large Ocean Management Area, namely Tarium Niryutait and Anguniaqvia Niqiqyuam. As can be seen from Figure 12 these protected areas are extremely close to shore and outside the AOI.

Figure 12: Beaufort Sea Large Ocean Management Area MPAs

Oil and Gas

2.23. There have been many discoveries of oil and gas in the 19 Arctic geological basins. However, exploration for petroleum in the Arctic is expensive and challenging, both technically and logistically, and only half the basins have been explored. The most notable of these, which lies within the AOI within U.S. and Canadian waters, is the Beaufort Sea/Mackenzie Delta basin, shown in Figure 13.

[11] International Union for Conservation of Nature.

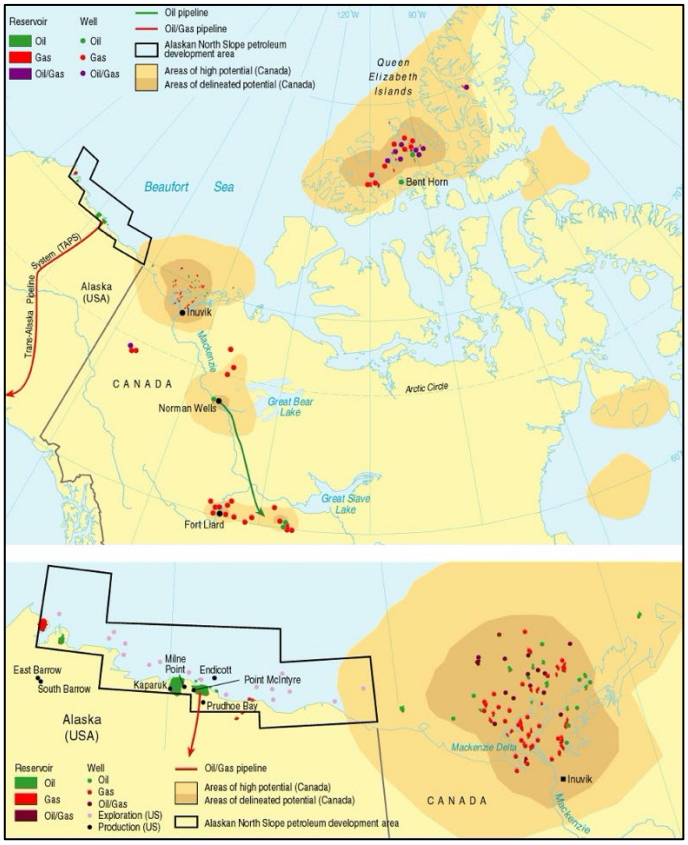

Figure 13: Alaska and Canadian Beaufort Sea and Mackenzie Basin Oil Infrastructure

2.24. The Prudhoe Bay Oil Field on Alaska's north Slope is the largest field in North America. Although the field is onshore, there are some wells that lie offshore, as shown in Figure 14. The exploitation of these nearshore[12] wells is possible as 6 man-made gravel fields have been constructed to facilitate the oil extraction infrastructure.

Figure 14: Alaska Oil Exploration Gravel Fields

2.25. In winter the gravel islands are accessible by ice roads, whereas in the summer months tugs, barges and often hovercraft are used for transportation to and from the islands.

2.26. A further gravel island site entitled Liberty Drilling and Production Island (LPDI), as illustrated in Figure 15, was approved in 2008 by the U.S. government. It was anticipated that the site would enable the extraction of 150 million barrels of oil, however due to safety and environmental issues the island has yet to be developed and its future remains uncertain.

[12] Approx. 6nm from the coast.

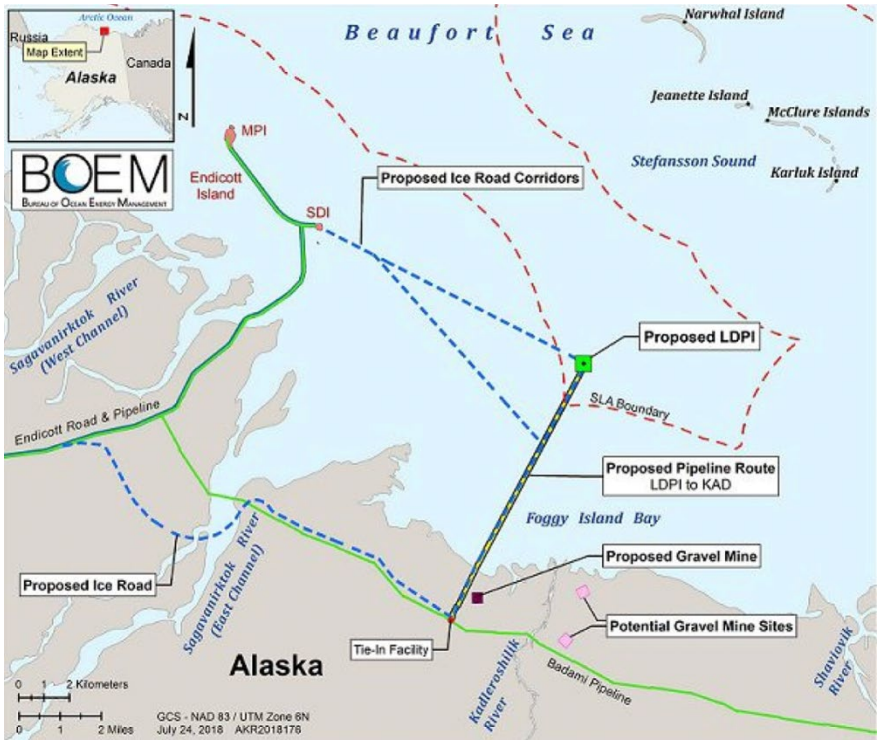

Figure 15: Proposed Liberty Island Drilling and Production Site

Cables & Pipelines

2.27. The AOI does not have a significant number of subsea cables and pipelines. The only maritime oil pipelines are those that service the artificial drilling and production gravel islands.

2.28. The two main subsea cable networks are the Quillion and the Far North, shown in yellow and grey respectively at Figure 16.

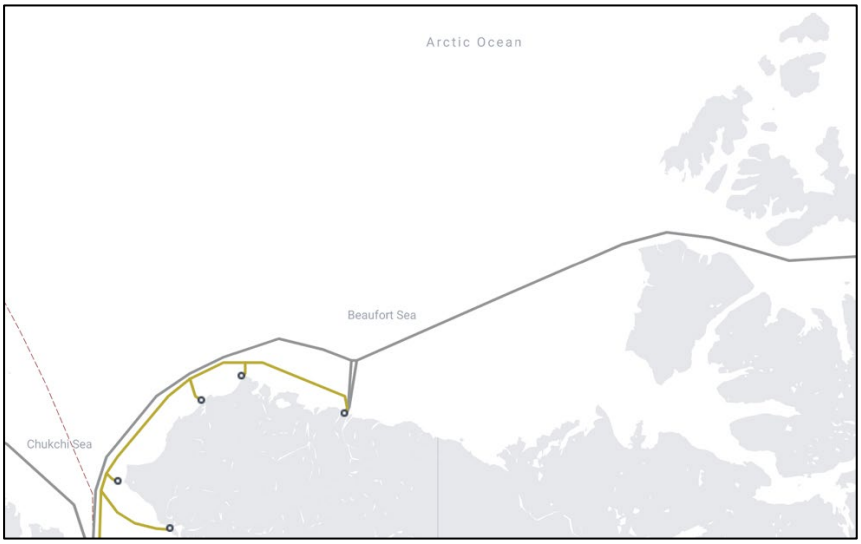

Figure 16: Beaufort Sea Subsea Cables

Maritime Tourism

2.29. Cruise ship tourism in the Arctic is increasing. However, as these tours are extremely expensive[13], and, for the Arctic Ocean/Beaufort Sea region, limited seasonally to August and September, numbers remain relatively low. In 2023 11 cruise ships and 18 yachts transited the Northwest Passage[14].

[13] A sample itinerary from a representative tour operator quoted £9,000 per person for a 12-day cruise of the Northwest Passage.
[14] https://ciltna.com/2023/10/30/record-year-in-the-northwest-passage-as-part-of-busy-arctic-season-by-fred-mccague-cmilt/

2.30. A typical Arctic Ocean/Beaufort Sea cruise, transiting the Northwest passage, is shown at Figure 17.

Figure 17: Typical Northwest Passage Arctic Cruise

Military Operations

2.31. Both the U.S. and Canadian navies patrol the Arctic Ocean and Beaufort Sea to assert sovereignty and conduct surveillance operations, although not in significant numbers. The Canadian Navy operates 3 icebreakers, whereas the U.S. Navy does not own any icebreakers.

2.32. The U.S., British, Russian and French navies all operate nuclear powered submarines, which all periodically operate under the ice and surface at or near the North Pole. These missions are complex and dangerous, and do not occur frequently. However, as the Arctic's strategic importance is increasingly exploited, it will undoubtedly be a more prominent area of naval operations in the future.

Government Operations

2.33. Canada, the U.S. and Russia all operate scientific research vessels that operate in the Arctic Ocean and Beaufort Sea. Often these vessels operate under the nation's coastguard and/or conduct fishery protection operations.

2.34. The U.S. Coast Guard (USCG) operates one heavy and one medium icebreaker for Arctic operations. The USCG also runs an operation entitled Arctic Shield, which is an annual mobile and seasonal deployment of forces (ships, aircraft and personnel) to the Arctic region and coordinated from a forward operating base in Kotzebue, Alaska. The operation covers the Summer and Autumn period when commercial and recreational maritime activity in the area is at its peak.

2.35. The Canadian Coast Guard (CCG) operates 2 heavy, 8 medium and 8 light icebreakers, as well as two large air cushioned vessels/hovercraft for Arctic operations. The CCG has its icebreaking vessels on secondary SAR duties at various locations during the Summer and Autumn periods.

International Maritime Organisation Polar Code

2.36. Ships operating in the Arctic and Antarctic environments are exposed to a number of unique risks. Poor weather conditions and the relative lack of good charts, communication systems and other navigational aids pose challenges for mariners. The remoteness of the areas makes rescue or clean-up operations difficult and costly. Cold temperatures may reduce the effectiveness of numerous components of the ship, ranging from deck machinery and emergency equipment to sea suctions. When ice is present, it can impose additional loads on the hull, propulsion system and appendages.

2.37. The International Maritime Organisation's (IMO) International Code for Ships Operating in Polar Waters (Polar Code) is mandatory under both the International Convention for the Safety of Life at Sea (SOLAS) and the International Convention for the Prevention of Pollution from Ships (MARPOL). The Polar Code covers the full range of design, construction, equipment, operational, training, search and rescue and environmental protection matters relevant to ships operating in the inhospitable waters surrounding the two poles. The Polar Code entered into force in January 2017.

2.38. The Code requires ships intending to operate in the defined waters of the Arctic[15] to apply for a Polar Ship Certificate, which would classify the vessel as: Category A ship - ships designed for operation in polar waters at least in medium first-year ice, which may include old ice inclusions; Category B ship - a ship not included in category A, designed for operation in polar waters in at least thin first-year ice, which may include old ice inclusions; or Category C ship - a ship designed to operate in open water or in ice conditions less severe than those included in Categories A and B.

2.39. In addition to the Polar Code, in 2007 the IMO Assembly adopted resolution A.999(25) 'Guidelines on voyage planning for passenger ships operating in remote areas', in response to the growing popularity of ocean travel for passengers and the desire for exotic destinations, which has led to increasing numbers of passenger ships operating in remote areas.

2.40. When developing a plan for voyages to remote areas, special consideration should be given to the environmental nature of the area of operation, the limited resources, and navigational information. The detailed voyage and passage plan should include the following factors: safe areas and no-go areas; surveyed marine corridors, if available, and contingency plans for emergencies in the event of limited support being available for assistance in areas remote from SAR facilities. In addition, the voyage and passage plan for ships operating in Arctic waters should include the following factors: conditions when it is not safe to enter areas containing ice or icebergs because of darkness, swell, fog and pressure ice; safe distance to icebergs, and presence of ice and icebergs and safe speed in such areas.

Canadian Maritime Vessel Traffic Services

2.41. The CCG runs 12 Marine Communications and Traffic Services (MCTS) centres across the country to provide: safety radio-communication services; vessel traffic services and regulation; information that supports marine activities, the screening of vessels entering Canadian waters, and a 24/7 marine telephone call service.

2.42. The programme's aims are to contribute to safety of life at sea; support maritime domain awareness; contribute to safety and efficiency of navigation; and contribute to the protection of the marine environment.

2.43. The Iqaluit MCTS centre, shown at Figure 18, has responsibility for the Arctic Ocean/Beaufort Sea area lies within the Canadian EEZ. The MCTS, operated seasonally, performs Alert and Warning Network desk duties and provides Navigational Warning services.

[15] For this AOI the IMO definition OF Arctic waters is north of 58°00'.0 N.

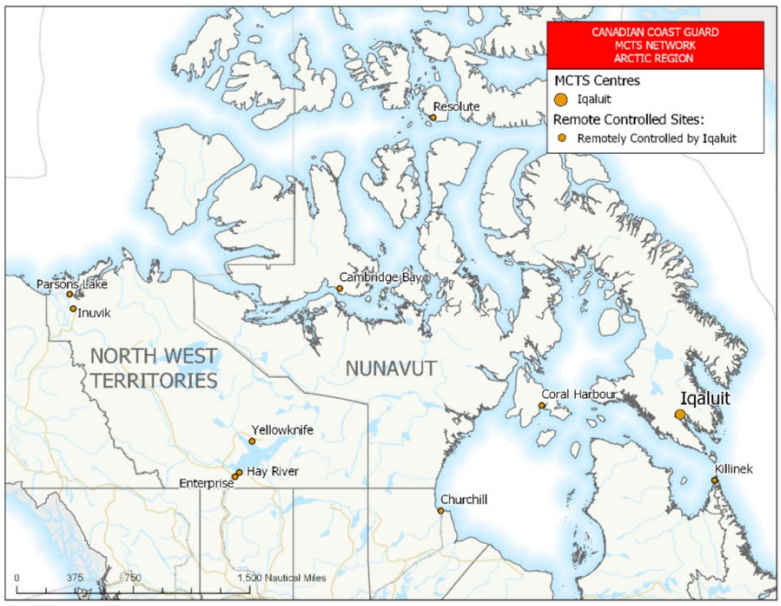

Figure 18: Iqaluit MCTS

U.S. Maritime Vessel Traffic Services

2.44. The USCG 17th District is responsible for the U.S. EEZ within the Arctic Ocean/Beaufort Sea area, as shown at Figure 19. The U.S. does not operate a Vessel Traffic Service in the Beaufort Sea/Arctic Ocean area of its EEZ. Nor does it mandate vessel reporting for this area. However, any vessel operating within the U.S. Arctic EEZ must comply with the Polar Code to ensure the safety of the ship, its crew and the maritime environment.

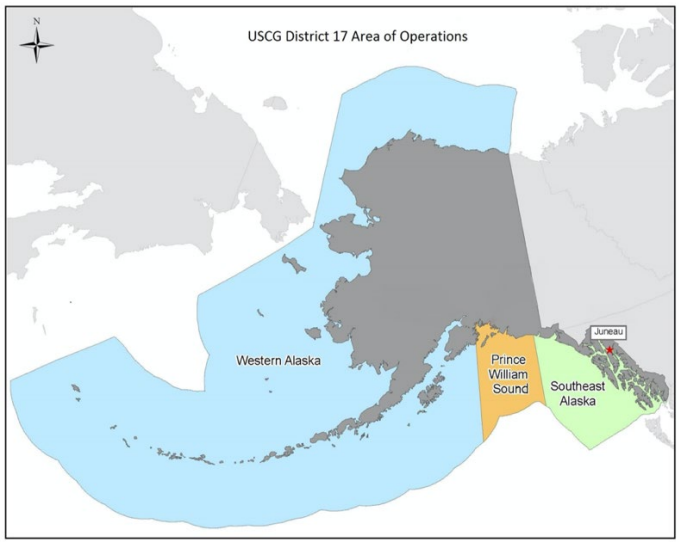

Figure 19: USCG 17th District Area of Responsibility

Maritime Traffic Reporting Regulations

2.45. Canada operates the Northern Canada Vessel Traffic Services Zone (NORDEG) Regulations. This divides Canadian waters into zones as shown in Figure 20. All vessels must comply to the mandatory reporting system if they are: 300 gross tonnage or more; engaged in towing or pushing another vessel, if the combined gross tonnage of the vessel and the vessel being towed or pushed is 500 gross tonnage or more, and; carrying as cargo a pollutant or dangerous goods, or that are engaged in towing or pushing a vessel that is carrying as cargo a pollutant or dangerous goods.

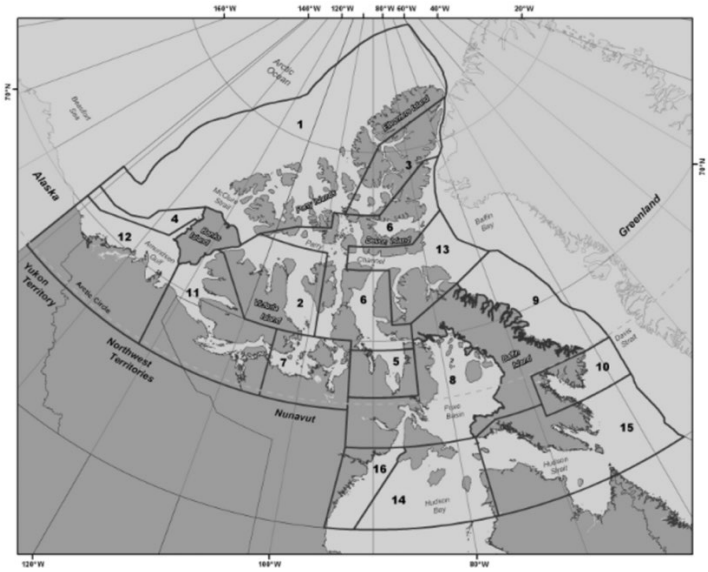

Figure 20: NORDEG Zones

Search and Rescue

2.46. The IMO introduced the Search and Rescue (SAR) Convention in 1979. This convention sets out an international blueprint for SAR, providing a framework for the execution of search and rescue operations worldwide. At the heart of the IMO SAR Convention lies the principle of international cooperation. Coastal states are assigned the responsibility of establishing and operating Maritime Rescue Coordination Centres (MRCCs) within their designated search and rescue regions[16] (SRR). These centres act as focal points for coordinating and directing rescue operations, ensuring seamless communication and cooperation between countries.

2.47. Two Search and Rescue Regions (SRRs) in the AOI are SRR fall within both the U.S. and Canada, as shown at Figure 21.

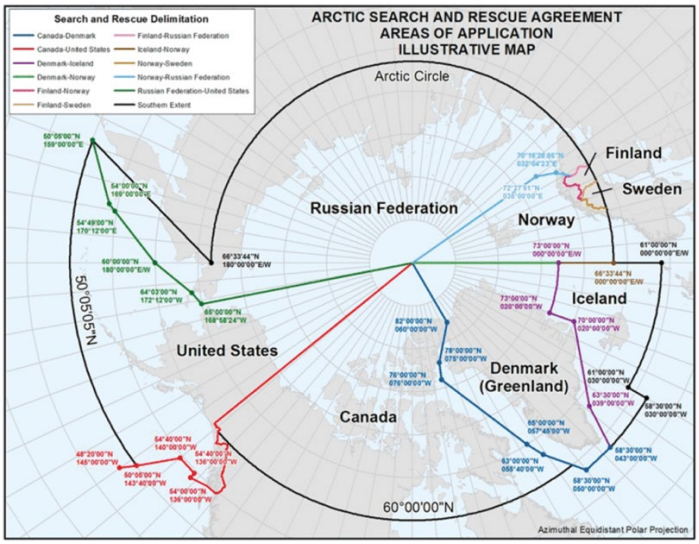

Figure 21: Arctic SAR Regions

2.48. Global SRRs are managed by either a Joint Rescue Coordination Centre (JRCC) or a Maritime Rescue Coordination Centre (MRCC). A JRCC coordinates aeronautical and maritime SAR, whereas a MRCC functions only in the maritime domain.

2.49. The U.S. centre that manages the Arctic Ocean/Beaufort Sea is JRCC Juneau and within the Canadian EEZ it is JRCC Trenton.

[16] 13 globally.

Canadian Maritime Incidents and Accidents

2.50. The Transportation Safety Board of Canada (TSB) investigates marine occurrences that take place anywhere in Canada—or elsewhere if Canadians are involved. The TSB also participates in foreign investigations to represent Canadian interests and, occasionally, to provide investigation services.

2.51. Since the TSB's creation in 1990, Marine Investigations Branch investigations and Board recommendations have led to numerous safety advancements in Canada, including: the mandatory use of personal flotation devices on fishing vessels, expanded use of emergency signalling devices on vessels, and increased awareness regarding the hazards associated with towing.

U.S. Maritime Incidents and Accidents

2.52. The USCG prepares and publishes reports of investigation in the U.S. EEZ in accordance with Federal statute and regulation. These reports publish the findings of fact, results of analysis, conclusions, and recommendations of the Coast Guard's investigation of marine casualties, outer continental shelf casualties, and commercial diving casualties.

2.53. The USCG Director of Inspections and Compliance develops and maintains policy, standards, and programme alignment for all prevention activities associated with the safe operation of vessels and facilities. This Directorate manages recreational boating safety, foreign and domestic commercial vessels compliance inspections, ports and facilities safety and security, vessel documentation, and marine casualty and incident investigation.

Marine Safety Information & Warnings and Notifications

2.54. Maritime Safety Information (MSI) including both weather information and navigational warnings is broadcast on VHF by JRCCs/MRCCs worldwide. MSI is defined in the Safety of Life at Sea (SOLAS) Convention, Chapter IV, as comprising navigational and meteorological warnings, meteorological forecasts and other urgent safety related messages broadcast to ships.

2.55. A Navigational Warning (NAVWARN) is a broadcast message containing urgent information relevant to safe navigation. In support of the Global Maritime Distress and Safety System (GMDSS), Broadcast Warnings are promulgated by the WWNWS to provide rapid dissemination of information critical to navigation and the safety of life at sea. NAVWARNS are issued regularly and contain information about persons in distress, or objects and events that pose an immediate hazard to navigation.

2.56. The Global Maritime Distress and Safety System (GMDSS) is a maritime communication system for all types of vessel-to-vessel and vessel-to-shore communication, including routine communications as well as emergency and distress messages. Within the GMDSS there are two independent systems for broadcasting MSI: the International SafetyNET Service (a system using satellite communications) and the International NAVTEX Service (which is a medium frequency telex system).

2.57. NAVTEX broadcasts in the region are transmitted by the Kodiak, Alaska USCG station, whereas Canadian Coast Guard Base Iqaluit provides the equivalent service.

2.58. Under the World-Wide Navigation Warning Service[17] (WWNWS) the world's oceans are divided into 21 geographical sea areas, called NAVAREAS (Navigational Areas). The administration of collating and distributing MSI to cover the whole of a NAVAREA is known as the NAVAREA coordinator and 19 nations fulfil this role for the 21 NAVAREAS. The Arctic Ocean/Beaufort Sea AOI falls within NAVAREAS 17 and 18, administered by Canada, as shown at Figure 22.

[17] A co-ordinated global service for the promulgation of navigational warnings.

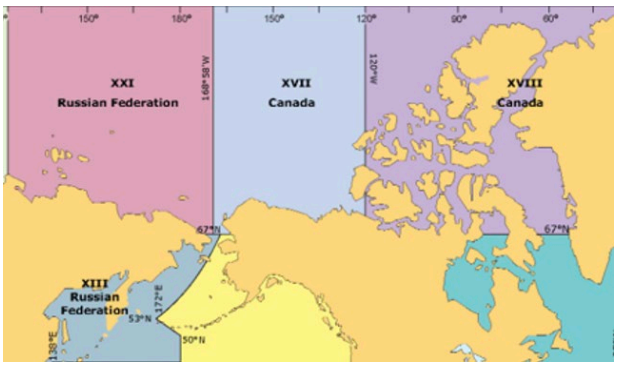

Figure 22: Arctic Ocean NAVAREAS

Notices to Mariners

2.59. Notices to Mariners (NtM) are weekly updates to provide the latest safety-critical navigational information, including corrections to nautical charts and publications. NtMs only contain information which is vitally important to safety at sea.

2.60. All national hydrographic offices publish NtMs. The Canadian Hydrographic Service[18] is responsible for issuing Canadian NTMs, whereas in the U.S. NTMs are made available weekly by the National Geospatial-Intelligence Agency[19], having been prepared jointly with the National Ocean Service and the USCG.

3. AOI 2: NORDIC SEA

The Maritime Environment

3.1. The Nordic Sea AOI falls within the Greenland, Iceland and Norwegian Seas, collectively known as the Nordic Seas, and comprises a combination of continental shelf and deep ocean/sea. Rich deposits of oil and natural gas are exploited commercially in the areas with sea depths of up to around 1000 metres.

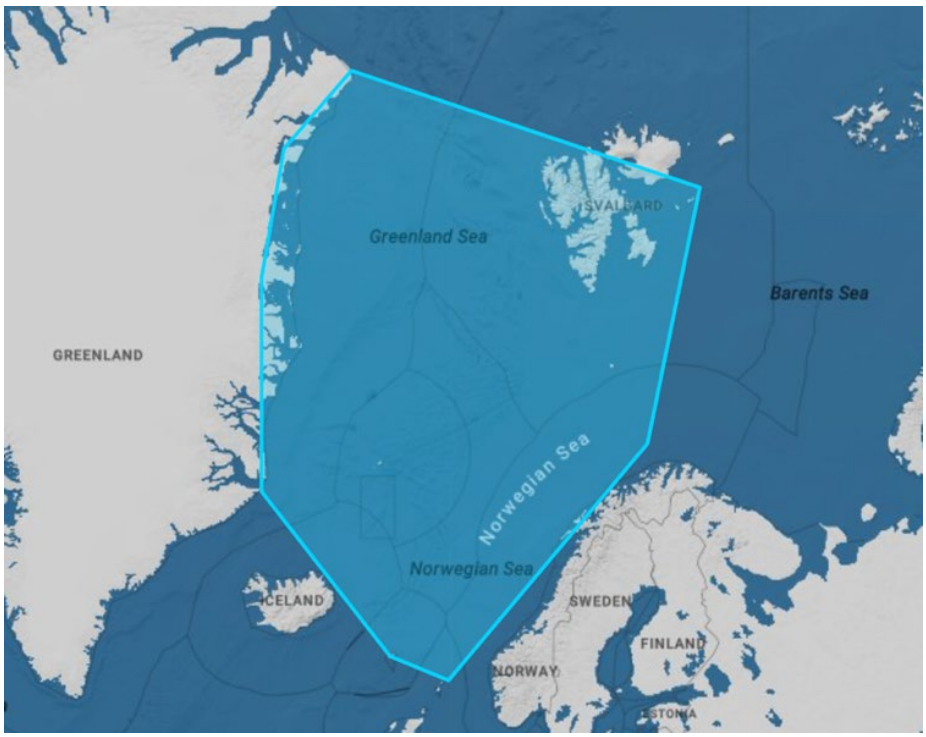

Figure 23: Saxa NRA AOI 2

[18] https://www.pac.dfo-mpo.gc.ca/fm-gp/maps-cartes/index-eng.html
[19] https://msi.nga.mil/NTM

3.2. The AOI straddles a combination of international waters, and both the Exclusive Economic Zones (EEZ) and Territorial Waters (TTW) of the adjacent nations of Greenland, Norway, Iceland, The Faroe Islands and the UK. The island of Jan Mayen (Norway), which has no indigenous or permanent population and is uninhabited for parts of the year[20], falls within the AOI. Maritime activity around Svalbard to the North and Bear Island to the north east has also been considered.

3.3. The coastal zones have considerable demersal fish stocks and are fished extensively, but the deeper waters also hold large stocks of pelagic species such as herring and mackerel and attract deep sea fishing fleets throughout the year.

Climate

3.4. The southern sector of the AOI has an oceanic temperate maritime climate, predominant features of which are clouds, precipitation and cool temperatures. Further north the area is more affected by Arctic winds which results in significantly colder temperatures. Storms are common across the entire AOI, particularly in the winter months. During the winter sea ice is formed in the western and northern regions of the Nordic Seas, whereas during the summer months, the majority of the region remains free of ice. In Shetland, the summers are short, cool, and windy; the winters are long, very cold, wet and extremely windy; and it is mostly cloudy year-round. Over the year, the temperature typically varies from 3°C to 15°C and is rarely below -1°C or above 17°C.

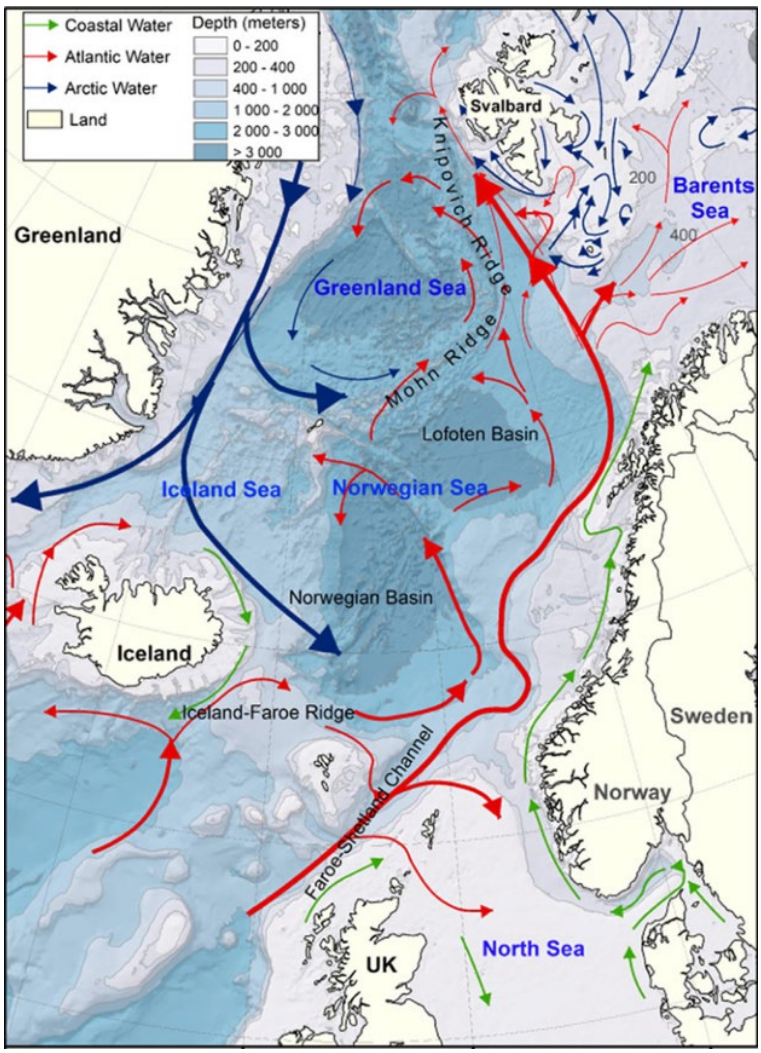

Figure 24: Ocean Currents

[20] Around 20-40 (depending on the season) military personnel and scientists are based on the island on 6-month roulements depending on projects and maintenance requirements.

Wind and Waves

3.5. The predominant wind direction around Shetland and in the Norwegian Sea is from the west, with frequent strong winds and gales and associated wave heights in excess of 6 metres in the winter months.

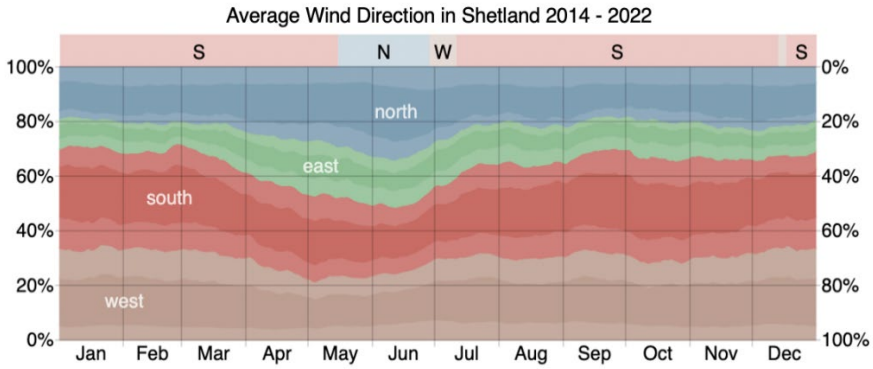

Figure 25: Shetlands Average Wind Direction

3.6. The average hourly wind speed in Shetland experiences significant seasonal variation over the course of the year. The windier part of the year from September to April lasts for around 6 months, with average wind speeds exceeding 15kts. January is the windiest month with an average hourly wind speed of 20kts. April to September is generally calmer; July is the calmest month with an average hourly wind speed of 12kts.

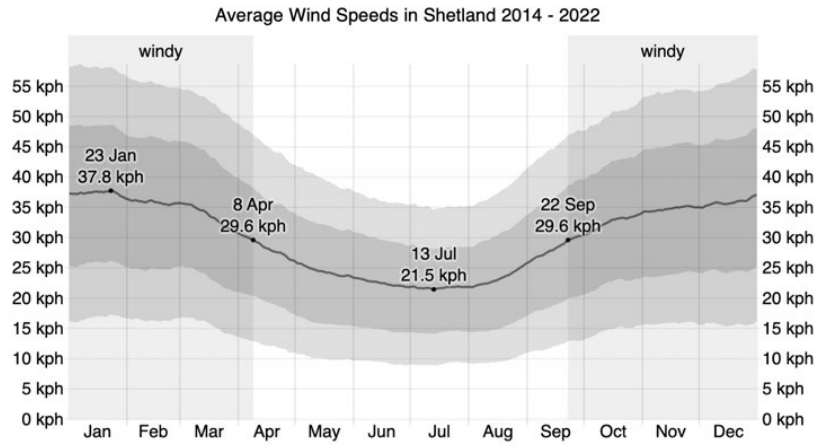

Figure 26: Shetlands Average Wind Speeds

Maritime Activity overview

3.7. Given the size of area analysed, the AOI is relatively quiet of maritime traffic, with the two principal industries being offshore energy and fishing. The former is almost exclusively limited to the continental shelf and the latter is predominantly within the coastal and continental shelf regions.

Fishing

3.8. The Shetland Islands have a long history of fishing, which is an important part of the local economy and a way of life for islanders. Shetland has both large and small-scale commercial fishing, with small day and recreational fishing boats working closer inshore. The Shetland Islands have up to 300 commercial fishing vessels, with 1,000 local jobs linked to the fishing industry. The following species make up the bulk of Shetland catches of finfish and shellfish species: mackerel and herring (pelagic); haddock, cod, whiting, saithe, monkfish and megrim (demersal); squid, velvet and brown crabs, lobster, king and queen scallops, and whelks (shellfish).

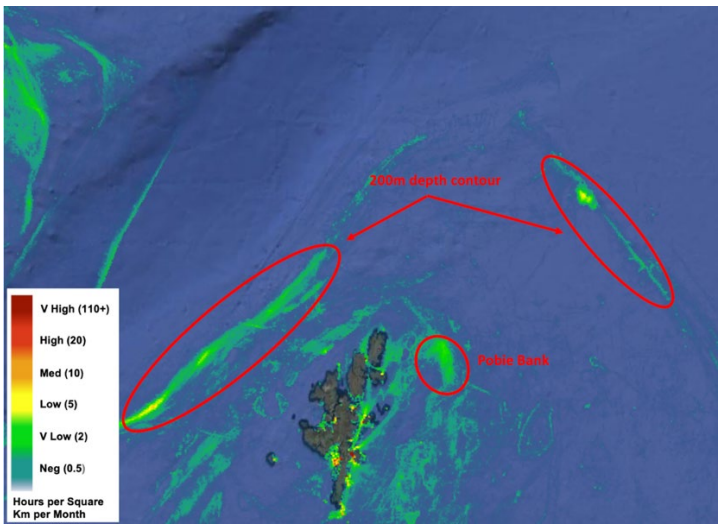

Figure 27: Heat map of Shetland Fishing Patterns over a Representative 12-month Period[21]

3.9. The wider Norwegian Sea area is a fertile and productive fishing ground, which covers more than 500,000 square miles, consisting of two deep basins (between 3000m and 4000m in depth), the Norwegian Basin and the Lofoten Basin, separated by the Vøring plateau (between 1000m and 3000m deep). The Norwegian Sea is separated from the Greenland Sea to the north by the Mohn Ridge. To the west, the basin slope forms the transition to the somewhat shallower Iceland Sea. The warm North Atlantic Current ensures relatively stable and high-water temperatures, so that unlike the Arctic Seas, the Norwegian Sea is ice-free throughout the year.

3.10. Many nations currently have fisheries targeting the marine stocks within the AOI. The largest landings are by Norway, Russia, Faroe Islands, and Iceland; lesser amounts are landed by the UK. Pelagic fishing by multinational fleets is the major activity in the region, and the number of fishing vessels is declining while the size of the vessel is increasing. The collective fishing effort of these nations comprises a total of approximately 365 pelagic fishing vessels operating in the AOI, fishing all year round. The mackerel season is traditionally the Spring and Autumn, whereas the herring seasons are the first, third and fourth quarter of each year, with the majority of the fishing taking place in the latter period. The intensity of fishing activity is therefore relatively low in relation to the size of the fishing area, confirming that the majority (90%) of fishing is on the continental shelf close to shore.

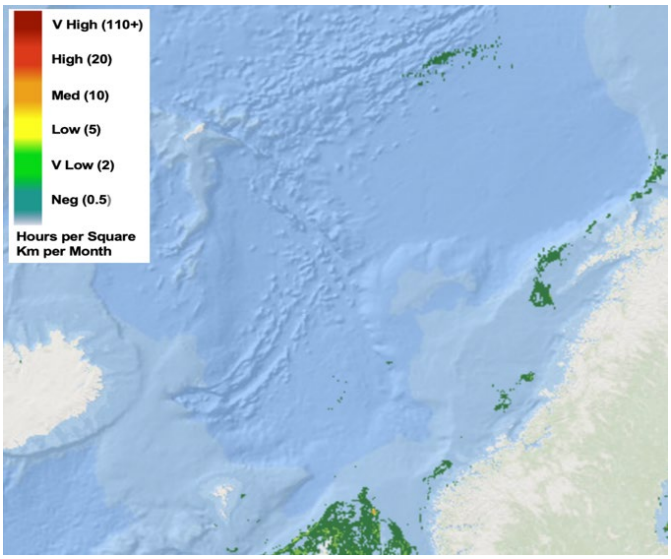

Figure 28: Heat Map of Overall Fishing Activity in AOI in a 12-month Period

[21] Source: https://www.emodnet-humanactivities.eu/view-data.php

Commercial Shipping

3.11. Marine transport by ship includes the transport of both freight and passengers, whether for commercial or recreational purposes. Marine transport is supported by a diverse range of ancillary activities including shipbuilding and repair, the construction of ports and marinas, and activities associated with navigation, including dredging. Marine transport is a significant contributor to national and regional economics, acting as a major intermediary for Scottish and Shetland imports and exports. Ports and harbours also provide key transport infrastructure between land and sea.

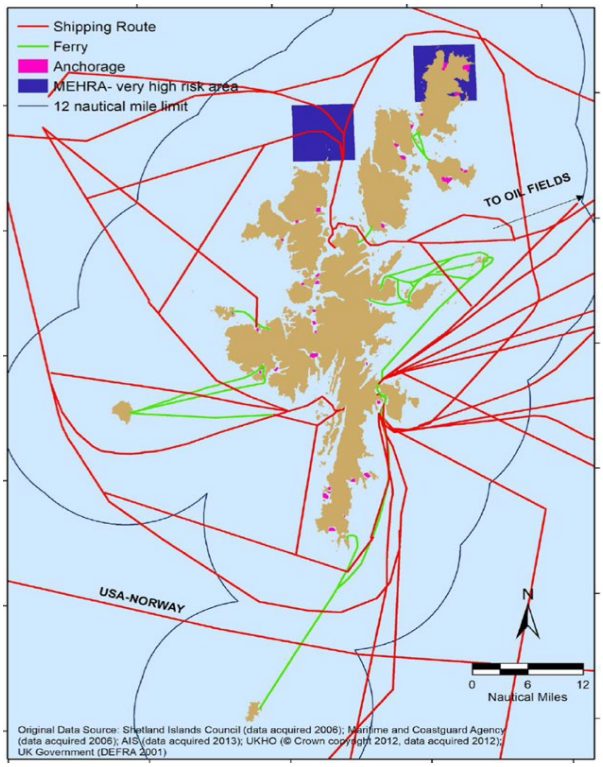

Figure 29: Shipping Routes in and around Shetland

3.12. In Shetland the sea transport industry alone was worth £18.4 million in 2011. The industry employed 175 people in 2017. The Shetland Islands ports and harbours industry was worth £23.4 million in 2011 and employed 149 people in 2017. Marine transport in Shetland is therefore significant, both economically and socially. The importance of international trade through Shetland's ports is also important for distribution of raw materials such as coal, timber and oil, as well as other goods not available naturally or locally on the Islands.

3.13. Ports and harbours also play a significant role in domestic freight and passenger travel by providing infrastructure and facilities to support lifeline ferry services to island communities. Their role is crucial not only in supporting the projected future growth of freight traffic, but also supporting more fragile and remote communities. Ports and harbours in Shetland support the oil and gas industry but are also essential in supporting emerging industries such as renewable energy development.

3.14. Commercial shipping in the wider AOI is varied and diverse, ranging from ferries to offshore energy support ships and cargo/freight vessels. Activity is more concentrated in the traffic routes from Europe to the Orkney and Shetland Islands, the Faroes, and Iceland; and amongst the UK and Norwegian oil and gas fields, and along the Norwegian coast – therefore in the southern and eastern section of the AOI.

3.15. Traditional shipping routes, as shown in Figure 30, generally follow the coasts of Greenland to the west and Norway to the east. The central and Northern AOI is sparsely populated by commercial shipping, as the heat map at Figure 31 illustrates.

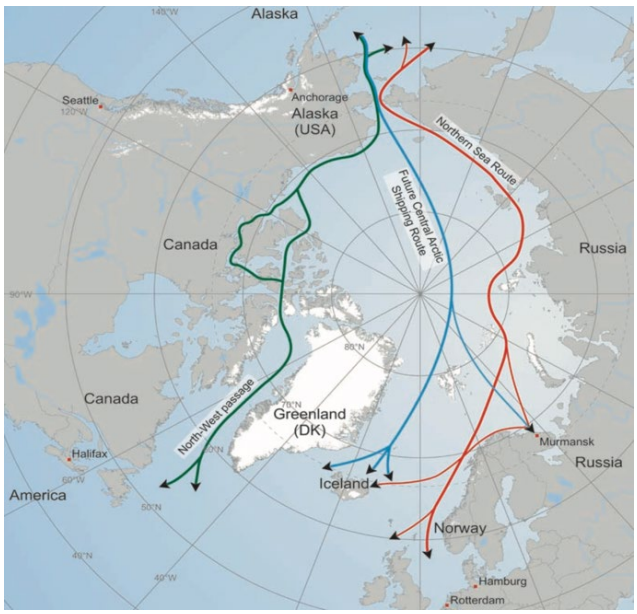

Figure 30: Nordic Seas and Arctic Shipping Routes

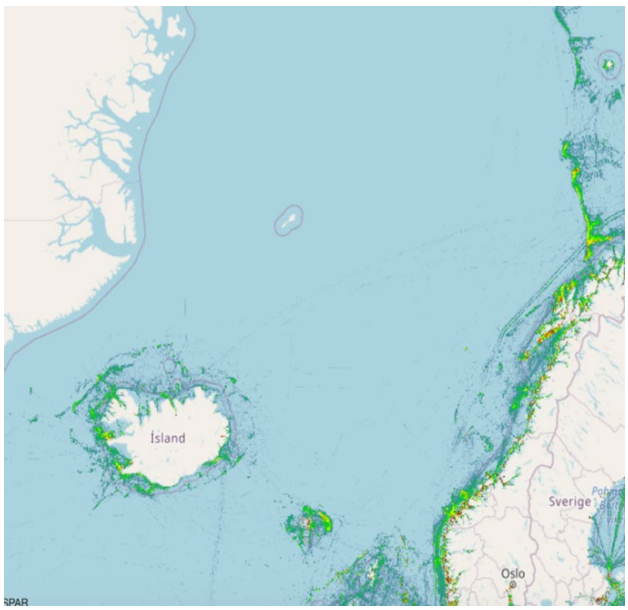

Figure 31: Representative Maritime Traffic Patterns in the AOI[22]

Transport

3.16. A critical lifeline to Shetland, Orkney, the Faroes and Iceland, there are well-established ferry routes to and from the UK and Europe. These routes are predominantly to the south of Shetland; Jan Mayen and Svalbard are not serviced by a dedicated ferry service, but instead rely upon resupply from cargo vessels, cruise ships and air transport.

[22] Source: European Atlas of the Seas.

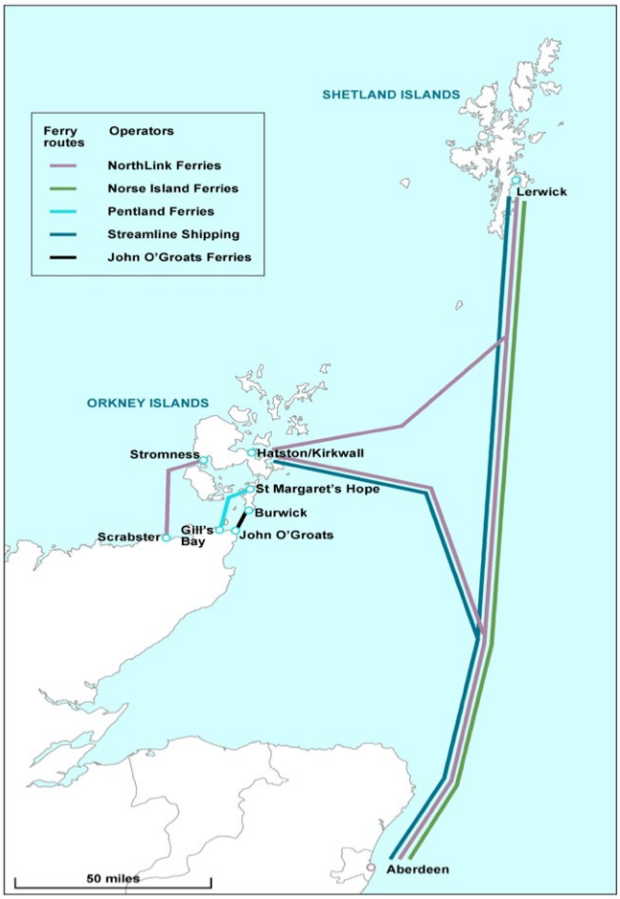

Figure 32: Ferry Route Scotland to Orkney and Shetland

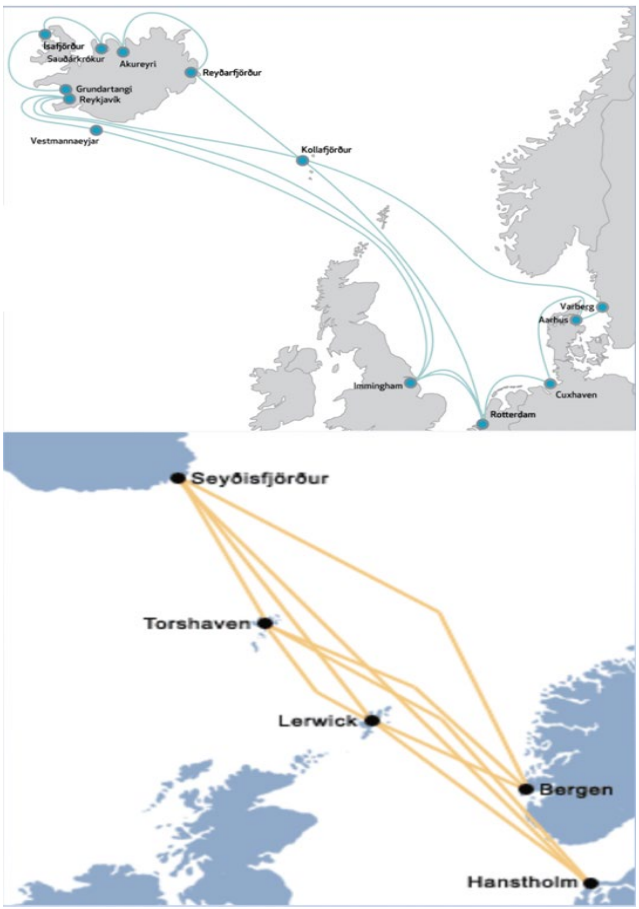

Figure 33: Ferry Routes to Shetland, The Faroes and Iceland

3.17. **From Scotland**. NorthLink Ferries operates two combined passenger car and freight vessels and two freight and livestock vessels between Aberdeen and the Northern Isles. It also operates a combined passenger, car and freight vessel on the shorter Pentland Firth crossing. Pentland Ferries began providing a combined passenger, car and freight service across the Pentland Firth in spring 2001. John O'Groats Ferries also operate a small passenger-only ferry on the Pentland Firth route but in summer only. For many years Streamline Shipping Group Ltd has operated a containerised freight vessel out of Aberdeen.

3.18. **From wider UK and Europe**. The two main transport operators from England, Norway and Denmark are Smyril Ferries and the Samskip Line. Smyril operates a weekly ferry service during the winter and twice weekly in the summer months. The Samskip Line operates weekly freight and cargo vessels to the Shetlands, Faroes and Iceland.

Cruise Ships and Leisure

3.19. Cruise tourism in the north east Atlantic, Norwegian Sea and Arctic region has increased considerably in the last 10–15 years. In 2018, 15 ships made a total of 27 port calls carrying around 45,900 passengers. This activity falls into two categories – general cruise tourism and the smaller, specialist expedition vessels – the former taking in destinations such as the Norwegian Fjords, the Orkney and Shetland islands, Iceland and Greenland, whereas the more specialist expedition cruises are predominantly focused on the Arctic region, including Greenland, Jan Mayen and Svalbard islands. The season generally runs from June – September each year.

3.20. The cruises either originate in Europe and travel up the Norwegian cost and across to Svalbard, or from Europe direct to specific destinations. Figures 34 to 37 show the cruise and expedition ship routes in this area.

Figure 34: Europe to Svalbard via Norway

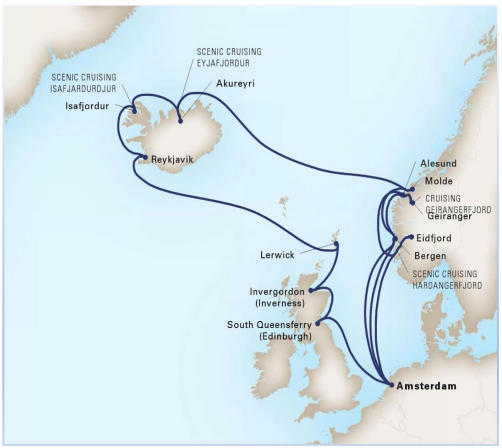

Figure 35: Europe to Iceland via Norwegian Coast

Figure 36: Iceland to Greenland and Svalbard

Figure 37: Svalbard Internal

Recreation - General Tourism

3.21. Tourism was worth approximately £23.1m to the Shetland economy in 2017, employing 865 full time personnel. Notwithstanding the impact of the coronavirus pandemic in 2020 and 2021, tourism in Shetland is generally on the increase. The sea around Shetland provides a variety of sporting and recreational opportunities. These include swimming, sailing, rowing, coasteering, recreational snorkelling and SCUBA diving, sea angling, kayaking, canoeing, windsurfing and surfing, as well as exploration of underwater and coastal heritage assets. Coastal recreation activities include walking and hiking, cycling, climbing, visiting heritage assets and wildlife watching. The coast also provides inspiration for a range of artistic and cultural activities.

3.22. Tourist facilities both on and offshore, as well as local cultural facilities, have also been developed to attract visitors all year round, which is important given that some marine activities will, by necessity, be restricted by the weather and times of the year. Such maritime tourism includes boat trips to observe wildlife/marine life and trips to nature reserves, for example trips to the Hermaness nature reserve and sightseeing around the Muckle Flagga lighthouse off the north coast of Unst.

Recreational Sailing

3.23. The coast offers a beautiful combination of dramatic cliffs and natural harbours – many with modern piers, slipways and marinas – and boats can drop anchor anywhere and explore. Yachts have unrestricted access to all the islands and berthing fees are minimal.

3.24. With 1,700 miles of coastline, 100 islands and numerous natural harbours, Shetland is a popular sailing destination. Around 500 visiting yachts a year call into the Shetland Islands, both at the principal port of Lerwick as well as the minor harbours. Recreational sail activity is generally limited to the summer months when the more favourable weather conditions can be exploited.

3.25. As well as recreational sailing/cruising there are a small number off offshore yacht races in the AOI. The principal annual yacht racing event is the Pantaenius Shetland Race from Bergen in Norway to Lerwick return, which takes place in late-June/early-July with around 100 yachts participating. An extension to this race is the Viking Offshore Race that continues from Lerwick to the Faroes and Iceland, completing around the second week in July. The 2024 race is scheduled to commence on 19 June.

3.26. The annual Tall Ships Race, organised by Sail Training International[23], takes place each year around Europe. Cities bid to be a race destination and the race circuit changes each year. Shetland was a host port for the 2023 Tall Ships Race, where the event generated over £5.4 million for the local economy and attracted around 52,000 visitors[24].

3.27. The Round Britain and Ireland Yacht Race takes place every 4 years in August, starting and completing in Plymouth. The race, comprising 5 legs totalling approximately 2,000 miles, last took place in 2022 with 30 entrants. Lerwick is one of the 4 stop-offs where crews visit for a 48-hour period. The next race is scheduled for 2026.

3.28. Sailing activity also take place in the wider AOI, but in very small numbers. In the summer months privately-owned and commercial expedition yachts tour the Greenland coast, Svalbard and the Arctic.

[23] Sail Training International is an international association of national sail training organisations devoted to promoting "the education and development of young people of all nationalities, religions and social backgrounds, through sail training".
[24] https://www.shetnews.co.uk/2023/12/20/tall-ships-brought-millions-into/#:~:text=THIS%20summer's%20Tall%20Ships%20event,day%20event%20in%20late%20July.

Recreational Boating

3.29. Private pleasure craft operate in small numbers around the Shetland coast. This activity is generally within 2nm of the coast and includes vessels such as speedboats, kayaks, commercial dive boats and sailing dinghies. In the north east and north coast of Unst, pleasure craft activity is generally contained within the area around Baltasound but does occasionally extend north west to Lamba Ness.

Oil and Gas

3.30. There is a significant offshore energy presence in the AOI to the west, east and north east of Shetland in the UK and Norwegian EEZs. The Norwegian and northern North Seas oil and gas fields provide a mix of hydrocarbons comprising both liquid petroleum and natural gas. Since production started in the 1960s, oil and gas has been produced from a total of 115 fields on the Norwegian shelf, 45 oil and gas fields in the UK EEZ in the vicinity of Shetland, including the Clair oil field which is one of the largest in Europe and is planned to be operational through to 2050[25]. The UK Government estimates up to 17% of the UK's undiscovered gas reserves are located west of the Shetland Islands.

3.31. As well as active fields there are a number that are in the process of being decommissioned; for example, the Brent oil field east of Shetland was once one of the most productive offshore energy sites in the UK EEZ but has reached the stage where production is no longer economically viable. Decommissioning of the Brent field is ongoing and will be completed in the early 2020s.

3.32. The UK oil and gas industry is supported in Shetland principally by Sullom Voe and Lerwick. Sullom Voe is a deep-sea oil terminal situated at Calback Ness on the shores of Sullom Voe, operated by EnQuest. The terminal has the capacity of 1.2 million barrels of crude oil per day and reached a peak in 1984 with a total receipt of 439,434,656 barrels (58,328,785 tonnes). In 2017 there were 38,529,312 barrels of oil processed at the terminal which saw 65 oil tankers and gas carriers visit the port. Sullom Voe averages 5 vessel visits per month[26]. Lerwick harbour is the largest port in the Shetlands and is used both as a base for offshore energy support vessels as well as supply and manufacturing support, handling in excess of 5,000 vessels per year. It is also a leading centre for the decommissioning and disposal of offshore structures from the oil & gas industry.

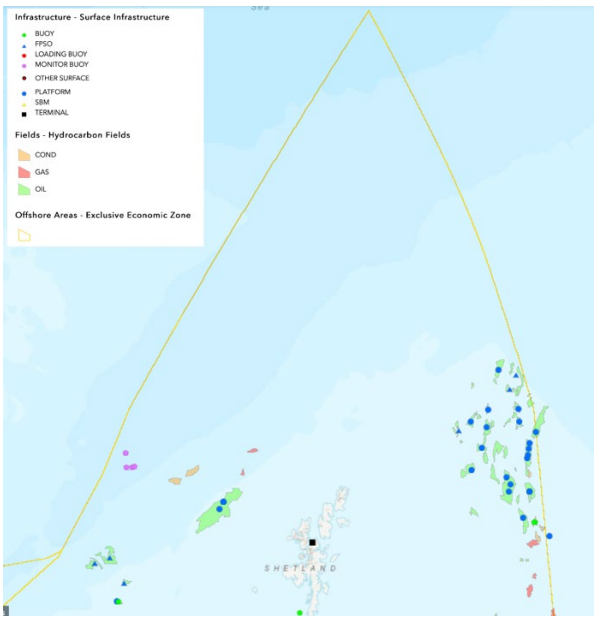

Figure 38: Oil and Gas Fields UK EEZ

[25] https://www.bp.com/en_gb/united-kingdom/home/where-we-operate/north-sea/north-sea-major-projects/clair-ridge.html
[26] https://www.shetland.gov.uk/downloads/download/101/sullom-voe-port-statistics

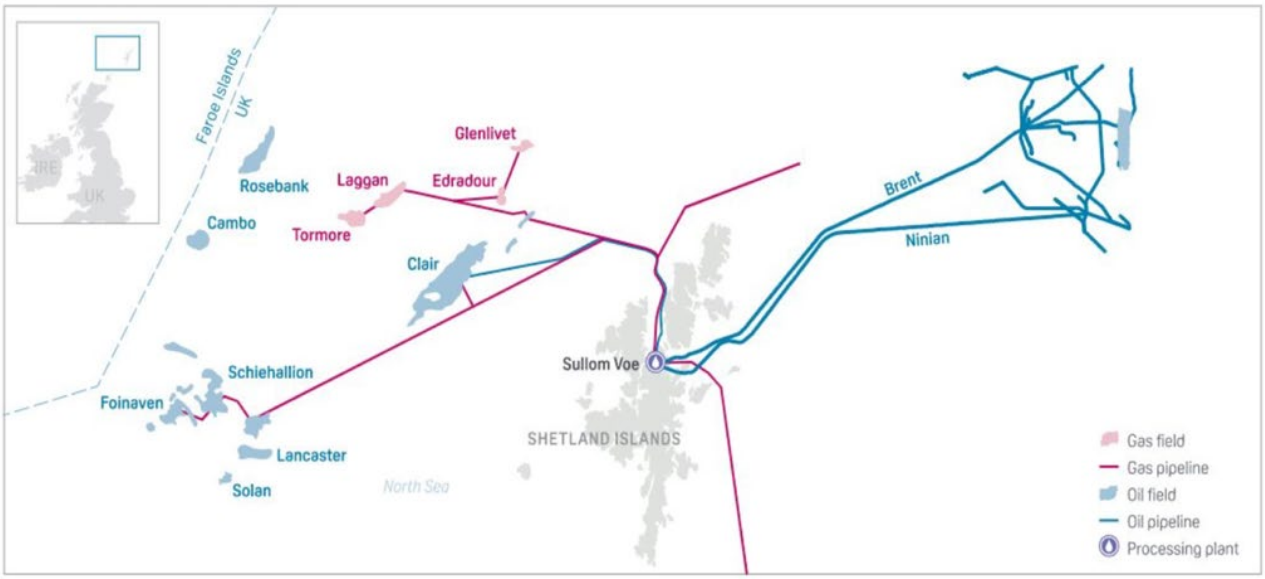

Figure 39: UK Oil Fields west and east of Shetland

3.33. **Rosebank Oil field**. Rosebank is the largest undeveloped oil field in the North Sea, which, although not active, is worthy of comment. It has had significant news coverage[27] over the last 12 months due to the controversy over the UK government potentially granting new licences for oil and gas exploration[28] whilst declaring its continued commitment to the 2015 Paris Climate Agreement[29]. If exploration is approved the field will be developed with a Floating Production Storage and Offloading vessel (FPSO) tied to a subsea production system. First production is expected in 2027; oil will be transported to refineries by shuttle tankers, while gas will be exported through the West of Shetland Pipeline system. As shown in Figure 40, Rosebank is situated 25nm west of the Laggan oil field and outside of the Saxa AOI.

Figure 40: Rosebank Oil Field

Wind Farms

3.34. There are currently no wind farms present in the Saxa AOI.[30] The Scottish Sectoral Marine Plan for Offshore Wind Energy[31] aims to identify sustainable plan options for the future development of commercial-scale offshore wind energy in Scotland, including deep water wind

[27] https://www.scotsman.com/news/politics/rishi-sunak-hints-at-go-ahead-for-controversial-rosebank-oil-field-4137866
[28] https://www.bbc.co.uk/news/science-environment-63163824
[29] https://unfccc.int/process-and-meetings/the-paris-agreement
[30] https://www.thecrownestate.co.uk/media/3954/offshore-wind-project-listing.pdf
[31] https://www.gov.scot/publications/sectoral-marine-plan-offshore-wind-energy/pages/1/

technologies, and covers both Scottish inshore and offshore waters. The areas for consideration, shown at Figure 41, include:

3.34.1. Innovation and Targeted Oil and Gas (INTOG) Areas[32]. The INTOG leasing round is a process by which developers will be able to apply for the rights to build offshore wind farms specifically for the purpose of providing low carbon electricity to power oil and gas installations and help to decarbonise the sector. In March 2023 the applicants for 13 INTOG areas[33] were offered agreements, however the areas off Shetland are still categorised future projects[34] and therefore do not currently impact on Saxa operations.

3.34.2. **Area NE (North East) 1**. NE1 is a 750km² area[35] to the east of Shetland for which Crown Estates Scotland has agreed a £36m lease with two companies[36] for a floating offshore wind farm, to be called the Arvern Wind Farm project.[37] Work will not commence until at least 2025 and the site is unlikely to be operational until the mid-2030s.[38] NE1 is outside the Saxa AOI.

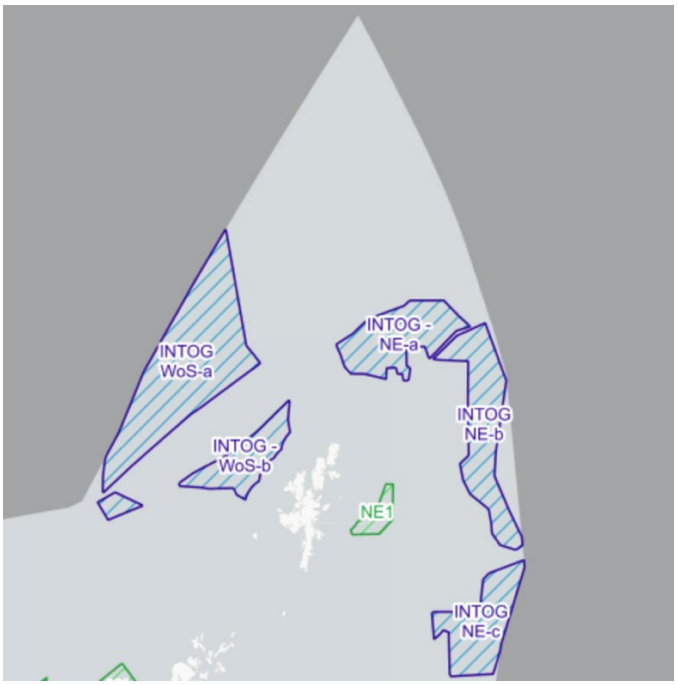

Figure 41: Wind Energy INTOG and NE Areas off Shetland

3.35. **Hywind Tampen**. Norway has an ambitious plan for the development of offshore renewable energy within its EEZ. However, as illustrated at Figure 41, most areas east and north east of Shetland are still under consideration, with the exception of the Hywind Tampen floating offshore wind farm.[39] This site of 11 turbines is situated 104nm north east of Saxa but outside the AOI and provides clean energy to the Snorre oil field installations.[40] The wind turbines will not be permanently crewed, but technical personnel may periodically be present on the structures.

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[32] https://www.crownestatescotland.com/resources/documents/intog-public-summary
[33] https://www.crownestatescotland.com/resources/documents/intog-map-and-project-details-march-2023
[34] https://www.crownestatescotland.com/news/intog-13-projects-selected-to-support-green-innovation-and-help-decarbonise-north-sea
[35] Three sites will be developed within the NE1 area: Arven is split into two sites (southern and middle) and Stoura (northern).
[36] Mainstream Renewable Power and Ocean Winds.
[37] https://www.crownestatescotland.com/news/three-shetland-scotwind-projects-announced
[38] https://www.shetnews.co.uk/2022/12/20/plans-for-offshore-wind-farms-east-of-shetland-at-very-early-stage/
[39] https://www.offshore-mag.com/renewable-energy/article/14188882/floating-offshore-wind-park-to-power-two-major-north-sea-field-centers
[40] https://rnews.biz/85776/hywind-tampen-starts-powering-snorre/#:~:text=The%2088MW%20Hywind%20Tampen%20floating,power%20to%20the%20Gullfaks%20field.

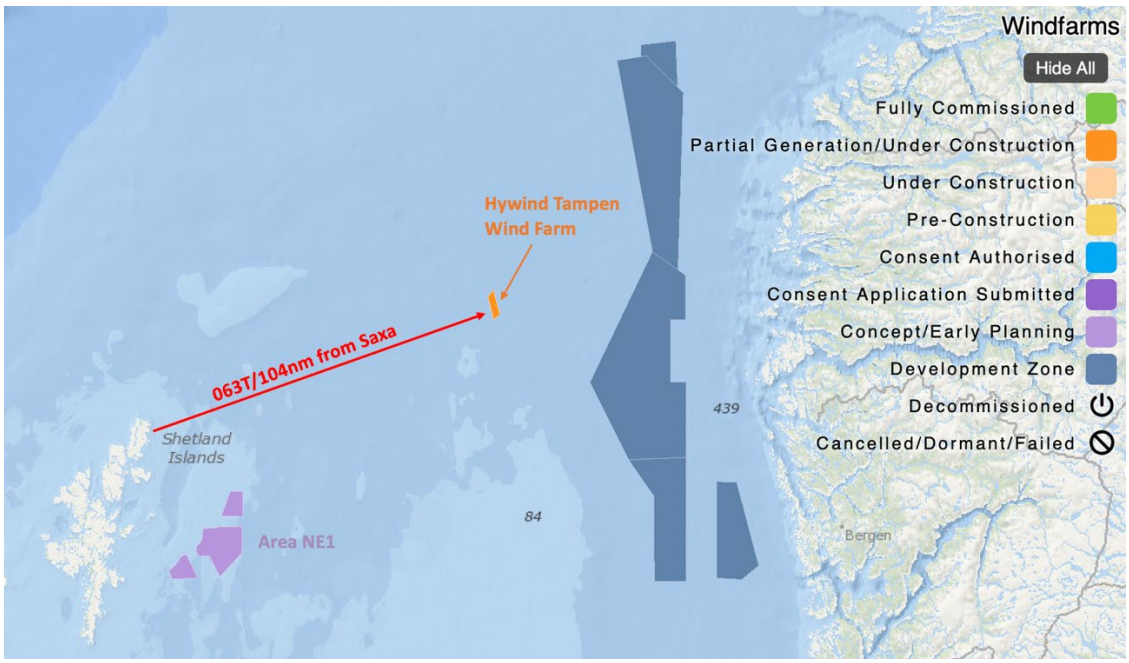

Figure 42: Norwegian Offshore Renewable Energy Status

3.36. **Development Area N8**. In November 2021 a series of news articles[41] were published regarding an announcement at the COP 26 climate summit by the energy company Aker of its intent to build a large wind farm north of Shetland, as shown in Figure 15. However, area N8 neither appears on Marine Scotland's Marine Spatial Plan nor on its interactive map.[42]

3.37. Through the response to a Freedom of Information request,[43] the author received confirmation from the Scottish government that N8 was not included in the adopted Sectoral Marine Plan for Offshore Wind Energy and was therefore not available for applicants to the ScotWind leasing round. Although a portion of that area was made available in the most recent INTOG decarbonisation plan framework and leasing round, Crown Estate Scotland did not make any award offers for this location. The INTOG leasing round closed in March 2023, and accordingly, there are no current opportunities for this region to be leased by Crown Estate Scotland.

Figure 43: Area N8

[41] https://www.shetnews.co.uk/2021/11/04/large-offshore-wind-farm-proposed-north-of-shetland/
[42] https://marinescotland.atkinsgeospatial.com/nmpi/default.aspx?layers=1892
[43] Scottish Government FOI Ref 202300361655.

Tidal/Wave Energy

3.38. The world's first offshore tidal energy array was installed in 2016 by Nova Innovation at Bluemull Sound, Shetland. The technology in Shetland is still in its infancy and there are no existing plans to extend the concept to other parts of the Islands. However, a 2011 report commissioned for Shetlands Island Council[44] identified suitable tidal energy sites around the Islands, and the north coast of Unst was acknowledged as a potential site for tidal energy arrays.

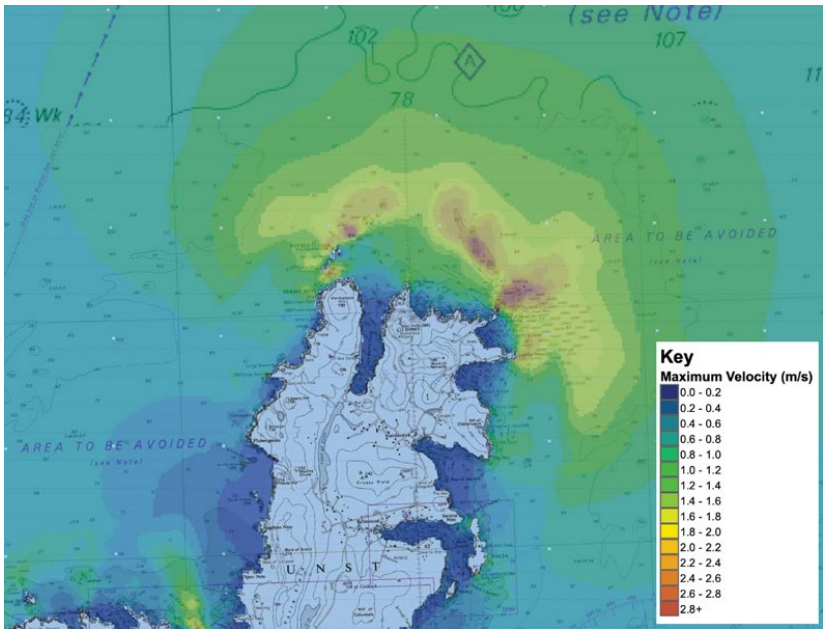

Figure 44: Potential Tidal Energy Site, Unst North Coast

Navigation

3.39. The AOI falls within NAVAREAS 1 and 19, administered by the UK and Norway respectively.

3.40. A range of Aids to Navigation are used in the vicinity of the Shetland Islands. These include a network of (unmanned) lighthouses, a Vessel Traffic System (VTS) and buoyage for Sullom Voe Oil Terminal on the Shetland mainland. There is no buoyage north of the Shetland Islands as the seabed shelves quickly providing deep water at the edge and beyond the continental shelf.

Military Exercises

3.41. The AOI is utilised by Allied[45] and NATO navies for exercise and operations, although not extensively. The deep waters with relatively low levels of maritime traffic are ideal for live firing and anti-submarine exercises.

3.42. The Royal Navy Joint Tactical Exercise Planning Staff (JTEPS) plan and execute two military exercises each year[46] for Allied and NATO navies, south of the AOI around the Scottish coast. These exercises, entitled 'Joint Warrior', also include land and air forces. The maritime element takes place in the UK MoD Scottish Practice Exercise Areas (PEXAs)[47] which generally do not extend north beyond Orkney, as illustrated in Figure 45, although the large NATO maritime exercise Trident Juncture[48] utilised the AOI in 2018 with around 50 ships and submarines.

3.43. The Joint Warrior exercises are popular with Allied and NATO navies, and NATO regularly utilises the exercise to train and validate its high readiness standing maritime forces. Russian naval and air forces[49] do regularly observe and occasionally interfere with the exercise.

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[44] https://www.shetland.gov.uk/downloads/file/1870/wave-and-tidal-resource
[45] For the purpose of this report the term Allied refers to western nations not part of NATO, e.g. Sweden and Finland.
[46] Generally, Apr and Sep.
[47] Red: danger area (e.g. where living firing takes place), Blue: general exercise area.
[48] Exercise Trident Juncture is not an annual exercise and only takes place periodically.
[49] Routinely intelligence gathering ships and long-range maritime reconnaissance aircraft.

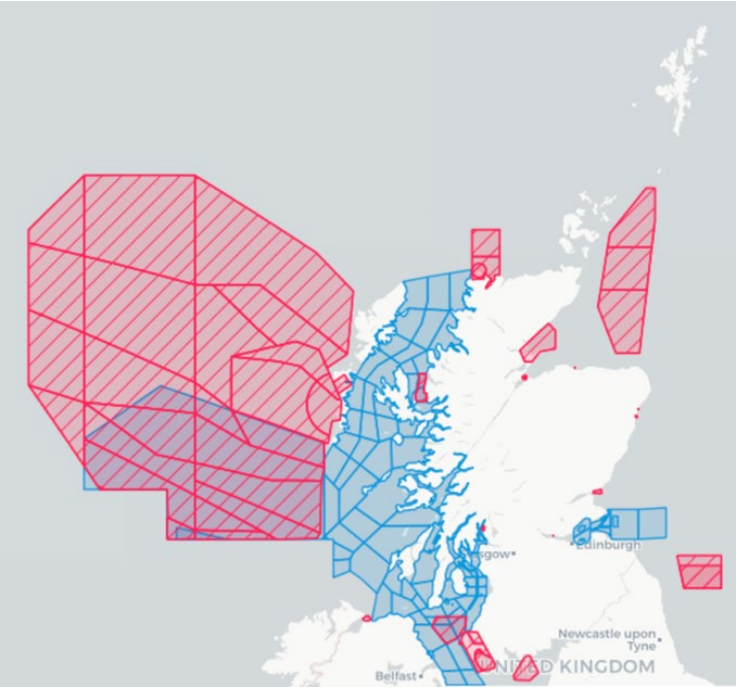

Figure 45: Scottish Military PEXAs[50]

3.44. Naval exercise activity does occasionally occur in the wider AOI, specifically the Norwegian Sea. In August 2019 the Russian Navy conducted a series of live firing exercises off the north west Norwegian coast on a return transit from operations in the Baltic Sea. However, Russian naval exercise activity in the AOI is low and generally in response to Allied/NATO activity, which is also infrequent and occasional.

Figure 46: Russian Navy Exercise Areas Aug 19

Military Operations

3.45. In light of a resurgence of Russian naval activity in recent years the AOI is becoming increasingly more strategically important, particularly to submarine operations. The Russian Northern Fleet must use the Greenland-UK Gap (GIUK), or the North Sea to transit to the Atlantic Ocean. As an example, in October 2019 ten submarines of Russia's Northern Fleet

[50] https://marinescotland.atkinsgeospatial.com/nmpi/default.aspx?layers=518

left their home bases in Kola Peninsula to participate in operations in the Atlantic. The main task of this operation was reportedly testing Russian ability to breach the GIUK gap undetected and sail into the Atlantic Ocean. In response NATO naval activity has increased in the AOI in the last five years, predominantly submarine operations.

UK MoD Maritime Domain Awareness (MDA)

3.46. The MoD's MDA team is nested within the Royal Navy. It forms part of the national maritime information organisation governed and overseen by the Joint Maritime Security Centre (JMSC) in Portsmouth. The JMSC is the multi-agency organisation responsible for ensuring that the UK maintains its understanding of the UK maritime domain and develops the cross-government coordination frameworks to respond to threats to security, law and order, and the marine environment.

3.47. JMSC incorporates the National Maritime Information Centre (NMIC) which since 2010 has provided a mechanism for the UK's civilian and military maritime and law enforcement focused organisations to fuse intelligence, data and capabilities.

3.48. JMSC's Operations Centre (known as the Joint Maritime Operations Coordination Centre) utilises cutting edge technology to provide 24/7 monitoring of UK waters. Utilising a staff drawn from across government it can swiftly identify maritime security incidents and enable the effective coordination of the UK's aerial and at-sea assets to respond. There is not yet a comprehensive UK-wide real or near real-time maritime surveillance picture, and the area around and to the north of Shetland is of general interest to the JMSC.

UK Maritime Policing, Fisheries Enforcement and Border Force Operations

3.49. **UK Border Force** is a law enforcement command within the Home Office, tasked with securing the border and promoting national prosperity by facilitating the legitimate movement of individuals and goods, whilst preventing those that would cause harm from entering the UK. This is achieved through the immigration and customs checks carried out at around 140 sea and air ports across the UK. There is no permanent Border Force maritime presence in Shetland. Border Force has a fleet of five cutters, which are principally deployed on a risk-led or intelligence-led basis to control general maritime traffic throughout UK waters. Border Force vessels do visit Shetland and the surrounding area, albeit infrequently (less than monthly).

3.50. **Police Scotland** has six area commands in Highlands and Islands division, one of which is Shetland. The command does not have a maritime division; the two maritime bases for Police Scotland are Aberdeen and Greenock, which comprise local inshore police patrol boats and small dive support vessels.

3.51. **Marine Scotland Compliance** (formerly Scottish Fisheries Protection Agency) has three ships in its fleet of Marine Protection Vessels, two of which are used for offshore enforcement. Their operations are a combination of routine patrols and intelligence-led enforcement activity; as such they do not routinely visit Shetland or patrol the UK EEZ around the islands more frequently than monthly.

3.52. **UK MoD Police** has a large marine fleet of launches and rigid inflatables, divided between the three Naval Bases at Plymouth Devonport, Portsmouth and the Clyde. These vessels do not operate in or around Shetland.

Scientific Research

3.53. Marine scientific research does take place in the Nordic Seas, but activity is more focussed on the Arctic region north of the AOI. The presence of scientific research vessels is generally seasonal; unsurprisingly the summer months are favoured, however, the activity in relation to the size of the AOI is extremely limited (single figures annually in an area of 2.4 million km^2).

3.54. Although the Arctic Ocean is opening up, the challenges for conducting marine scientific research remain. Seasonal sea ice cover, the polar night, remoteness, and harsh weather all contribute to a demanding research environment. These difficult conditions, coupled with the increased quest for knowledge and information, have resulted in the introduction of new and innovative technologies to overcome these challenges and a resultant upsurge in activity.

Shetland Maritime Incident and Emergency Response

3.55. A range of emergency response organisations and systems are available in and around the Shetland islands, and in the wider Saxa AOI.

3.56. **Maritime and Coastguard Agency (MCA)**. The MCA is an executive agency of the UK Department for Transport (DfT) working to prevent the loss of lives at sea and is responsible for implementing UK and international maritime law and safety policy. The MCA is responsible for the initiation and coordination of all civilian maritime search and rescue operations within the UK Maritime Search and Rescue (SAR) Region. This includes the mobilisation, organisation and tasking of adequate resources to respond to persons in distress at sea, or to persons at risk of injury or death along the shoreline within the UK. SAR is undertaken by HM Coastguard, which has access to a range of resources including aircraft and coastal search teams. Shetland falls within the jurisdiction of the Shetland Maritime Rescue Coordination Centre (MRCC) located in Lerwick. HM Coastguard has two Sikorsky S92 SAR helicopters based at Sumburgh Airport, 17 miles south of Lerwick in the Shetland Islands.

3.57. **Royal National Lifeboat Institution (RNLI)**. The RNLI is a charity organisation that saves lives at sea around the coasts of the UK and the Republic of Ireland. It has 238 lifeboat stations and operates 444 lifeboats. There are two RNLI lifeboat stations in Shetland, located at Aith and Lerwick; both stations are manned by a voluntary crew providing a 24-hour service and operate an all-weather Severn Class lifeboat which has a top speed of 25kts and a range of 250nm. Both lifeboats are approx. 50nm from Saxa.

Warnings and Notifications

3.58. **Notices To Mariners (NtM)**. The UK Hydrographic Office (UKHO) is responsible for publishing, issuing maintaining and updating admiralty charts. Charts are now widely available electronically as well as in paper format. Amends to charts are issued in the form of Admiralty NtMs (weekly, cumulative, annual, temporary and preliminary). UKHO generally requires three months to process and implement chart amends.

3.59. The UK Hydrographic Office (UKHO) is the NAVAREA I (NE Atlantic) Co-ordinator for the WWNWS and also the UK National Co-ordinator for issuing coastal navigational warnings. The global NAVAREAS map is at Figure 47.

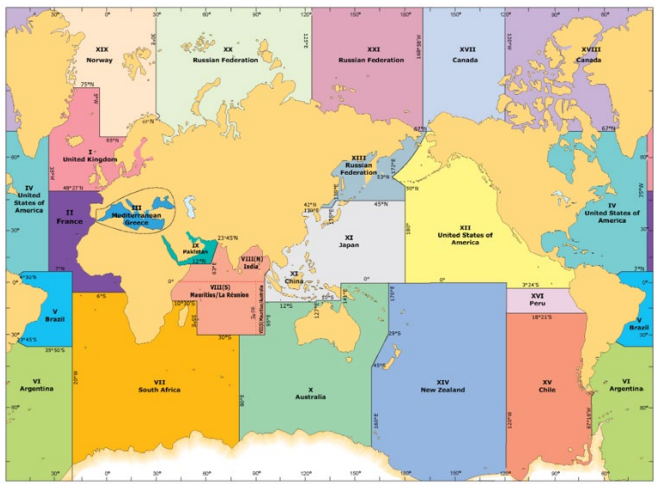

Figure 47: WWNWS NAVAREAs

3.60. In addition to meeting its international obligations the UK also currently provides MSI using VHF and MF radiotelephony.

3.61. The North Atlantic-East NAVTEX system is shown at Figure 48.

Figure 48: NAVTEX and MSI Broadcast Network NE Atlantic

Maritime Emergency Response

3.62. Within the IMO's global SAR plan[51], defining detailed responsibilities for each member nation and listing the relevant SAR authorities[52], the UK (JRCC UK), Norway (JRCCs Bodoe and Stavanger), Greenland (JRCC Greenland), the Faroe Islands (MRCC Torshaven) and Iceland (JRCC Iceland) all have allocated SAR regions in the AOI.

Figure 49: Nordic Sea SAR Regions

[51] https://www.imo.org/en/OurWork/Safety/Pages/GlobalSARPlan.aspx
[52] https://sarcontacts.info/

Figure 50: UK/Norway/Iceland SAR Areas

Environmental Considerations

3.63. The Shetland Islands Council has introduced a Marine Spatial Plan (dated 2015) and an updated 2021 draft Regional Maritime Plan (SIRMP) is currently being progressed. The purpose of the SIRMP is to provide effective marine management through a more co-ordinated and robust framework that ensures the fundamental principles of sustainable development are applied to all marine activities and includes all aspects of marine and coastal resource use including fishing, aquaculture, oil and gas, marine renewables, transportation and shipping, culture and heritage, sport and recreation, education and the environment.

Marine Protected Areas

3.64. A network of 244 Scottish MPAs[53] helps to protect nationally and internationally important marine wildlife, habitats, geology and undersea landforms. Developing Scotland's network of MPAs is part of a wider strategy to meet the Scottish Government's commitment to a clean, healthy, safe, productive and biologically diverse marine and coastal environment that meets the long-term needs of people and nature.

3.65. The most significant site in Unst is the Fetlar to Haroldswick MPA, the northerly limit of which is 5.5 miles south of Lamba Ness as illustrated in Figure 51. The MPA contains a diverse array of flora and fauna, including the black guillemot; circalittoral sand and coarse sediment communities; horse mussel beds; kelp and seaweed communities on sublittoral sediment; maerl beds; and shallow tide-swept coarse sands with burrowing bivalves.

3.66. There are currently 12 SPAs and 13 SACs in Shetland, of which 11 SPAs are for seabirds and 7 SACs have a marine element, and there are also currently three proposed SPAs around Shetland.

[53] Shetland's network includes: Nature Conservation MPAs (NCMPAs); Special Areas of Conservation (SACs); Special Protection Areas (SPAs); Habitat Protected Areas (SSMO closed areas); Sites of Special Scientific Interest (SSSIs), and; Local Nature Conservation Areas (LNCAs).

Figure 51: Fetlar to Haroldswick MPA.

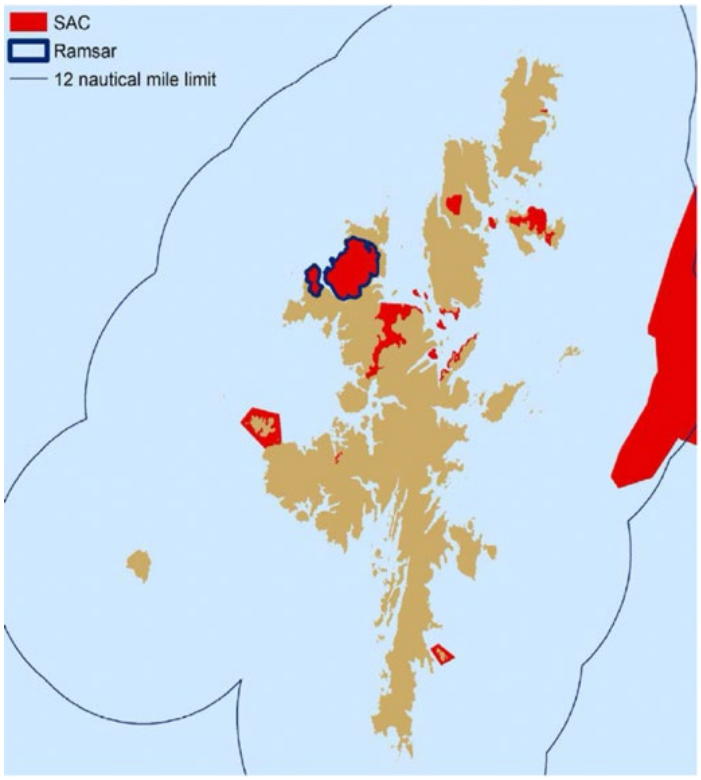

Figure 52: Shetlands SACs and Ramsar[54]

[54] A Ramsar site is a wetland site designated to be of international importance under the Ramsar Convention.

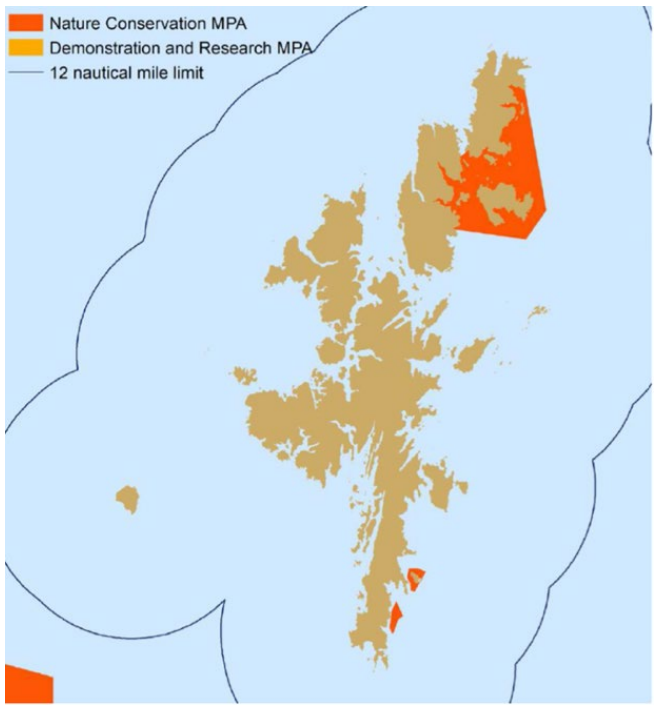

Figure 53: Shetlands NCMPA

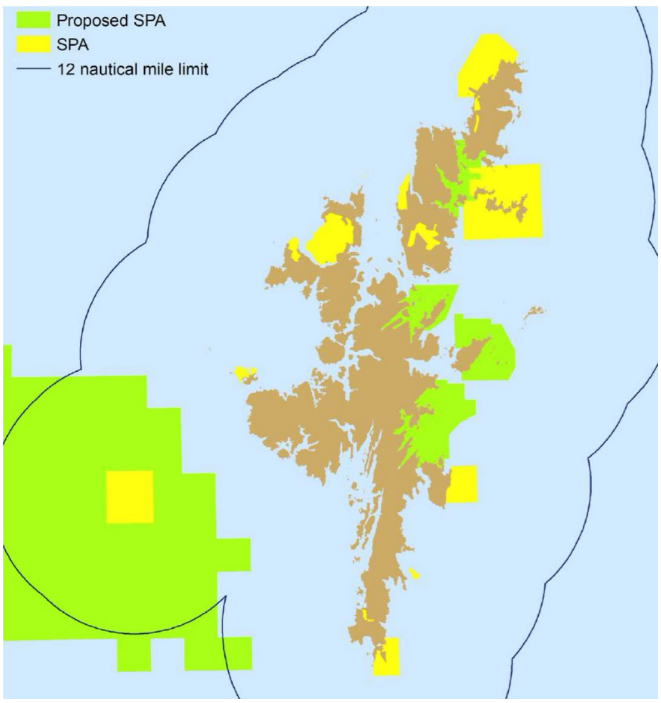

Figure 54: Shetlands SPAs and Proposed SPAs

Sites of Special Scientific Interest (SSSI)

3.67. There are 78 designated SSSIs in Shetland, of which 31 are notified for marine biological features, including seabirds and <Redacted> , and 36 are coastal sites notified for geological or geomorphological features.

3.68. The closest SSSI to the Saxa is Norwick Meadows, located 1 mile inland from Lamba Ness. It occupies the valley floor along the Burn of Norwick and comprises the Mires of Northdale, Norwick Meadow and Norwick Beach. It is notified for its valley fen habitat and sand dune complex. The only other SSSI in vicinity of the Saxa is Saxa Vord, which lies 3.2 miles west of Lamba Ness on the west coast of Unst. The site is notified for its nationally and internationally important breeding fulmar and guillemot populations and for the seabird colony as a whole.

Special Areas of Conservation (SAC)

3.69. The closest SACs to Saxa are the Keen of Hamar and Pobie Bank sites, which support flora and a marine habitat respectively unique to the Shetland Islands, but neither of which should be affected by SAXA operations.

3.70. The Keen of Hamar reserve, 4 miles south west of Lamba Ness, is primarily of botanical interest, for example for populations of Cerastium nigrescens a plant unique to Unst, and has the largest surviving area in the UK of near-natural Calaminarian grasslands on serpentine soil.

3.71. The Pobie Bank Reef, 12nm east of Shetland, is composed of a combination of stony and bedrock reef and in the central section of the reef there are very large, rugged bedrock outcrops. The reef provides a habitat to an extensive community of encrusting and robust sponges and bryozoans, which are found throughout the site. These include encrusting coralline algae, cup sponges, and bryozoans in the shallower areas, and small erect sponges, cup corals and brittlestars in the deeper areas.

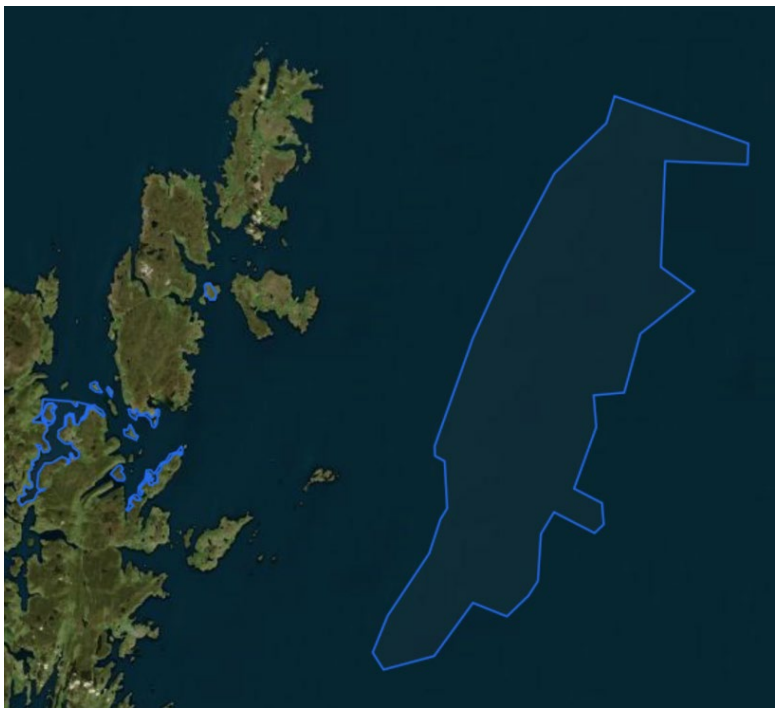

Figure 55: Pobie Bank Reef SAC

Special Protected Areas (SPA)

3.72. The Hermaness, Saxa Vord and Valla Field SPA lies in the north west corner of Unst, the closest point to Saxa of which is 1.7 miles north west of Lamba Ness. This SPA is important for a number of breeding seabird species that nest on the cliffs and the heathland and grassland here. During the breeding season, the area regularly supports 152,000 seabirds including guillemots, kittiwakes, shags, fulmars, puffins, great skuas and gannets.

3.73. Fetlar is a small island east and south respectively of Yell and Unst. The species-rich heath, bog and mire communities on the island support an important and characteristic breeding bird community, with the cliffs, rocky shores, and adjacent coastal waters important for breeding seabirds, including the red-necked phalarope, Arctic tern, <Redacted> , great skua, southern dunlin, Arctic skua and northern fulmar.

Nature Conservation Marine Protected Areas

3.74. Nature conservation MPAs (NCMPAs) are regions of the seas and coasts where wildlife is protected from damage and disturbance. The MPAs consist of the marine components of sites designated as SACs, SPAs, SSSIs and Ramsar. Together these help to form an ecologically coherent network, as per international agreements including the OSPAR Convention and the Convention on Biological Diversity.

3.75. **The Faroe-Shetland Sponge Belt NCMPA** is located in offshore waters on the Scottish side of the Faroe-Shetland Channel, a large rift basin that separates the Scottish and Faroese continental shelves. Five different water masses meet in the Faroe-Shetland Channel, which interact with each other and the continental slope to generate ideal conditions for the boreal 'ostur' type of deep-sea sponge aggregations to settle. Offshore subtidal sands and gravels are also present, supporting a diversity of polychaete worms and a slow-growing bivalve mollusc known as ocean quahog, a large and slow growing clam which has a lifespan of more than 400 years and is thus considered to be amongst the oldest living animals on Earth.

3.76. **North-East Faroe-Shetland Channel NCMPA**. This MPA covers a large part of the north-eastern reaches of the Faroe-Shetland Channel in Scottish waters and is one the largest designated UK NCMPAs. The continental slope here plays an important role in funnelling ocean currents that bring valuable food and nutrients to the region, which support a wide diversity of life. The channel is believed to be a corridor for migrating marine mammals, including the fin and sperm whales. At depths of 400–600m, the combination of seabed type and plentiful nutrients are ideal for deep-sea sponges. Below 800 m, the muddy seabed is home to those species that can tolerate the cooler arctic-influenced waters, such as deep-sea worms. The MPA also includes several features of geological importance, including a series of deep-water mud volcanoes known as the pilot whale diapirs.

Habitat Protected Areas (HPA)

3.77. Also known as SSMO closed areas, these sites are specifically selected for their protection to certain habitats, such as acting as nursery grounds for commercial species of fish and shellfish or assisting in climate regulation by providing a carbon sink and helping to stabilise soft sediments. There is one SSMO on the southern Unst coast closed to scallop dredging.

Local Nature Conservation Sites (LNCS)

Shetland has 49 LNCS - selected for their biodiversity or geodiversity interest, 9 of which are on Unst, and 6 RSPB Scotland Reserves, none of which are located on or around Unst. The LNCS closest to Lamba Ness is Hill of Clibberswick, selected because 2 nationally scarce plant species are present on-site.

4. SAXAVORD OPERATIONS

4.1. The purpose of this NRA is to both refresh Saxa's 2022 NRA and to analyse a new AOI required for Saxa's inaugural launch of Rocket Factory Augsburg's 'NOM One' (RFA NOM One) orbital rocket in August 2024.

4.2. The Saxa AOIs for this NRA are extensive, covering a total of around 1,400,000nm² in both the Nordic Seas and Arctic Ocean. Whilst it is essential to analyse this area in order to understand the nature, volume, patterns and concentrations of general maritime activity, risk will be analysed for orbital and sub-orbital space flight operations in smaller and defined portions of the water space.

4.3. As defined in the UK Space Industry Act 2018 (SIA) and the UK Space Industry Regulations 2021 (SIR), a Range is 'a zone (or zones) consisting of a volume of airspace and area of land and/or sea, in relation to which warnings, restrictions or exclusions are put in place'. Establishing a Range will be critical to the safe operation of spaceflight activities. Use of an appropriate Range will ensure that persons and property are not exposed to unacceptable risk from spaceflight activities and do not pose such a risk to spaceflight activities themselves'[55]. Under the SIA the Civil Aviation Authority (CAA) is nominated as the UK's space regulator and responsible for Range licence applications and utilises the SIR as principal UK legislation.

4.4. The proposed trajectories of the rockets or 'Launch Vehicles' (LVs) from Saxa will have an overall northerly direction. The number of splash down impact points[56] arising from a launch

[55] https://www.legislation.gov.uk/ukpga/2018/5/contents/enacted

[56] A splash down impact point is the position where the fairing/stage lands on the surface of the water. It has a safety radius, as defined in Appendix B of the Federal Aviation Administration (FAA) regs, entitled the Impact Dispersion Area.

will depend on the number of stages in the LV, which may be up to 3. Accounting for the payload fairing, up to 3 splash down points are expected per typical launch (Stage 1, Stage 2 and the payload fairing). The splash down points are expected to occur at a minimum distance of 50nm from the launch site, but the maximum distance will be determined by the type of LV in use. Splash down points should remain clear of any fixed structures by a safety margin of 20nm. Figure 56 illustrates the principle.

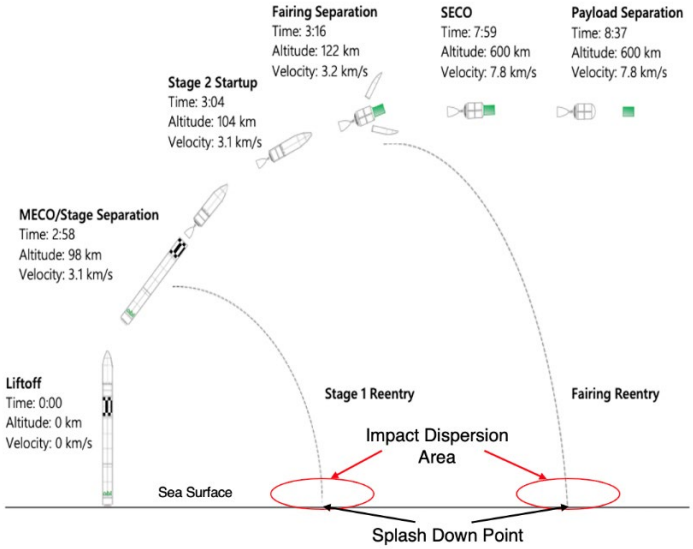

Figure 56: Splash Down Points and Impact Dispersion Areas

Saxa Range

4.5. The Saxa Range will be the area in which space vehicle launch and (where required) recovery operations will take place, and where control measures will be implemented to ensure that all launch operations are ALARP. From previous launch planning, Saxa had determined that the Range parameters would be defined as an area extending no greater than between 330° to 030° to a range from Lamba Ness of 900nm, which is an area 1.1 million km². 330° to 030° offers an arc of operation to the north west towards the Greenland coast and north east adjacent to the Norwegian coast. However, as can be seen from Figure 57, the RFA NOM One rocket trajectory over water before it reaches Greenland will exceed the Saxa 900nm outer range limit. Therefore, for this NRA the outer Range limit has been extended to 1000nm, as per Figure 58, to cover the additional sea space over which the RFA rocket will fly until it reaches the Greenland mainland.

4.6. Similarly, from Figure 57 it can be seen that the RFA NOM One trajectory, on a broadly north westerly heading from Saxa, will cross the Arctic Ocean/Beaufort Sea. Therefore, an additional Range area, as illustrated in Figure 59, has been added to this NRA so that appropriate risk analysis can be undertaken.

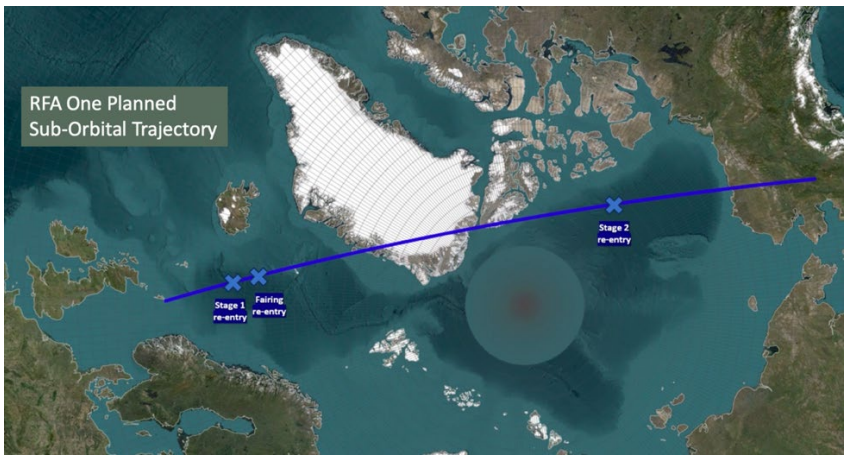

Figure 57: RFA NOM One LV Trajectory

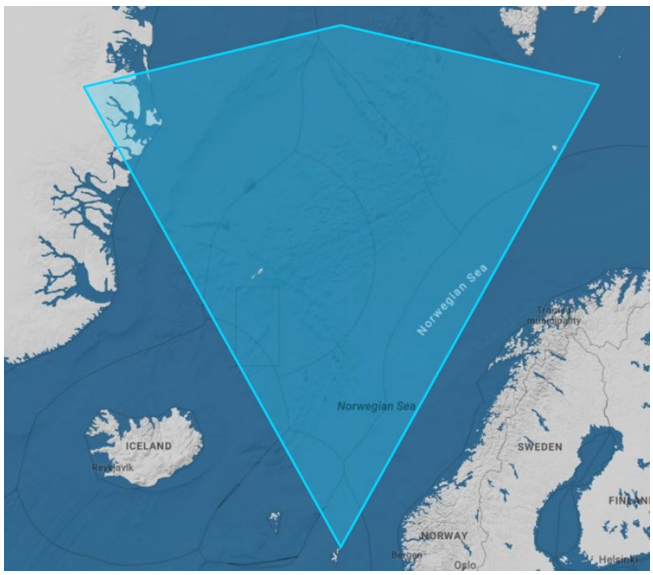

Figure 58: Saxa Range extended to 1000nm

Figure 59: Saxa additional Range Area – Arctic Ocean

Hazard Areas

4.7. The UK Space Industry Regulations 2021 mandate that the licensee's Range control services consist of or include identifying an area or areas of sea falling within the designated Range (a 'hazard area') which need to be made subject to restrictions, exclusions or warnings for keeping the area clear at relevant times for: Persons or things that might pose a hazard to the operator's spaceflight activities; and, Persons or things to which the operator's spaceflight activities might pose a hazard[57]. Therefore, prior to the commencement of spaceflight activities, the hazard areas will be designated as either:

4.7.1. An Exclusion Zone (part of a hazard area to which entry by any vehicle, ship, aircraft, or other craft, individual or domestic animal is excluded).

4.7.2. A Restricted Zone (part of a hazard area to which entry is restricted to authorised individuals whose presence is necessary for the carrying out of spaceflight activities or for the performance of duties in connection with such activities).

4.7.3. A Warning Zone (part of a hazard area to which entry is not restricted but which is subject to a requirement to provide a warning notice[58]).

[57] Para 47(1 & 2).
[58] In accordance with Regulation 51 of the UK Space Industry Act 2021.

4.8. To ensure the risk to life in the vicinity of the Saxa launch site and wider Range is ALARP, appropriate control measures will be in place. UK SIR regulations and direction on how to implement control measures for launch operations will be applied as the principal legislation, but U.S. Federal Aviation Administration (FAA) regulations will also be utilised to determine hazard area construction.

4.9. For the RFA One launch three impact zones are planned – first and second stages, and the payload fairing. The third stage carries the payload into orbit. Therefore, one Exclusion Zone (the Launch Exclusion Zone or LEZ) and a number of Warning Zones will be established.

Launch Exclusion Zone

4.10. The methodology for computing ship LEZ in the vicinity of the launch site requires that the analysis must establish the ship-hit contours as follows:

4.10.1. A ship-hit contour must account for the size of the largest ship that could be located in the ship hazard area. The analysis must demonstrate that the ship size used represents the largest ship that could be present in the ship hazard area or, if the ship size is unknown, the analysis must use a ship size of 120,000 square feet.

4.10.2. The analysis must first calculate the probability of impacting the reference ship selected at the location of interest. From the location of interest, move the ship away from the launch location along a single radial until the probability that debris is present at that location multiplied by the probability that a ship is at that location is less than or equal to 1 × 10−5. When calculating the probability of impacting a ship, an impact occurs when:

4.10.2.1. The analysis predicts that inert debris will directly impact the vessel with a mean expected kinetic energy at impact greater than or equal to 11 ft-lbs; or

4.10.2.2. The analysis predicts the peak incident overpressure at the reference vessel will be greater than or equal to 1.0 psi due to any explosive debris impact.

4.10.3. The analysis must account for: the variance in winds; the aerodynamic properties of the debris; the variance in velocity of the debris; guidance and performance errors; the type of vehicle breakup, either by any flight termination system or by aerodynamic forces that may result in different debris characteristics, and; debris impact dispersion resulting from vehicle breakup and the malfunction turn capabilities of the launch vehicle.

4.10.4. Repeat the process while varying the radial direction until enough locations are found where the reference ship's probability of impact is less than or equal to 1 × 10−5 such that connecting each location will result in a smooth and continuous contour.

4.11. RFA, as the launch operator, has utilised the methodology above to establish the Saxa LEZ for its launch. The LEZ is entitled NM 1 to correspond with the associated RFA Notice to Mariners request and is shown at Figure 60.

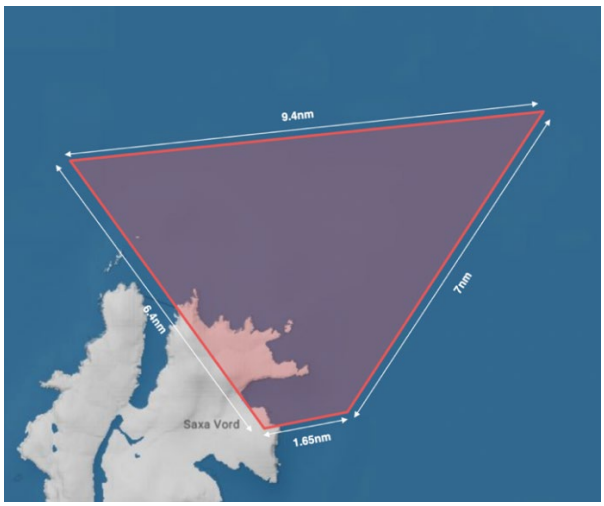

Figure 60: Saxa RFA NM1 LEZ

Warning Zones

4.12. Warning Zones will be established to provide suitable control measure to minimise the risk to personnel and vessels within the areas where the Stages and Fairing from the LV will impact on the sea surface. The methodology for computing ship hazard areas in the vicinity of each planned water impact location mandates that the launch operator must compute a ship hazard area in the vicinity of each planned impact location as required by the following:

4.12.1. The analysis must calculate a three-sigma dispersion ellipse by determining the three-sigma impact limit around a planned impact location.

4.12.2. Taking the three-sigma dispersion ellipse calculated, plot a co-centric ellipse in the xy plane where the major and minor axes are 10 nm longer than the major and minor axes of the three-sigma dispersion ellipse.

4.13. From the above analysis Warning Zones can be established in which mariners will be notified of the risk during launch operations. The 3 Warning Zones established for the Saxa RFA launch, entitled NM 2, 3 & 4 to correspond with the associated RFA Notice to Mariners request, which can be found at Enclosure 1, are as follows:

4.13.1. NM2 is the Warning Zone for the hazard area for the jettisoning of LV Stage 1 and Fairing, as per Figure 61.

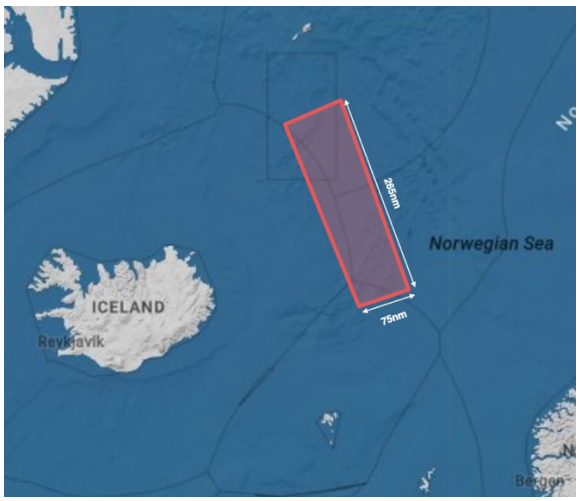

Figure 61: Saxa RFA Warning Zone NM2

4.14. NM3 is the Warning Zone for the hazard area of the jettisoning of Stage 2, as shown at Figure 62.

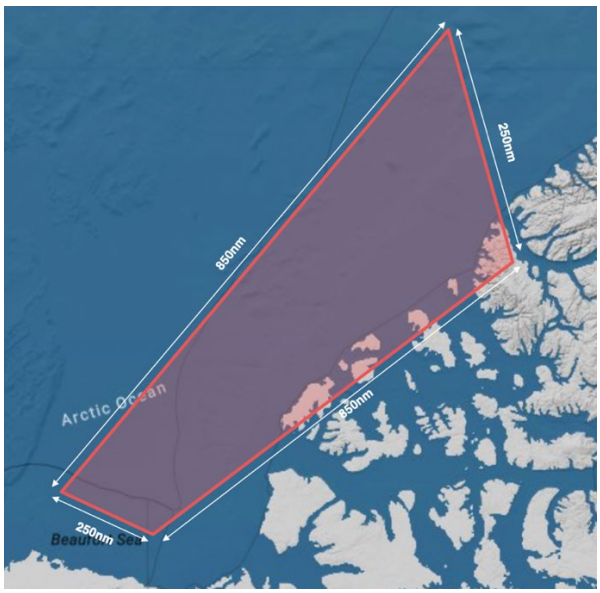

Figure 62: Saxa RFA Warning Zone NM3

4.15. NM4 is the Warning Zone associated to the risk mitigation to the early phase of the flight, as per Figure 63.

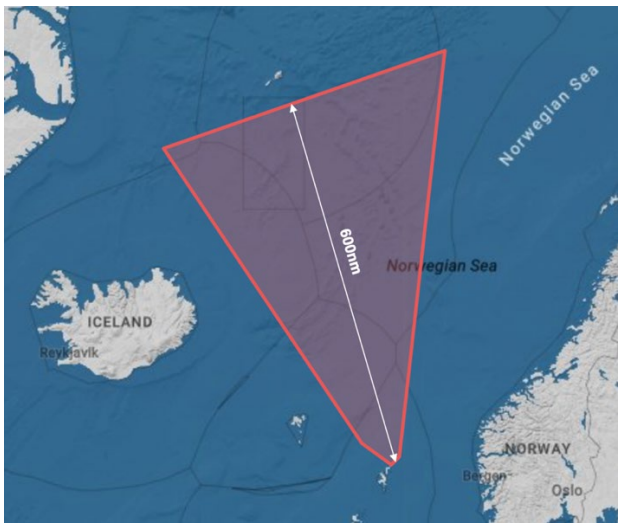

Figure 63: Saxa RFA Warning Zone NM4

Saxa Sites

4.16. **Range and Launch Control Complex Plus Support Facilities**. The SaxaVord domestic site is located around 2km inland from the eastern coast and 5km from the northern most tip of the island of Unst. This site comprises the launch control, range control and administrative buildings for the spaceport as well as all accommodation and hospitality buildings. There is no hazardous materials storage or use on this site and no practical activities related to launch or launch vehicles.

4.17. **Lamba Ness Launch Site and Launch Vehicle/Payload Processing Facilities**. The Lamba Ness site occupies the entirety of the Lamba Ness peninsula, located around 6km north east of the SaxaVord site on the island of Unst. The peninsula is around 2km long stretching east into the North Sea. The site consists of the launch pads for both suborbital and orbital rocket launches, propellant storage facilities, launch vehicle and payload preparation/processing/ assembly hangars and infrastructure related to launch activity. Whilst, under normal circumstances, there will be far fewer personnel on the Lamba Ness site than the SaxaVord site, there will be hazardous materials and pyrotechnics/explosives stored and used on this site altering the risk profile of emergencies at this site.

Launch Vehicle Types

4.18. Although this NRA is predominantly assessing the risk associated with the RFA One LV, Saxa has been designed to host a wide variety of vertical launch missions on small[59] rockets with payloads of up to 1.5 tonnes into Sun-Synchronous, Polar and High Inclination orbits, the purpose of which is to deliver satellites into space. Sub-orbital flights will also take place, predominantly utilising rockets which are one or two stage solid/liquid propellent rockets designed for test and research purposes. Saxa is in commercial negotiation to launch the following rockets detailed at Table 1.

Provider	Name	Type	Stages	Length (m)	Diameter (m)	Weight (kg)	Max Payload (kg)	Propellent	Recovery Required?
HyImpulse	SR75	Sub-Orbital	Single	11.2	0.64	700	300	LOX[60]/ Kerosene	Yes: only booster - not nose cone

[59] Rocket sizes are defined by payload capacity rather than rocket size, as detailed in FAA Pt. 420.
[60] Liquid oxygen.

Provider	Name	Type	Stages	Length (m)	Diameter (m)	Weight (kg)	Max Payload (kg)	Propellent	Recovery Required?
HyImpulse	SL1	Orbital	Three	27	2.2	36,000	500	LOX/ Kerosene	No – boosters designed to sink
Venture Orbital Systems	Zephyr	Orbital	Two	17	1.2	13,500	80	LOX/ RP1[61]	No – boosters designed to sink
ABL	RS1	Orbital	Two	26.8	1.83	46,209	700	LOX/ Kerosene	No – boosters designed to sink
Warsaw Institute of Aviation - Łukasiewicz Research Network	ILR-33 Amber 2K	Sub-Orbital	Two	4.6	0.23	270	10	Hydrogen Peroxide/ Polyethylene	Yes
Skyrora	XL	Orbital	Three	22.7	2.2	55,838	315	Hydrogen Peroxide/ Kerosene	No – boosters designed to sink
Rocket Factory Augsburg	RFA 1 MVP	Orbital	Three	22.4	2.15	61,500	550	LOX/RP1	No – boosters designed to sink
Rocket Factory Augsburg	RFA 1 NOM	Orbital	Three	31	2.15	91,500	1500	LOX/RP1	No – boosters designed to sink

Table 1: Saxa Launch Vehicle Types

LV Launches and Recoveries

4.19. **Orbital LVs.** Orbital rockets will be launched vertically from Saxa to deliver satellites into space. The boosters and fairings will be detached from the LV in the initial stages of launch prior to the rocket leaving the earth's atmosphere. Boosters and fairings ejected during launch will fall back to the sea surface and sink on impact. All fuel contained within the boosters will be expended prior to parting from the LV. All rockets have a Flight Termination System (FTS) installed to allow launch control staff to instantaneously terminate the rocket in flight if required.

4.20. **Sub Orbital LVs**. Sub-orbital rockets will be launched in the same manner as their orbital counterparts. However, sub-orbital rockets are designed to be recovered[62] and their flight path will terminate at a pre-planned position where a recovery vessel will retrieve the rocket. In the final stage of flight, the rocket engine will extinguish, and the rocket will free-fall to the sea surface. A parachute will be deployed to slow the rocket's final descent so that it remains intact

[61] RP-1 = Rocket Propellent 1 – a highly refined form of Kerosene.

[62] Recoveries may not require retrieval of the entire rocket. Depending on the specific rocket and flight the entire rocket, or the payload, or other parts containing scientific equipment (e.g. nose cone), may be jettisoned from the rocket (which would then continue to termination and sink on impact with the sea). These jettisoned parts would descend to the sea surface by parachute ready for recovery.

and undamaged on contact with the sea surface. The parachute and cables will also be recovered so that they are not a hazard to navigation or a danger to marine life.

Control Measures – Range Operations Team

4.21. The Saxa Range Operations Team will manage safe and effective launch activity. The team is responsible for ensuring that any risk associated with the safety of mariners is minimised, using the ALARP principle. To do so specific control measures within Saxa will be implemented in the planning phase of launch activities, including:

- Planning range safety operations.
- Establishing suitable warnings to the maritime community (NTMs, WZs, Press releases, social media bulletins, stakeholder briefings) inc. LEZ activation times.
- Ensuring that an appropriate training and certification process is in place for operations and safety staff.
- Ensure range surveillance equipment is functional.
- Routine and regular analysis of the Saxa AOI to identify and determine changing patterns of maritime activity.
- Consult maritime shipping schedules (cruise ship itineraries, Sullom Voe tanker schedule, ferry timetables) to ensure any transits through LEZ are deconflicted.
- Maintaining an extant NRA.
- Ownership of the Saxa Range Safety Emergency Plan, and ensuring that it is kept up to date, promulgated and understood by all involved in range operations and safety.
- Maintain active engagement with legislative, statutory and regulatory bodies, law enforcement agencies, NGOs.
- Maintaining accurate mid-long term weather forecasting.

4.22. Immediately prior to and during Saxa launch operations the Operations Team will:

- Liaise with and control supporting entities, e.g. Boundary Boat(s).
- Provide Range surveillance command and control.
- Maintain active control of LEZ to prevent and/or deconflict any encroachments and ensure that no person is inside the LEZ unless the person's presence there is essential for the carrying out of spaceflight activities or for the performance of duties connected with such activities.
- Monitor and manage safety communications, including broadcasting VHF sécurité and GMDSS messages as part of the Saxa Communications Plan. This will include close liaison with JRCCs, particularly for the Arctic Ocean/Beaufort Sea AOI.
- Conduct dynamic weather forecasting.
- Conduct dynamic risk assessments.
- Execute the Emergency Response Plan in the event of an incident.

Range Encroachments

4.23. The Saxa Range parameters will encroach on Greenland and Jan Mayen Island to the north west – but at very low risk as the area over Greenland has no habitation, and neither Jan Mayen nor Bear Islands have permanent populations. To the north east the Range Aasta Hansteen oil terminal 425nm to the north east[63]. as shown in Figure 64, does present a risk to personnel and property and must be taken into consideration if planning launch activities with a north eastern trajectory.

[63] In position 67 06.69N 007 09 49E.

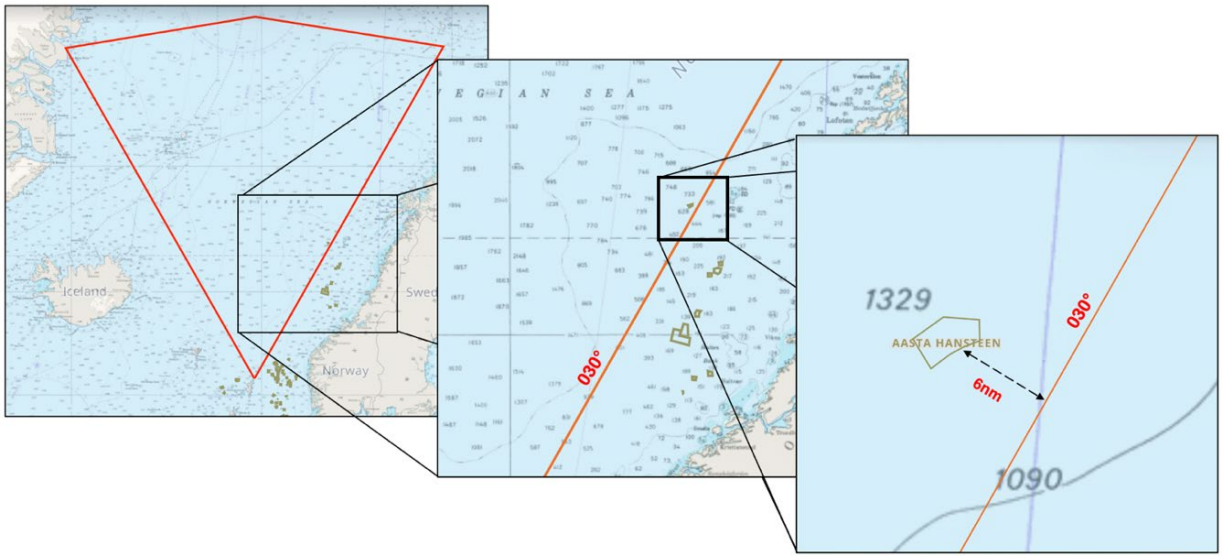

Figure 64: Aasta Hansteen Oil Rig Location relative to Saxa Range

4.24. The Aasta Hansteen terminal is routinely crewed by up to 150 personnel and therefore does not meet the CAA ALARP threshold[64]. However, the majority of Saxa launch trajectories will have a northerly bias, so any mission planning that requires a north eastern trajectory must consider the rig's location. Provided a rocket trajectory has a lateral separation of more than 20nm from a fixed structure the risk is reduced to ALARP. For the Aasta Hansteen rig, adjusting the right-hand Range arc limitation from 030° 022° will achieve this trajectory lateral separation. To avoid the Aasta Hansteen rig, as a pre-launch standard operating procedure Saxa will liaise with the launch operator and discuss altering the launch azimuth to satisfy the ALARP requirements.

4.25. UK oil and gas fields are present to the west and east of Shetland. However, as can be seen from Figure 65 no fields or structures encroach the Saxa Range or northerly Launch Area.

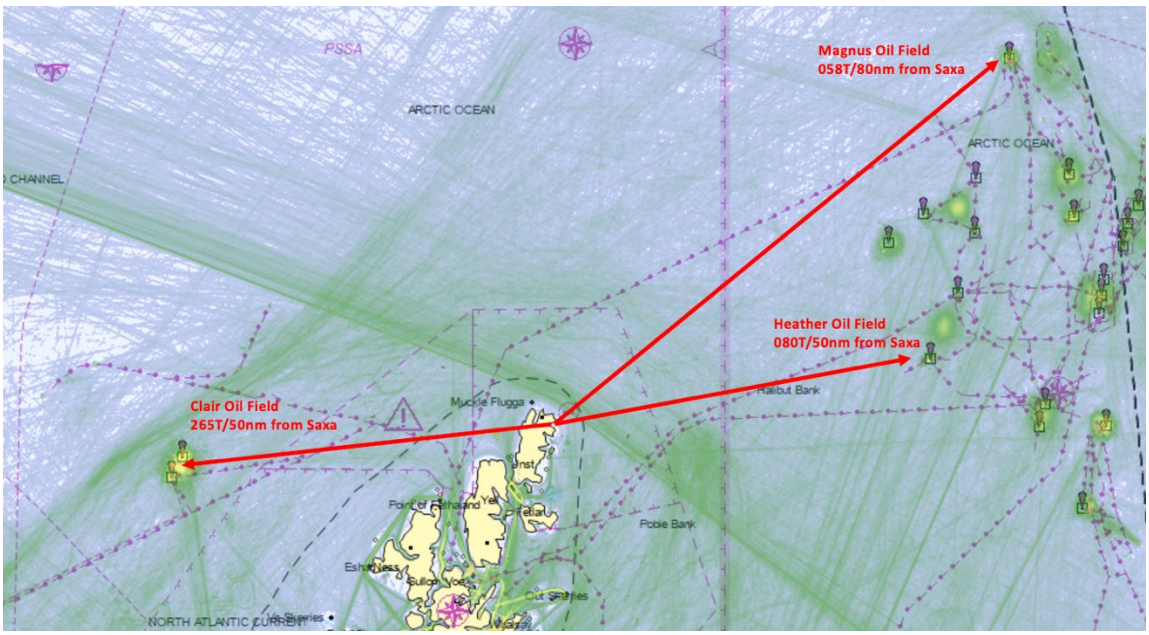

Figure 65: UK Oil and Gas Fields closest to Saxa

Rocket Recovery

4.26. Sub-orbital rocket operations may require a recovery operation to retrieve the rocket, its payload and parachute/cabling at the end of its flight mission. For recovery operations Saxa

[64] 1 x 10^{-4} expected casualties per launch.

will employ a suitable vessel with appropriately trained crew and will be pre-positioned to recover sub-orbital rockets.

Range Surveillance

4.27. The Saxa Range staff will provide active surveillance of the LEZ prior to and during launch operations utilising a multi-sensor system that incorporates radar, AIS and CCTV. The system will also be capable of monitoring maritime traffic beyond the LEZ to the limit of the radar horizon, AIS coverage and visual range. This, in conjunction with advanced navigational notices, admiralty chart annotations[65] and dynamic VHF sécurité broadcasts, will ensure that the maritime community is provided with sufficient notification of launches. The wider Warning Zones will also be monitored utilising AIS.

Boundary Boats

4.28. In support of the Saxa surveillance system vessels, entitled Boundary Boats will be employed to provide additional surveillance, communications, debris recovery, emergency response and a LEZ clearance function. Appropriate Shetland-based vessels will be contracted by Saxa when the spaceport is operational. The Boundary Boat will meet the following criteria:

- Vessel can withstand the challenging Shetland environment and still deliver a Range safety service. This is likely to be the ability to operate in up to sea state 6[66].
- IMO/SOLAS/STCW/MCA compliant.
- Effective GMDSS communications equipment with redundancy.
- Means of recovering personnel/objects (debris) from the sea surface.
- First aid facilities and trained personnel.
- Maritime radar (I or E/F band) suitable for tracking small vessels.
- AIS system.
- Suitable crew numbers to perform SAR/safety duties.
- All crew SQEP[67].

4.29. If the launch operation includes the recovery of a sub-orbital rocket, two Boundary Boats will be utilised – one to provide a safety function within the LEZ and another 'down range' to recover the sub-orbital rocket.

Communications

4.30. Saxa will employ a robust and effective maritime communication plan to support efficient Range safety operations. Maritime routine and safety communication are well-established and extensively used; the Global Maritime Distress and Safety System (GMDSS) will be used by Saxa for routine and safety communications during launch operations.

4.31. **VHF Safety Messages**. Saxa's principal means of communicating safety information over VHF will be by the Sécurité process[68]. VHF will also be the primary means of contacting vessels at sea during Saxa launch operations, using the 'hail and response' method. Many of the smaller vessels will not have a means, or necessarily be aware of, the NTM and NAVWARN processes (particularly recreational craft) but are highly likely to be carrying a VHF system, even it is only a portable handheld radio. Therefore, a dynamic means of communication is key to effective Range safety. The Boundary Boats will provide a Sécurité relay service where required.

4.32. **Mobile Phone Network**. The mobile phone network in Shetland is effective with good coverage. However reliable, mobile phone communications will not be utilised as the primary means of routine and safety Saxa maritime communications. While the Boundary Boat is likely to be within mobile phone range while on duty, and can achieve two-way direct communications with Saxa, the wider users of the maritime space, particularly at range from

[65] Admiralty charts will not be annotated for the 2024 RFA launch – see para 4.34.
[66] Sea State 6 Conditions: Large waves with white foam crests. Spray probable. Wind Speed: 22 - 27 knots, Wave Height: 9.9 feet/3m.
[67] Suitably Qualified and Experienced Personnel.
[68] *Sécurité* is a procedural word used in the maritime radio service that warns personnel at sea that the following message is important safety information. Saxa will also utilise Digital Selective Calling as part of its GMDSS system.

the coast, will not have access to a reliable signal. So, the mobile phone network will not be used for maritime communications and will only be utilised as a back-up system to contact emergency response services if the landline network is inoperable.

Navigational Warnings

4.33. A Navigational Warning (NAVWARN) is a broadcast message containing urgent information relevant to safe navigation. In support of the GMDSS, Broadcast Warnings are promulgated by the Worldwide Navigational Warnings Service (WWNWS) to provide rapid dissemination of information critical to navigation and the safety of life at sea. NAVWARNS are issued regularly and contain information about persons in distress, or objects and events that pose an immediate hazard to navigation. The UK[69] and Norway[70] are the NAVAREA I (NE Atlantic) NAVAREA XIX (Nordic Sea and Arctic) Coordinators.

4.34. In accordance with MCA guidance[71] Saxa will utilise the Temporary Notices to Mariners process and NAVWARN system to issue prior notification of launch operations, including LEZ activation and Warning Zone locations. Saxa is also in dialogue with the UKHO regarding space rocket launch operations warning hazard notifications being added to admiralty charts in due course. UKHO is in liaison with the U.S. and Canadian hydrographic services for a similar service in NM3 Warning Zone.

Emergency Response

4.35. **Maritime Emergency Response Plan**. An emergency plan has been created by Saxa detailing the response to emergency situations involving with Range Safety operations. The plan interfaces with available emergency services and provides appropriate contact details[72]. The detailed responses include step-by-step procedures appropriate to the emergency situation. The Saxa Emergency Response Plan outlines:

- The purpose of the plan.
- Area covered by the plan.
- Emergency organisation/teams (Saxa and external).
- Key roles, authority, accountability, responsibilities/division of responsibilities:
  - Who is in overall command.
  - Is there an on-scene commander.
  - Who/what are the emergency team(s).
- How personnel will be accounted for, including muster lists.
- List of emergency equipment, where it is located and user guides.
- Missing personnel/search procedures.
- Evacuation plan.
- Key dependencies.
- What additional resources may be required and how are they obtained.
- Description of possible scenarios.
- Categorisation of incidents/emergencies (i.e. major/minor).
- Potential consequences of an incident and consequence management.
- Decision making process.
- Emergency cards – a series of cards that summarise the incident and an actions tick-off list. These will be carried by all Range safety personnel.
- Communication plan, which includes:
  - External communications (emergency services, local leadership, government, statutory bodies and authorities).
  - Internal communications (communications plan to deal with incident(s), reassurance plans to Saxa staff).
  - Full emergency contact list.

[69] UK Hydrographic Office.
[70] The Norwegian Department of Maritime Safety.
[71] Spaceflight Activities: Risk Mitigation for Shipping, Navigation and Emergency Response V.1 (draft), MCA, Feb 22.
[72] Detailed specifically by Saxa as a Multi-Agency Initial Response Plan.

- Public Relations Plan – defensive media brief, incident statement, liaison with press and media.
- Casualty/fatality plan (including how to get casualties ashore and to hospital – landing sites, harbours, airfields, landing pads).
- Environmental impact and management plan.
- Which laws, legislation, rules, guidelines are being used and followed (or not, and why).
- Emergency training plans and procedures.
- Record keeping/emergency reporting log, evidence gathering, after-action report and Lessons Learned process.
- Process for returning to routine operations.

4.36. In the event of an incident/accident that involves the failure or intentional termination of a LV, emergency/short-notice and critical safety information will be broadcast via a NAVWARN to notify mariners of the danger, particularly of rocket debris floating on or near the sea surface.

5. DATA SOURCES AND VESSEL TRAFFIC ANALYSIS

Maritime Traffic Summary

5.1. Maritime activity in AOIs 1 & 2 has already been described earlier in this NRA. While this has provided a general overview of the maritime landscape, in order to undertake a risk assessment a comprehensive analysis of maritime traffic and vessel concentrations and patterns is required. The NRA will now narrow the focus and analyse specific areas of water space, namely the Saxa Range and hazard areas.[73] The determination of vessel types and number has been predominantly based on AIS and S-AIS information. However, key stakeholders were engaged to provide additional and/or corroborative data to ensure that the figures in this NRA are accurate.

5.2. A full monthly breakdown of vessel numbers and types in the Saxa Range between 2020 and 2023 is at Enclosure 2 with a summary illustrated at Table 2 below. Overall maritime activity in the analysed areas, apart from the LEZ, is determined to be extremely low relative to its size, thus meeting the ALARP threshold. Maritime activity in the LEZ is low relative to its size but does not meet the regulatory risk threshold formulae[74] of 1 x 10^{-4} and is therefore not ALARP. Therefore, additional control measures will be required to reduce the risk to a tolerable level.

5.3. The main category of vessel most prevalent in the Extended Nordic Sea Saxa Range was cargo vessels and the second most frequent category fishing vessels.

Vessel Type	2020	2021	2022	2023	4 Yr Mean
Saxa Extended Range	1974	2382	2416	2844	2404
Arctic Ocean/Beaufort Sea Range	109	101	130	143	124
Saxa RFA LEZ	140	142	170	204	164
Stage 1 and Fairing Warning Zone	187	262	273	288	252
Stage 2 Warning Zone	9	10	7	11	9.5
Early Phase Flight Warning Zone	1130	1321	1459	1795	1430

Table 2: Vessel Numbers Summary 2020-2023

[73] The AOI is for Maritime Domain Awareness purposes; the Saxa Range is where control measures will be implemented.
[74] If the estimated expected casualty rate per launch exceeds 1 x 10^{-4} then the risk is not considered ALARP. Sources: FAA & CAA.

Analysis of Predominant Maritime Traffic

5.4. **Cargo**. In the Nordic Sea Range area cargo vessels constitute the largest grouping of maritime traffic. The main cargo routes are along the Norwegian coast, although there is a route from the Atlantic to Scandinavia that passes south of the Faroes and north of the Shetlands. Traffic is consistently light (2-3 vessels per day) on this route. Fishing vessel transhipment operations regularly take place in the northern Norwegian Sea. They are categorised as cargo vessels and take on the pelagic fishing vessels' fish stocks to empty the fishing vessels' tanks and allow them to remain on station uninterrupted for longer periods. Transhipment almost exclusively is restricted to the Russian pelagic fleet. Cargo vessel trade in the Beaufort Sea is extremely low (an average of 19 vessels per year or 0.05 per day). The cargo vessel traffic is limited to the north Alaska coast and peaks in August/September each year when the north west Passage is accessible.

5.5. **Tugs**. In the Beaufort Sea tugs and towed barges are the most prominent of the maritime traffic in the area. Tugs tow barges to service northern Alaska's near shore commercial activity, almost exclusively the offshore energy sector. Given the challenging maritime environment due to the extent of the Arctic sea ice, overall numbers remain extremely low at an average of 0.02 vessels per day and these vessels almost never venture more than 6nm from land.

5.6. **Icebreakers**. Total vessel traffic further north in the Saxa Stage 2 Dispersion Area Warning Zone: vessel numbers are negligible at an annual average total of 9.5 vessels per year. As the region is almost exclusively sea ice, generally icebreakers are the only vessels that can access this area.

5.7. **Fishing**. Commercial fishing is prohibited in the Beaufort Sea area but is an important maritime activity in the Nordic Sea. Demersal fishing vessels concentrate inside the continental shelf, whereas pelagic boats fish the deeper water. Therefore, demersal fishing boats will mostly-affect Saxa launch operations within the UK EEZ and to an extent the Norwegian EEZ. The pelagic fishing vessels are all over 12 metres in length, and more than 300 tonnes and fish in the deeper waters of the Nordic Sea. Overall numbers of both types are still very low, and the Saxa Range contained less fishing boats than to the west and east of Shetland where there are richer fishing grounds[75].

5.8. **Monitoring**. Fishing vessels are monitored nationally and internationally through a Vessel Monitoring System (VMS), which allows a vessel to be automatically located and identified via a satellite-tracking device. VMS systems are used to improve the management and sustainability of the marine environment through ensuring proper fishing practices and the prevention of illegal fishing. The exact functionality of a VMS system and the associated equipment varies with the requirements of the nation of the vessel's registry, and the regional or national water in which the vessel is operating. Within regional and national VMS initiatives there are also sub-divisions which apply different functionality to different vessel categories. Categories may be size or type of vessel or activity, but from 2012, all EU, Faroese and Norwegian vessels which exceed 12 metres overall length must be fitted with VMS units. Because of their size pelagic boats carry both VMS and AIS and can therefore be identified prior to and during Saxa launch operations. Similarly, for safety and situational awareness purposes an increasing number of small demersal fishing boats carry AIS as well as the mandated VMS, which again will assist with vessel detection and identification.

5.9. **UK VMS**. All UK commercial fishing vessels 12m or more in overall length are legally required to have a UK government-approved VMS[76]. Fisheries management is devolved to national governments, and the UK Fisheries Monitoring Centre, operated by Marine Scotland on behalf of DEFRA, monitors commercial fishing activity and supports the four UK legislative bodies' enforcement and compliance operations. Under the 2018 UK Data Protection Act access to UK VMS data is strictly controlled as it is considered to be personal information.

5.10. **Inshore Fishing Vessels**. Smaller fishing vessels under 12m in length, which generally comprise the day boat and inshore fleets, are more challenging to track. They are not

[75] Source: https://www.gov.scot/publications/scottish-sea-fisheries-statistics-2019.
[76] Shetlands-registered fishing vessels are legislated by Scottish Statutory Instrument (SI) 392/2004.

mandated to carry VMS and may not have an AIS system installed, although as AIS systems become more affordable[77] an increasing number of smaller fishing boats carry this important navigational, situational awareness and safety equipment. The closest point to Saxa where fishing vessels can land their catch is Cullivoe on the island of Yell, which is used by the majority of dayboats fishing around Unst. Cullivoe only accounts for 4% of all Shetland's shellfish[78], and 11% of finfish[79] landings and lies outside of the Saxa Range.

5.11. **Inshore Fishing Activity**. Within 6 nautical miles of the Shetland coast, shellfish fishing is managed by the Shetland Shellfish Management Organisation (SSMO) via the Shetland Regulated Fishery (Scotland) Order 2012. The SSMO has around 100 licensed shellfish vessels operating around the Shetland Islands. The SSMO manages fishing methods and fishing gear, restricts fishing seasons, sets minimum sizes for shellfish and manages shellfish beds for stock conservation. The SSMO also undertakes the collection of data which allows a comprehensive stock assessment to be developed year on year. By permission, Project Purple obtained historic tracking information from SSMO-licenced vessels to support MDA analysis around the north east Shetland coast. Some smaller vessels can also jig for mackerel and squid as a secondary income.

5.12. **Offshore Energy**. It is a legislative requirement that oil and gas platforms have a safety vessel in the vicinity of the rig. In addition, there is a significant amount of support and supply vessels on transit between the platform and the mainland (and islands). Vessels supporting the oil and gas infrastructure almost exclusively remain inside UK and Norwegian EEZs as the energy fields are on the continental shelf. Lerwick is the main hub in Shetland for oil and gas support vessels and the routeing to and from the fields are generally to the south of Shetland, so these vessels rarely impact on the Saxa Range. In the Beaufort Sea offshore oil infrastructure is limited to Gravel Islands, which are man-made drilling and production facilities that sit around 2 miles off land and out-with the Saxa Stage 2 Warning Zone.

5.13. **Survey Operations**. Survey activity does take place in the Nordic Sea, but in very small numbers particularly in the Beaufort Sea where they are seasonally limited because of the sea ice. In the Nordic Sea the vessels commonly remain on station for 2-4 weeks while on operations. Surveying generally comprises offshore energy exploitation, hydrographic surveying and scientific research.

5.14. **Cruise Ships**. Cruise ships are present in both the Nordic and Beaufort Seas. In the Nordic Sea cruises pass through the Saxa extended Range enroute to Iceland, Greenland, Svalbard and the Arctic. In the Beaufort Sea cruise ships utilise the north west passage when it is accessible in August and September but remain outside the Saxa Stage 2 Warning Area.

5.15. **Other**. Other types of maritime activity, including military exercises and recreational traffic, generally did not present in any considerable numbers for an extended period within the Saxa Range.

Predicting Future Traffic Flows

5.16. There are no current indications that for the period that this NRA[80] is valid there will be any significant variations in the volume and nature of maritime traffic in the AOI.

[77] Systems that link to laptops/tablets are available commercially for under £100.
[78] https://www.ssmo.co.uk/site/assets/files/1/shetland_shellfish_statistics_2016.pdf
[79] Data provided by Shetland Fishermen's Association.
[80] MCA recommendation is that NRAs are refreshed every 2 years to ensure that there are no significant changes to the data on which risk is being assessed.

6. HAZARD IDENTIFICATION

6.1. As part of the NRA, it is necessary to identify a number of hazards that Saxa will need to consider when planning launches. These hazards may vary depending on the rocket type, trajectory, and number of stages, but there also exists inherent hazards common to rocket launches for Saxa.

6.2. A hazard is defined by the IMO as 'something with the potential to harm human life, health, property or the environment' and a risk as 'the combination of the frequency and the severity of the consequence'.[81]

6.3. The process for carrying out an NRA follows the key risk assessment principles and methodology from the Department for Transport (DfT)and Maritime and Coastguard Agency (MCA) Methodology for Assessing the Marine Navigational Safety and Emergency Response Risks of Offshore Renewable Energy Installations (OREI). The process is also identified in the PMSC "Guide to Good Practice" (DfT/MCA, 2018). These are the following outlines to carrying out an NRA.

6.3.1. Identification of hazard definitions.

6.3.2. Listing of potential hazard scenarios (i.e. descriptions of hazard and outcome).

6.3.3. Identification of causes that may lead to one of the described hazard scenarios (i.e. an accident or incident outcome).

6.3.4. Consideration of existing (embedded) mitigation measures, which either control or address the outcome of an accident or incident.

6.3.5. Additional (future) risk controls, which are not currently in place, but could be used to further reduce or eliminate risk.

6.4. The IMO further states that 'characterisation of hazards and risks should be both qualitative and quantitative, and both descriptive and mathematical, consistent with the available data, and should be broad enough to include a comprehensive range of options to reduce risks'.

Hazard Definitions

6.5. The DfT and MCA provide hazard category definitions, taken from 'Methodology for Assessing the Marine Navigational Safety and Emergency Response Risks of Offshore Renewable Energy Installations' (DfT/MCA 2023)[82], as shown at Table 3.

Category	Description
Accidents to the general public	Accidents to the general public are defined as those accidents which lead to injury, death or loss of property amongst the population ashore resulting from one of the other ship accident categories.
Accidents to personnel	Accidents to personnel are defined as those accidents which cause harm to any person on board the vessel e.g. crew, passengers, stevedores, which do not arise as a result of one of the other accident categories. Essentially, it refers to accidents to individuals, though this does not preclude multiple human casualties as a result of the same hazard, and typically includes harm caused by the movement of the vessel when underway, slips, trips, falls, electrocution and confined space accidents, food poisoning incidents, etc.
Allision	Defined as a violent contact between a moving and stationary vessel or fixed object.
Capsizing	The overturning of a vessel after attaining negative stability.

[81] https://wwwcdn.imo.org/localresources/en/OurWork/Safety/Documents/MSC-MEPC%202-Circ%2012-Rev%202.pdf
[82] https://assets.publishing.service.gov.uk/media/656f2dc49462260721c56932/NRA_Methodology_2023_v3.1.pdf

Category	Description
Collision	Collision is defined as a vessel striking, or being struck by, another vessel, regardless of whether either vessel is under way, anchored or moored, but excludes hitting underwater wrecks.
Contact	Contact is defined as a vessel striking, or being struck by, an external object that is not another vessel or the sea bottom. Sometimes referred to as impact.
Explosion	An explosion is defined as an uncontrolled release of energy, which causes a pressure discontinuity or blast wave.
Electrocution	Electrocution is death or severe injury caused by electric shock from electric current passed through the body.
Fire	Fire is defined as the uncontrolled process of combustion, characterised by heat or smoke or flame or any combination of these.
Flooding	Flooding is defined as sea water, or water ballast, entering a space, from which it should be excluded, in such a quantity that there is a possibility of loss of stability leading to capsizing or sinking of the vessel.
Foundering	To sink below the surface of the water.
Grounding	Grounding is defined as the ship coming to rest on, or riding across, underwater features or objects, but where the vessel can be freed from the obstruction by lightening and/or assistance from another vessel (e.g. tug) or by floating off on the next tide.
Hazardous substance accidents	Hazardous substance accidents are defined as any substance which - if generated as a result of a fire, accidental release, human error, failure of process equipment, loss of containment, or overheating of electrical equipment - can cause impairment of the health and/or functioning of people or damage to the vessel. These materials may be toxic or flammable gases, vapours, liquids, dusts or solid substances.
Loss of Hull Integrity	Loss of hull integrity is defined as the consequence of certain initiating events that result in damage to the external hull, or to internal structure and sub-division, such that any compartment or space within the hull is opened to the sea or to any other compartment or space (where it is not designed to be).
Machinery-related accidents	Machinery-related accidents are defined as any failure of equipment, plant and associated systems which prevents, or could prevent if circumstances dictate, the ship from manoeuvring or being propelled or controlling its stability.
Payload-related accidents	Payload-related accidents include loss of stability due to cargo shifting and damage to the vessel's structure resulting from the method employed for loading or discharging the cargo. This category does not include incidents which can be categorised as Hazardous substance, Fires, Explosions, Loss of hull integrity, Flooding accidents, etc.
Stranding	Stranding is defined as being a greater hazard than grounding and is defined as the ship becoming fixed on an underwater feature or object such that the vessel cannot readily be moved by lightening, floating off, or with assistance from other vessels (e.g. tugs).

Table 3: Hazard Category Definitions

6.6. Not all hazard categories are relevant to this NRA. A list of hazards scoped out is at Table 4.

Category	Description
Accidents to the general public	In terms of a navigational risk assessment, the maritime element of range safety will not affect shoreside safety. This assessment (a NRA) does not cover risks associated with the general public ashore resulting from Saxa operational activities.
Grounding/ Stranding	Grounding and stranding are scoped out of these operations as the area of operation is in deep water and the vessels used are small craft which can manoeuvre close inshore and are unlikely to ground or be stranded.
Payload-related accidents	Payload-related accidents are scoped out of the NRA as the vessels' payloads will have no effect on Saxa's operations.

Table 4: Hazards Scoped Out

Hazard Scenarios

6.7. A description of Saxa space rocket launch operations is at Section 5. Using the hazard categories (Table 5), the following specific hazards have been identified. In total 10 hazard scenarios are identified for the NRA:

Hazard Assessment Number	Hazard Scenario	Hazard Category
1	A rocket fails/is terminated soon after launch and debris lands on vessel at sea.	Contact
2	A vessel is struck by a fairing that has been intentionally detached from the rocket as part of the stages of separation during a routine launch and has fallen to the sea surface.	Contact
3	A vessel strikes rocket debris floating on or just under the sea surface if a rocket fails/is terminated outside the Launch Area but prior to reaching orbit.	Contact
4	A fixed offshore structure (oil/gas platform or offshore wind turbine) is struck by a fairing that has been intentionally detached from the rocket as part of the stages of separation during a routine launch.	Contact
5	A rocket fails/is terminated prior to reaching orbit and the debris falls on a fixed structure (oil/gas platform or offshore wind turbine).	Contact
6	Spectator and fishing vessels – sightseeing, day boats and other fishing and recreational craft – are not detected in the Launch Exclusion Zone during a launch and are struck by rocket debris.	Contact
7	A rocket fails/is terminated soon after launch and debris lands in a Marine or Special Protected Area (MPA/SPA) and sinks below the surface.	Foundering/ Hazardous Substance Accidents
8	A rocket explodes soon after launch and combustible materials/chemicals that are on fire land on the sea surface.	Fire

Hazard Assessment Number	Hazard Scenario	Hazard Category
9	A rocket fails/is terminated soon after launch and debris and material, including parachutes, wires and cables, on or just under the sea surface, foul a propeller and disable a vessel's propulsion system or a fishing vessel's nets.	Contact/ Machinery-Related Accidents
10	A rocket fails/is terminated outside the Launch Area but prior to reaching orbit and the debris and lands on vessel at sea.	Contact

Table 5: Hazards Scenarios

7. RISK ANALYSIS AND ASSESSMENT

ALARP

7.1. This NRA follows the CAA's[83] principles and guidelines for assessing ALARP and acceptable risk.

7.2. ALARP is a fundamental concept in UK health and safety law. Alongside the requirements in the Act, it applies to all activities within the scope of the Health and Safety at Work Act 1974 (HSWA). It is widely adopted within engineering good practice and across many sectors as a proportionate approach to safety risk management. Before granting either a launch operator licence, return operator licence or spaceport licence, the spaceflight regulator must be satisfied that the applicant has taken all reasonable steps to ensure the health and safety risks arising from their activities are as low as reasonably practicable (ALARP). Reasonably practicable involves weighing a risk against the trouble, time and money needed to control it. Thus, ALARP describes the level to which we expect to see workplace risks controlled.[84]

Hazard Scenario Causes

7.3. The hazard scenarios identified in Table 5 have been considered according to their 'Most Likely' and 'Worst Credible' outcomes. This provides the option to consider very serious outcomes, which could credibly occur, along with outcomes that are less serious, but could occur on a more frequent basis.

7.4. The assessment of risk is based upon the descriptions of the 'Most Likely' and 'Worst Credible' to determine the outcome in respect of effect to people, property (1-6, 8-10) and the environment (7). This approach follows the best practice guidance[85]. In making the assessment, the outcome from each scenario using the receptors of 'people, property, environment and port' was evaluated to give a baseline risk with **no mitigation** measures in place.

7.5. Each hazard scenario was considered to determine the possible causes, both individually and in combination. Using a hazard frequency methodology requires clear definitions for each Score. For example, how frequent a hazard or risk may be to be ranked as 6 – Frequent.

7.6. There is no generally accepted standard for Hazard Frequency. The following definitions are therefore based on plans submitted to the Shetlands Islands Council of up to 30 launches per year, with a division of 2.5 launches per month. They are also formatted from IMO examples based on ship-board scenarios of navigational risk posed by OREI. The two approaches are combined to consider both the number of launches over a period and the number of vessels in the Saxa Range over a period.

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[83] CAA Principles and guidelines for the spaceflight regulator in assessing ALARP and acceptable risk.
[84] https://www.hse.gov.uk/comah/alarp.htm#:~:text=%22ALARP%22%20is%20short%20for%20%22,to%20see%20workplace%20risks%20controlled
[85] PMSC 'Guide to Good Practice' (DfT/MCA, 2018).

7.7. IMO Example of Frequency:

1 – Extremely Remote: Once in 20 years in a fleet of 5000 ships.

3 – Remote: Once a year in a fleet of 1000 ships.

5 – Reasonably Probable: Once a year in a fleet of 10 ships.

7 – Frequent: Once per month on one ship.

Score	Frequency (per year)
1	Very Unlikely
2	Unlikely
3	Remote
4	Occasional
5	Probable
6	Frequent

Table 6: Hazard Frequency Methodology

7.8. Frequency Index:

Frequency Index			
Frequency	1	Very Unlikely	Once in 10 years over 300 launches
	2	Unlikely	Once in 5 years over 150 launches
	3	Remote	Once a year over 30 launches
	4	Occasional	Twice a year over 30 launches
	5	Probable	Four times a year over 30 launches
	6	Frequent	Between once a month and eight times a year over 30 launches.

Table 7: Frequency Index

7.9. Table 8 gives a frequency (count) of the causes identified during the hazard scenario process for Saxa operations taking place inside the Saxa Launch Exclusion Zone, Launch Area or Impact Dispersion Areas of jettisoned rocket fairings. Vessels refer to marine traffic not involved with Saxa operations. In compiling this Table official data from NASA[86], MAIB, CCG, USCG and the RNLI[87] has been analysed.

[86] A 2019 NASA report stated that between 2000 and 2016 41.3% of small satellites launched failed or party failed, of which 6.1% were launch vehicle failures: https://ntrs.nasa.gov/api/citations/20190002705/downloads/20190002705.pdf

[87] MAIB and RNLI maritime accident and incident data in UK waters and UK-registered vessels in area bounded by 59 30'N to 74 30'N and 044 00'W to 024 00'E over the period 2011 – 2021 obtained by FOI requests.

Cause	Frequency
Vessel breakdown, malfunction or equipment failure	5
Human error/competence/fatigue - fishing vessel	4
Human error/competence/fatigue - commercial vessel	4
Adverse weather conditions	3
Human error/competence/fatigue - recreational vessel	3
COLREGS failure to comply	3
Restricted visibility	2
Communication failure - operational/procedural	2
Communication failure - equipment	2
Equipment failure - rocket and guidance equipment	2
Notice to Mariners/Navigational Warnings failure to observe	2
Radar/multi sensor coverage inadequate	2
Inadequate training/procedures/competence – shore staff	2
Human error/fatigue - shore staff	2
Inadequate bridge resource management	1
Failure to comply with safe systems of work	1
Risk Assessment, incomplete/not reviewed	1
Inadequate maintenance/inspection	1
Unexpected change in schedule	1
Vessel breakdown or malfunction	1

Table 8: Cause Frequency

7.10. The top selected cause for the operation is ‘Vessel breakdown, malfunction or equipment failure’. Human error/fatigue – fishing vessel’ and ‘Human error/fatigue - commercial vessel’ are the joint second most frequent cause, with a score of four. The next stage of the process considers these causes in the context of existing controls, which might be applicable to prevent the hazard scenario from occurring.

8. RISK CONTROLS

Embedded Risk Controls

8.1. Each hazard scenario has been considered in light of embedded risk controls, noting that these controls, in the context of marine safety, relate to processes, practices and available safety resources that are currently in existence and items identified as part of the proposed operations. These might include international regulations (such as the International Regulations for Preventing Collisions at Sea (COLREGS)), or SAR provision (such as Coastguard or RNLI). They may also refer to 'equipment redundancy' which refers to the assurance of structural redundancy in technical systems both on board the Boundary Boat and the rocket.[88] In addition, any controls planned as part of the scheme have been considered as embedded within the project design. Table 9 presents the embedded risk controls with a frequency count of the number of assessments to which they apply.

No	Control	Frequency
E-1	High standards of rocket equipment serviceability, maintenance and testing	5
E-2	Availability and implementation of weather forecasting data	5
E-3	Equipment redundancy – structural redundancy in technical systems	5
E-4	Emergency services equipment	5
E-5	Emergency Response Plan	4
E-6	Implementation and practice of Standards of Training, Certification and Watchkeeping for Seafarers (STCW)	3
E-7	Implementation and practice of SOLAS regulations	2
E-8	Implementation and practise of International COLREGS 1972 (as amended)	2
E-9	Vessel maintenance	2
E-10	Operational planning	2
E-11	Training of operations personnel	2
E-12	Vessel inspection/survey	2
E-13	Vessel safety management system	1
E-14	Emergency equipment available	1
E-15	Passage planning	1
E-16	Contractor Risk Assessment Method Statement (RAMS)	1
E-17	Standard Operating Procedure	1

Table 9: Embedded Risk Controls

[88] The Flight Termination System (FTS) has redundant transceivers in the launch vehicle that can receive a command to self-destruct then set off charges in the launch vehicle to combust the rocket propellants at altitude. The Boundary Boat, like other marine vessels, should be assured to have a level of availability that can be increased by carrying out preventive and corrective maintenance of system components with structural redundancy.

Risk Matrix: Frequency, Severity and Risk Matrices

8.2. There is no generally accepted standard for a risk matrix for navigational risk assessments (NRA) as they are required to be defined by the operator as appropriate to operations' development. However, following MCA/DfT recommendations on matrices for NRAs, the following structure is proposed. A Risk Matrix requires a Frequency Index (Table 7) and a Severity Index (Table 10). Below is an IMO example of a Severity Index.

1 – Minor: Single of minor injuries

2 – Significant: Multiple of severe injuries

3 – Severe: Single fatality of multiple severe injuries

4 – Catastrophic: Multiple fatalities

Severity/Consequence Index			
Severity	1	Minor	Single of minor injuries / Minor environmental damage / minor economic cost
	2	Significant	Multiple of severe injuries / Significant environmental damage / significant economic cost
	3	Severe	Single fatality of multiple severe injuries / Major environmental damage / major economic cost
	4	Catastrophic	Multiple fatalities / Extreme or irreversible environmental damage / Enormous economic cost

Table 10: Severity Index

Classification	Outcome
21-24: Very High Risk	VH
15-20: High Risk	High
10-14: Significant Risk	Sig
5-9: Moderate Risk	Mod
3-4: Low Risk	Low
1-2: Negligible Risk	Neg
0: No Risk	Non

Table 11: Risk Score Rating

Risk Matrix

8.3. Combining the Frequency Index (Table 7) and Severity Index (Table 10) gives you an effective Risk Matrix, illustrated at Table 12.

Risk Matrix					
Frequency		Severity			
		1	2	3	4
		Minor	Significant	Severe	Catastrophic
6	Likely	6	12	18	24
5	Probable	5	10	15	20
4	Occasional	4	8	12	16
3	Remote	3	6	9	12
2	Unlikely	2	4	6	8
1	Very Unlikely	1	2	3	4

Table 12: Risk Matrix

Risk Evaluation: Embedded

8.4. After deciding which controls are applicable to each hazard scenario, an embedded risk score was calculated by determining the reduction in likelihood and impact for each risk control should it be implemented. These reductions were then applied to the frequency and impact of the scenario to give the overall risk score.

Ranked Hazard Scenarios for Saxa Operations

8.5. Table 13 shows the hazard scenarios ranked by current risk after embedded risk controls have been considered. The risk scores associated with each of the ten hazard scenarios have been set on a scale of No Risk to Very High Risk. The classification of each score is given in Table 11.

No.	Hazard Category	Hazard Scenario	Baseline Risk	Current Risk
6	Contact	Spectator and fishing vessels: sightseeing, day boats and other fishing and recreational craft are not detected in the Launch Exclusion Zone during a launch and are struck by rocket debris.	Sig	Sig
1	Contact	A rocket fails/is terminated soon after launch and debris lands on a vessel at sea.	Mod	Mod
9	Contact / Machinery-related Accidents	A rocket fails/is terminated soon after launch and debris and material, including parachutes, wires and cables, on or just under the sea surface foul a propeller and disable a vessel's propulsion system or a fishing vessel's nets.	Mod	Mod
3	Contact	A vessel strikes rocket debris floating on or just under the sea surface if a rocket fails/is terminated outside the Launch Area but prior to reaching orbit.	Mod	Mod
2	Contact	A vessel is struck by a fairing that has been intentionally detached from the rocket as part of the stages of separation during a routine launch and has fallen to the sea surface.	Low	Low

No.	Hazard Category	Hazard Scenario	Baseline Risk	Current Risk
4	Contact	A fixed offshore structure (oil/gas platform or offshore wind turbine) is struck by a fairing that has been intentionally detached from the rocket as part of the stages of separation during a routine launch.	Low	Low
5	Contact	A rocket fails/is terminated prior to reaching orbit and the debris falls on a fixed structure (oil/gas platform or offshore wind turbine).	Low	Low
7	Foundering/ Hazardous Substance Accidents	A rocket fails/is terminated soon after launch and debris lands in a Marine or Special Protected Area (MPA/SPA) and sinks below the surface.	Low	Low
8	Fire	A rocket explodes soon after launch and combustible materials/chemicals that are on fire land on the sea surface, causing a hazard to shipping.	Low	Low
10	Contact	A rocket fails/is terminated outside the Launch Area but prior to reaching orbit and the debris and lands on vessel at sea.	Low	Low

Table 13: Ranked Hazard Scenarios for the Operational Phase

Additional (Future) Risk Controls

8.6. Additional controls have been identified to ensure that risk levels are reduced to a level which is considered to be ALARP. These additional controls are safety recommendations which were then assigned a likelihood and impact reduction to allow the calculation of a Future risk score.

8.7. The identified measures, if fully adopted, should be incorporated into Saxa's operational plans for routine operations. Table 14 details the additional controls which were identified as recommendations for potential mitigation for routine operations along with the frequency in which they were applied to the hazard scenarios.

No	Control	Frequency
F-1	Promulgation of information through robust and effective communications plan to Shetland Islands, maritime communities and Saxa stakeholder groups.	5
F-2	Introduce space launch hazard areas/zones (Launch Exclusion Zone, Warning Zone).	5
F-3	Notices to Mariners, Local Notice to Mariners and Navigational Warnings promulgating details of space vehicle launch operations, including Impact Dispersion Areas.	5
F-4	Installation of multi-sensor maritime surveillance system.	4
F-5	Annotation of admiralty charts with space port operations warning information.	3
F-6	VHF Sécurité and GMDSS messages promulgating details of space vehicle launch operations.	4
F-7	Boundary Boat in Launch Exclusion Zone prior to, and immediately adjacent to during, launch operations.	4
F-8	Saxa Operational Range arcs to be modified to avoid fixed maritime infrastructure.	3
F-9	Visual confirmation (clear line of sight).	1
F-10	Boundary Boat equipped with rocket propellent firefighting equipment.	1

Table 14: Additional Controls for the Operation

Hazard Scenarios Discussion

8.8. The listed Hazard Scenarios are given further consideration below. To reduce the Hazard to the point of ALARP, both embedded and additional 'future' risk controls will be a prerequisite. However, following this are several further mitigation measures that would be needed to reach ALARP.

8.9. **Hazard 1 (Contact): A rocket fails/is terminated soon after launch and debris lands on vessel at sea.**

8.9.1. It is determined that one of the higher risks to Saxa space rocket operations is at or immediately after launch, where a rocket is most vulnerable to failing or exploding. This could happen after the rocket exits the Launch Exclusion Zone but is in its first few seconds of flight as it commences its northerly trajectory. Should a rocket fail or be terminated soon after launch it may hit a vessel as it lands on the sea surface where there is a higher proportion of maritime traffic relative to the wider range, therefore a risk to life exists and the unmitigated risk is deemed **MODERATE**.

8.9.2. To reduce the risk identified, the following further mitigation measures would need to be implemented by Saxa:

8.9.2.1. Temporary NTMs and NAVWARNS issued ahead (up to 3 months[89]) of launch operations.

8.9.2.2. Full multi-sensor surveillance of LEZ, and wider surveillance of Warning Zones through AIS. Boundary Boat to be fully utilised in support.

8.9.2.3. VHF Sécurité and GMDSS broadcasts prior to and during launch operations.

[89] Maritime & Coastguard Agency, Space Launch Activities: Risk Mitigation for Shipping, Navigation and Emergency Responses, Para 1.2.4.1.

This must include an open and tested communications channel with the U.S. and Canadian JRCCs.

8.9.2.4. Early and sustained promulgation of information through robust and effective communications plan to Shetland Islands, regional maritime communities and stakeholder groups and relevant authorities, utilising both local and regional press, social media and local community organisations to promulgate the information.

8.9.2.5. Notification of launch operations to be promulgated on notice boards at Shetland ports, slipways and harbours.

8.9.2.6. Admiralty charts annotated with space rocket launch operations warning hazard.

8.9.3. Following the implementation of mitigation measures to ensure that if a rocket fails or is terminated early due to a malfunction the maritime community around Shetland has been sufficiently warned of Saxa launch operations, and the risk area is known by mariners and effectively monitored to ensure there are no concentrations of vessels under the planned trajectory, the risk is reduced to **LOW**.

8.10. **Hazard 2 (Contact): A vessel is struck by a fairing that has been intentionally detached from the rocket as part of the stages of separation during a routine launch and as fallen to the sea surface.**

8.10.1. This event would most likely occur further out from the coast once the rocket has exited the Early Phase Flight Area. When a fairing is released upon separation during a routine launch, there is a small chance that it strikes a vessel as it lands on the sea surface. However, as the analysis in this NRA has shown, the splash down points will not be in an area of busy maritime activity as it is further from the coast where traffic is very quiet. Therefore, the unmitigated risk is deemed as **LOW.** Nonetheless, the following mitigation measures should be implemented:

8.10.1.1. Temporary NTMs and NAVWARNS issued ahead (up to 3 months) of launch operations. This must include details of the LEZ and Warning Zones' coordinates so that vessels can avoid the area accordingly.

8.10.1.2. VHF Sécurité and GMDSS broadcasts prior to and during launch operations. This must include an open and tested communications channel with the U.S. and Canadian JRCCs.

8.10.1.3. Early and sustained promulgation of information through robust and effective communications plan to Shetland Islands, regional maritime communities and stakeholder groups and relevant authorities, utilising both local and regional press, social media and local community organisations to promulgate the information.

8.10.1.4. Notification of launch operations to be promulgated on notice boards at Shetland ports, slipways and harbours.

8.10.1.5. Admiralty charts annotated with space rocket launch operations warning hazard.

8.10.2. Following the implementation of mitigation measures, Saxa can ensure that when a fairing is released there is no vessel in the Warning Zones as the maritime community will be sufficiently warned of Saxa launch operations. Therefore, the risk is reduced to **NEGLIGIBLE.**

8.11. **Hazard 3 (Contact): A vessel strikes rocket debris floating on or just under the sea surface if a rocket fails/is terminated outside the Early Phase Flight Dispersion Area but prior to reaching orbit.**

8.11.1. This hazard scenario is in the event of a rocket failing/being terminated 'down range' in the Nordic/Beaufort Sea. If rocket debris is floating on or just under the sea surface, or is not easily visible, a vessel may strike the debris and inflict significant damage to its hull. This could affect hull integrity and endanger the crew. Furthermore, if the vessel is transiting

through the area at night-time the likelihood of observing the debris would be significantly reduced, thus increasing the risk of impact. However, the material used to construct the rocket is not designed to float, therefore the chance of the debris remaining on or just below the water is slight. However, despite the sea being very sparsely populated with maritime traffic, there is potential harm to life, so the unmitigated risk is deemed **MOD**.

8.11.2. To reduce the risk identified, the following further mitigation measures would need to be implemented by Saxa:

8.11.2.1. Saxa Emergency Response Plan immediately initiated. This will include a communications plan to warn mariners of the danger and advise all relevant authorities and stakeholders.

8.11.2.2. Navigational Warnings issued, advising of the risk to mariners and to avoid the area.

8.11.2.3. VHF and GMDSS broadcasts (relayed via all relevant JRCC/MRCCs if needed) warning of the danger and position of impact.

8.11.2.4. Effective plotting of likely drift of debris.

8.11.3. Following these mitigation measures, any event that leads to floating rocket debris becoming a hazard should have been prevented by the damage-control measures. Thus, the risk is reduced to **LOW.**

8.12. **Hazard 4 (Contact): A fixed offshore structure (oil/gas platform or wind turbine) is struck by a fairing that has been intentionally detached from the rocket part of stages of separation during a routine launch.**

8.12.1. The payload fairing is the equipment intentionally detached from the rocket as part of stage separation during any routine launch. As it is a frequent process, there is a risk of fairing striking a fixed offshore structure such as an oil, gas or fixed turbine platform.

8.12.2. There is significant offshore energy presence in the AOI to the west, east and north east of Shetland in the UK and Norwegian EEZs, however as previously highlighted in the NRA only one platform is present within the Saxa Range[90]. Thus, the risk is deemed **LOW.** However, the risk can be lowered with the following mitigation measures:

8.12.2.1. Saxa should avoid overflight of this platform as part of launch planning. This can be achieved by ensuring a launch trajectory is no further east than 022° thus achieving a lateral separation safety distance from the platform of 20nm.

8.12.3. Fairing releases are planned and pre-determined, thus the launch operator has the control of steering a trajectory away from a platform so to decrease the likelihood of contact. This measure reduces the risk to **NEGLIGIBLE.**

8.13. **Hazard 5 (Contact): A rocket fails/is terminated prior to reaching orbit and the debris falls on a fixed structure (oil/gas platform or wind turbine).**

8.13.1. There is significant offshore energy presence in the AOI to the west, east and north east of Shetland in the UK and Norwegian EEZs, however as previously highlighted in the NRA only one platform is present within the Saxa Range[91]. Therefore, a potential danger to life exists and therefore the unmitigated risk is categorised as **LOW**.

8.13.2. To reduce the risk identified, even further the following further mitigation measure would need to be implemented by Saxa:

8.13.2.1. Saxa should avoid overflight of this platform as part of launch planning. This can be achieved by ensuring a launch trajectory is no further east than 022° thus achieving a lateral separation safety distance from the platform of 20nm, which is

[90] Aasta Hansteen oil platform – see Section 3 para 3.25.
[91] Aasta Hansteen oil platform – see Section 3 para 3.25.

sufficient in the case of a rocket fail (and associated explosion) or an intended intervention to terminate the rocket[92].

8.13.3. Following the implementation of this mitigation measure the risk is reduced to **NEGLIGIBLE**.

8.14. **Hazard 6 (Contact): Spectator and fishing vessels: sightseeing, day boats and other fishing and recreational craft are not detected in the Launch Exclusion Zone during a launch and are struck by rocket debris.**

8.14.1. As part of routine launch activity there is a risk of debris being dispersed at high velocity in the vicinity of the Saxa launch pads. Analysis has shown that the most likely point at which a rocket will fail is on initial launch[93]. Therefore, to account for this risk a Launch Exclusion Zone centred on the Saxa launch site will be in place prior to and during launch operations to ensure no persons or vessels are endangered by the launch debris or an explosion from a defective rocket. The LEZ will be monitored and patrolled thoroughly and robustly to ensure no person or vessel are within the zone during a launch.

8.14.2. Launch activity will undoubtedly attract much interest from spectators. To maximise the experience the general public is likely to want to be as close as possible to the launch site. There are a number of bays, coves and headlands in the LEZ that could contain small vessels such as kayaks, paddleboards and canoes not easily visible from the sea. The most likely launch spot for small recreational craft will be Norwick - the bay closest to Saxa. Additionally, because the bay is a sheltered and designated anchorage within sight of the Saxa launch site, it is the most probable loiter area for waterborne spectators.

8.14.3. Similarly, the crew of local inshore day fishing vessels may not have up to date Temporary NTMs or NAVWARN information, or maintain a listening watch on VHF[94], so may inadvertently stray into the LEZ during launch operations.

8.14.4. Potential significant danger to live exists therefore this unmitigated risk is assessed as **SIGNIFICANT**.

8.14.5. To reduce what is deemed to be the highest maritime risk associated with Saxa operations, the following further mitigation measures would need to be implemented by Saxa:

8.14.5.1. Temporary NTMs and NAVWARNS issued ahead (up to 3 months) of launch operations. This must include details of the LEZ and Warning Zones.

8.14.5.2. Full multi-sensor surveillance of LEZ and wider Warning Zones utilising AIS.

8.14.5.3. VHF Sécurité and GMDSS broadcasts prior to and during launch operations. Particular focus should be on small day fishing boats close to the Unst north and north east coasts which may not consistently hear the broadcasts.

8.14.5.4. Boundary Boat to conduct regular, thorough sweeps of the LEZ close to the coast prior to launch operations to visually inspect the shoreline for the presence of personnel and/or vessels. Saxa staff will also work in cooperation with the Boundary Boat and inspect the coastline from land.

8.14.5.5. Early and sustained promulgation of information through robust and effective communications plan to Shetland Islands, regional maritime communities and stakeholder groups and relevant authorities, utilising both local and regional press, social media and local community organisations to promulgate the information.

8.14.5.6. Notification of launch operations to be promulgated on notice boards at Shetland ports, slipways and harbours, particularly Nor Wick Bay.

8.14.5.7. Admiralty charts annotated with space rocket launch operations warning hazard.

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[92] If, for example, the rocket veers off its intended trajectory where the margins for termination are extremely small.
[93] https://ntrs.nasa.gov/api/citations/20190002705/downloads/20190002705.pdf
[94] A large number of inshore day fishing vessels are single crew, who will often be out of the wheelhouse on deck. In this noisy environment the crew may not hear VHF broadcasts.

8.14.6. Following the implementation of mitigation measures to ensure that an appropriate and effective means of monitoring and managing the LEZ, particularly both the 'shadow' areas of the coast, and the wider sea area around Saxa for approaching vessels, the risk is reduced to **LOW**.

8.15. **Hazard 7 (Hazardous Substance Accidents): A rocket fails/is terminated soon after launch and debris lands in a Marine and/or Special Protected Area (MPA/SPA).**

8.15.1. The Saxa Nordic Sea AOI contains several large Marine Protected Areas (MPA). Both MPAs located in UK waters are governed by the Joint Nature Conservation Committee (JNCC) and are classed as Scottish Marine Protected Areas. The rest are under the jurisdiction of Norway and Iceland. Table 15 lists all MPAs exceeding an area size of 100km², and it can be seen from Table 16 that only 2 MPAs are inside the Saxa Range.

MPA No.	Name	Area size	Jurisdiction
1	North-east Faroe-Shetland Channel MPA	23,682 km²	JNCC / United Kingdom
2	Faroe-Shetland Sponge Belt MPA	5,279 km²	JNCC / United Kingdom
3	Jan Mayen MPA	4,302 km²	Norway
4	Bjørnøya	2,799 km²	Norway
5	Breiðafjörður	2,738 km²	Iceland
6	Sulaveret	993 km²	Norway
7	Iverryggen	624 km²	Norway
8	Trænaravet	445 km²	Norway
9	Rostrevet	331 km²	Norway
10	Rósagarður	164 km²	Iceland
11	Nordkvaløya – Rebbenesøya	145 km²	Norway
12	Svellingsflaket	116 km²	Norway

Table 15: MPAs

Figure 46: MPAs within Saxa Range

8.15.2. Debris sinking below the surface can lead to damaging marine pollution. However, floating debris as attachment for pelagic organisms and the ingestion of debris is generally considered unlikely in best practice for ecological risk assessment for rocket launches.[95] Furthermore, MPAs are not necessarily areas with denser ecosystems than their surroundings. Instead, they are defined areas where human activities are managed to protect important natural or cultural resources. It would be likely that the governing bodies, such as the JJNCC and Norwegian Environment Agency, could provide advice/support in the event of material/debris landing in an MPA in the Saxa Range.

8.15.3. Therefore, whilst there is the potential risk of debris/material landing in an MPA located within the Saxa Range, the risk to ecological life is **LOW.** This is the same if the material sinks. MPAs are not areas where sunken debris and material will pose a dire threat to marine life unless there are toxic substances released from the event. Overall risk in this scenario remains **LOW**.

8.16. **Hazard 8 (Fire): A rocket explodes soon after launch and combustible materials/ chemicals that are on fire land on the sea surface.**

8.16.1. In the event of a rocket exploding soon or immediately after launch, and the burning flammable material is not extinguished upon landing on the sea surface, it could become a danger to personnel and vessels in the vicinity of its splash down point. Unused fuel could potentially feed the fire for a sustained period. However, rocket debris is not designed to float and has a negative buoyancy, therefore is most likely to sink on impact with the sea surface and any residual fire/flames would be extinguished on impact or when the debris starts to sink. Thus, the unmitigated risk is deemed **LOW.** Nonetheless, the following mitigation measures can be used to further reduce the risk:

8.16.1.1. Saxa Emergency Response Plan immediately initiated. This will include a communications plan to warn mariners of the danger and advise all relevant authorities and stakeholders.

8.16.1.2. Navigational Warnings issued, advising of the risk to mariners and to avoid the area.

8.16.1.3. Marine salvage operation initiated immediately to be ready to remove rocket debris. Boundary Boat should have suitable firefighting equipment to extinguish rocket propellent.

8.16.1.4. VHF Sécurité and GMDSS broadcasts prior to and during launch operations.

8.16.1.5. Boundary Boat to immediately transit to the splash down point (standing-off at a safe distance so as not to endanger itself), to warn-off any vessels in the vicinity of the incident.

8.16.2. Following these mitigation measures, any event that leads to floating rocket debris becoming a hazard. Thus, the risk is reduced to **NEGLIGIBLE.**

8.17. **Hazard 9 (Contact, Machinery-Related Accidents): Debris and material such as parachutes, wires and cables on or just under the sea surface foul a propeller and disable a vessel's propulsion system or fishing vessel's nets.**

8.17.1. The potential debris and materials from rocket launch or mid-launch failures, including sounding rockets, could contain parachutes, wires and cables. These materials laying on or just under the sea surface may foul a propeller and disable the vessel's propulsion system or entangle a fishing vessel's nets. Furthermore, if the vessel is transiting through the area at night-time the likelihood of observing and floating debris would be significantly reduced, thus increasing the risk of impact. Therefore, this type of unmitigated risk is deemed **MODERATE.**

8.17.2. To reduce the risk identified, the following further mitigation measures would need to be implemented by Saxa:

[95] NIWA (2016), "Marine Ecological Risk Assessment of the Cumulative Impact of Electron Rocket Launches".

8.17.2.1. Saxa Emergency Response Plan immediately initiated. This will include a communications plan to warn mariners of the danger and advise all relevant authorities and stakeholders.

8.17.2.2. Navigational Warnings issued, advising mariners of the risk to mariners and for them to avoid the area. This must include an open and tested communications channel with the U.S. and Canadian JRCCs.

8.17.2.3. VHF and GMDSS broadcasts (relayed via JRCC/MRCC if needed) warning of the danger and position of impact.

8.17.2.4. Marine salvage operation initiated immediately to locate and remove rocket debris. If within a reasonable distance from Saxa the Boundary Boat should transit to the splash down point to warn-off any vessels in the vicinity of the incident, and, if possible, recover debris, parachutes and cables (suitable crew training must already be in place for this scenario).

8.17.2.5. Effective plotting of likely drift of debris.

8.17.3. Following the implementation of mitigation measures to ensure that if a rocket fails or is terminated early due to a malfunction the maritime community has been sufficiently warned and recovery operations initiated, the risk is reduced to **LOW**.

8.18. **Hazard 10 (Contact): A rocket fails/is terminated outside the Early Phase Flight Area but prior to reaching orbit and the debris and lands on vessel at sea.**

8.18.1. Unlike Hazard 1, this scenario is in the event of a rocket failing/being terminated 'down range' in the Nordic/Beaufort Sea outside the Early Phase Flight Area. Should a rocket fail or be terminated prior to reaching orbit it may hit a vessel as it lands on the sea surface, which could potentially be catastrophic to personnel and the vessel. However, the wider Saxa Range in the Nordic and Beaufort Seas are areas of very low maritime traffic, so the risk is minimal and assessed as **LOW**.

8.18.2. To reduce the risk identified, the following further mitigation measures would need to be implemented by Saxa:

8.18.2.1. Temporary NTMs and NAVWARNs issued ahead (up to 3 months) of launch operations. This must include details of the Warning Zone in the wider Saxa Range.

8.18.2.2. VHF Sécurité (relayed via all relevant JRCC/MRCC) and GMDSS broadcasts prior to and during launch operations so that the maritime traffic is aware of the rocket trajectory and may avoid the immediate area for the duration of the launch.

8.18.2.3. Early and sustained promulgation of information through robust and effective communications plan to regional and international maritime communities and stakeholder groups, and relevant authorities, utilising press, social media and local community organisations to disseminate the information.

8.18.2.4. Admiralty charts annotated with space rocket launch operations warning hazard notifications.

8.18.3. Following the implementation of mitigation measures to ensure that if a rocket fails or is terminated early due to a malfunction, the maritime community in the Saxa Range deeper into the Nordic Sea has been sufficiently warned of Saxa launch operations, and the risk area is known by mariners and effectively monitored to ensure there are no concentrations of vessels under the planned trajectory, the risk is reduced to **NEGLIGIBLE**.

Risk Evaluation: Future

8.19. Following the application of the additional (future) risk controls, the outcome of each hazard scenario in respect of the assessed future risk has been determined. The future risk outcome takes into account the likelihood reduction and impact reduction from each proposed risk control. Table 16 presents the future risk level for the hazard scenarios after the additional controls have been applied.

No	Hazard Category	Hazard Scenario	Baseline Risk	Current Risk	Future Risk
6	Contact	Spectator and fishing vessels: sightseeing, day boats and other fishing and recreational craft are not detected in the Exclusion Zone during a launch and are struck by rocket debris.	Sig	Sig	Low
1	Contact	A rocket fails/is terminated soon after launch and debris lands on a vessel at sea.	Mod	Mod	Low
9	Contact/ Machinery-Related Accidents	A rocket fails/is terminated soon after launch and debris and material, including parachutes, wires and cables, on or just under the sea surface foul a propeller and disable a vessel's propulsion system or a fishing vessel's nets.	Mod	Mod	Low
3	Contact	A vessel strikes rocket debris floating on or just under the sea surface if a rocket fails/is terminated outside the Launch Area but prior to reaching orbit.	Mod	Mod	Low
8	Fire	A rocket explodes soon after launch and combustible materials/chemicals that are on fire land on the sea surface, causing a hazard to shipping.	Low	Low	Neg
7	Hazardous Substance Accidents	A rocket fails/is terminated soon after launch and debris lands in a Marine or Special Protected Area (MPA/SPA) and sinks below the surface.	Low	Low	Low
2	Contact	A vessel is struck by a fairing that has been intentionally detached from the rocket as part of the stages of separation during a routine launch and as fallen to the sea surface.	Low	Low	Neg
4	Contact	A fixed offshore structure (oil/gas platform or offshore wind turbine) is struck by a fairing that has been intentionally detached from the rocket as part of the stages of separation during a routine launch.	Low	Low	Neg
5	Contact	A rocket fails/is terminated prior to reaching orbit and the debris falls on a fixed structure (oil/gas platform or offshore wind turbine).	Low	Low	Neg
10	Contact	A rocket fails/is terminated outside the Launch Area but prior to reaching orbit and the debris and lands on vessel at sea.	Low	Low	Neg

Table 16: Future Risk for the Operational Phase

Mitigation Measures Summary

8.20. From the NRA process, 10 additional mitigation measures were identified for Saxa proposed routine operations:

Mitigation Measures Summary		
No	Mitigation Measures	Description
1	Notices to Mariners (NTMs)	Full use should be made of the Temporary and Local NTM processes to provide the maritime community with prior warning of launch operations. This should include details of the Warning and Launch Exclusion Zones and launch windows.
2	Admiralty Charts Annotations	Admiralty charts should be annotated with a hazard warning notification to advise mariners that space rocket launch operations take place in the area of the Saxa Range. This will alert the maritime community to the existence of such operations.
3	Multi-Sensor Surveillance	Full multi-sensor surveillance of the LEZ is required to provide suitable command and control of this area prior to and during launch operations. The Warning Zones must also be observed using AIS to monitor maritime traffic during operations. Saxa staff must use all means available to visually confirm that the coastline within the LEZ is clear or personnel and vessels.
4	Use of VHF/GMDSS	VHF Sécurité and GMDSS broadcasts should be provided by Saxa, and if required via JRCCs/MRCCs prior to and during launch operations as part of the wider communication plan. Broadcasts and DSC messages should contain details of the Warning and Launch Exclusions Zones, launch timings/windows and rocket trajectory/flight path.
5	Boundary Boat	A Boundary Boat will support command and control of the LEZ by patrolling the area prior to and during launch operations to warn, advise and remove personnel and vessels from the zone. It will also be utilised to provide additional/alternative communications broadcasts if needed, to respond to emergencies and act as a visual reference to the extremity of the LEZ should vessels not be aware of the coordinates nor have a means of plotting the zone.
6	Communications	The Saxa communication plan must include early and sustained promulgation of launch operations information through robust and effective communications to the Shetland Islands population, regional maritime communities and key stakeholder groups, and relevant authorities, utilising local, regional and national press, social media and local community organisations to promulgate the information. Notification of launch operations should also be promulgated on notice boards at Shetland ports, slipways and harbours, particularly Norwick Bay, Baltisound, Belmont, Haroldswick and Cullivoe.
7	Communicating Emergencies	WZ navigational warning issued, advising of the risk to mariners and to avoid the area[96].
8	Emergency Response Plan	The plan should include an effective communications plan to warn mariners of any dangers associated with Saxa emergencies (such as a rocket failing/being terminated after launch) and advise all relevant authorities and stakeholders. Emergency response team should be capable of plotting maritime coordinates and assessing drift rates of any debris that is the result of a rocket impacting on the sea surface.

[96] Saxa's Letter of Agreement with the UKHO and MCA requires the Saxa to inform these organisations of a sub-nominal launch so that appropriate emergency/safety messages can be broadcast and promulgated.

Mitigation Measures Summary		
9	Saxa Range Coordinates	To avoid overflight of the one offshore energy platform that is inside the Saxa Range of 330° to 030°/900nm an amended right-hand arc of 022° should be considered[97]. This will achieve a lateral separation safety distance from the platform of 20nm, which is sufficient in the case of a rocket fail (and associated explosion) or an intended intervention to terminate the rocket.
10	Recovery Vessel	Any vessel contracted as a Boundary Boat may also have to recover sub-orbital rockets or rocket debris and should have suitable firefighting equipment to extinguish rocket propellant.

Table 17: Risk Mitigation Measures

8.21. **Notices to Mariners (NTMs)**. Full use should be made of the Temporary and Local NTM processes to provide the maritime community with prior warning of launch operations. This should include details of the Warning and Launch Exclusion Zones, launch windows, trajectory heading/coordinate and position of Sounding Rocket/fairing Impact Dispersion Areas and safety radii.

8.22. **Admiralty Charts Annotations**. Admiralty charts should be annotated with a hazard warning notification to advise mariners that space rocket launch operations take place in the area of the Saxa Range. This will alert the maritime community to the existence of such operations.

8.23. **Multi-Sensor Surveillance**. Full multi-sensor surveillance of the LEZ is required to provide suitable command and control of this area prior to and during launch operations. The wider Range must also be observed using AIS to monitor maritime traffic during operations. Saxa staff must use all means available to visually confirm that the coastline within the LEZ is clear or personnel and vessels.

8.24. **Use of VHF/GMDSS**. VHF Sécurité and GMDSS broadcasts should be provided by Saxa, and if required via JRCCs/MRCCs prior to and during launch operations as part of the wider communication plan. Broadcasts and DSC messages should contain details of the Warning and Launch Exclusions Zones, launch timings/windows, rocket trajectory/flight path, coordinates of Impact Dispersion Areas and safety radii.

8.25. **Boundary Boat**. A Boundary Boat will support command and control of the LEZ by patrolling the area prior to and during launch operations to warn, advise and remove personnel and vessels from the zone. It will also be utilised to provide additional/alternative communications broadcasts if needed, to respond to emergencies and act as a visual reference to the extremity of the LEZ should vessels not be aware of the coordinates nor have a means of plotting the zone.

8.26. **Communications**. The Saxa communication plan must include early and sustained promulgation of launch operations information through robust and effective communications to the Shetland Islands population, regional maritime communities and key stakeholder groups, and relevant authorities, utilising local, regional and national press, social media and local community organisations to promulgate the information. Notification of launch operations should also be promulgated on notice boards at Shetland ports, slipways and harbours, particularly Norwick Bay, Baltisound, Belmont, Haroldswick and Cullivoe.

8.27. **Communicating Emergencies**. WZ navigational warning issued, advising of the risk to mariners and to avoid the area[98].

8.28. **Emergency Response Plan**. The plan should include an effective communications plan to warn mariners of any dangers associated with Saxa emergencies (such as a rocket failing/being terminated after launch) and advise all relevant authorities and stakeholders.

[97] For Sounding Rocket launches a right-hand arc of 030° may still be acceptable as their range is significantly less than orbital rockets and will not reach or endanger to the Aasta Hansteen oil platform.

[98] Saxa's Letter of Agreement with the UKHO and MCA requires Saxa to inform these organisations of a sub-nominal launch so that appropriate emergency/safety messages can be broadcast and promulgated.

Emergency response team should be capable of plotting maritime coordinates and assessing drift rates of any debris that is the result of a rocket impacting on the sea surface.

8.29. **Saxa Range Coordinates**. To avoid overflight of the one offshore energy platform that is inside the Saxa Range of 330° to 030°/900nm an amended right-hand arc of 022° should be considered. This will achieve a lateral separation safety distance from the platform of 20nm, which is sufficient in the case of a rocket fail (and associated explosion) or an intended intervention to terminate the rocket.

8.30. **Recovery Vessel**. Any vessel contracted as a Boundary Boat may also have to recover sub-orbital rockets or rocket debris and should have suitable firefighting equipment to extinguish rocket propellant.

9. SUMMARY

9.1. This document has followed MCA direction and guidance and adhered to 'best practice' for producing a Navigational Risk Assessment. The NRA has described in detail the maritime environment in which SaxaVord UK Spaceport will conduct space rocket launch operations, and these operations have been explained. A detailed examination has been undertaken of vessel volumes, types, concentrations, patterns, incidents and accidents within the Area of Interest, followed by a logical analysis of additional risks that may result from introducing space rocket launch operations into this maritime environment. Finally, these risks have been mitigated by a list of additional measures and mechanisms that could be introduced at Saxa.

9.2. From the NRA process, 10 additional mitigation measures were identified for Saxa's proposed launch and recovery operations. The risk assessment for 'Spectator and fishing vessels: sightseeing, day boats and other fishing and recreational craft are not detected in the Launch Exclusion Zone during a launch and are struck by rocket debris produced the highest risk (SIGNIFICANT) when compared to other scenarios. The risk identified for this assessment results from the consequences and likelihood resulting in a conclusion of significant risk. With additional mitigations in place the risk score is reduced to **LOW**.

9.3. Following implementation of appropriate mitigation by Saxa within the context of the proposed operations, the risk to the maritime community – personnel, property, ports and the environment within the Saxa Range can be maintained within a level that is:

'As Low As Reasonably Practicable'

Enclosure One: RFA Notices to Mariners Request

<table>
<tr><th>Information Requirement</th><th>Information</th><th>Notes</th></tr>
<tr><td>The position of launch site in WGS84 Datum.</td><td>60° 49.127'N 0° 46.504'W</td><td></td></tr>
<tr><td>Launch date(s)/window and timings.</td><td>From 01/08/2024 to 30/09/2024.
3am to 5pm UTC</td><td>The launch window will be tailored more precisely before each launch attempt.</td></tr>
<tr><td>The limits for the Restricted Zone, Exclusion Zone, Space Launch Hazard Area and expected Splashdown Area, that exist within the designated range.</td><td>
<table>
<tr><td>NM1</td><td>Coordinate (Lat-long)</td></tr>
<tr><td>A</td><td>60º53.6793’ N 0 º 55.85796’ W</td></tr>
<tr><td>B</td><td>60 º 54.45672’ N 0 º 36.71832’ W</td></tr>
<tr><td>C</td><td>60 º 48.2121’ N 0 º 44.72574’ W</td></tr>
<tr><td>D</td><td>60 º 47.88192’ N 0 º 47.4477’ W</td></tr>
</table>
<table>
<tr><td>NM2</td><td>Coordinate (Lat-long)</td></tr>
<tr><td>A</td><td>69 º 10.93542’ N 9 º 27.02424’ W</td></tr>
<tr><td>B</td><td>69 º 40.70076’ N 6 º 12.94098’ W</td></tr>
<tr><td>C</td><td>65 º 28.56552’ N 2 º 17.58246’ W</td></tr>
<tr><td>D</td><td>65 º 4.14684’ N 5 º 9.49962’ W</td></tr>
</table>
<table>
<tr><td>NM3</td><td>Coordinate (Lat-long)</td></tr>
<tr><td>A</td><td>71 º 57.5103’ N 140 º 20.2155’ W</td></tr>
<tr><td>B</td><td>73 41.11218’ N 152 º 45.57126’ W</td></tr>
<tr><td>C</td><td>84 º 31.49376’ N 99 º 59.33346’ W</td></tr>
<tr><td>D</td><td>80 º 30.23514’ N 91 º 15.42588’ W</td></tr>
</table>
<table>
<tr><td>NM4</td><td>Coordinate (Lat-long)</td></tr>
<tr><td>A</td><td>69 º 26.08596’ N 15 º 43.6158’ W</td></tr>
<tr><td>B</td><td>71 º 34.60308’ N 2 º 45.91368’ W</td></tr>
<tr><td>C</td><td>62 º 48.31866’ N 0º 3.87378’ E</td></tr>
<tr><td>D</td><td>61 º 4.1859’ N 0º 14.07606’ W</td></tr>
<tr><td>E</td><td>60 º 48.00828’ N 0 º 45.2829’ W</td></tr>
<tr><td>F</td><td>60 º 47.95752’ N 0 º 47.12796’ W</td></tr>
<tr><td>G</td><td>60 º 52.63404’ N 1 º 31.07304’ W</td></tr>
<tr><td>H</td><td>62 º 12.12684’ N 3 º 53.06874’ W</td></tr>
</table>
</td><td>NM1 is the exclusion zone in the vicinity of the launch site.

NM2 is the warning zone for the hazard area of the jettisoning of the stage 1 and the fairing.

NM3 is the warning zone for the hazard area of the jettisoning of the stage 2.

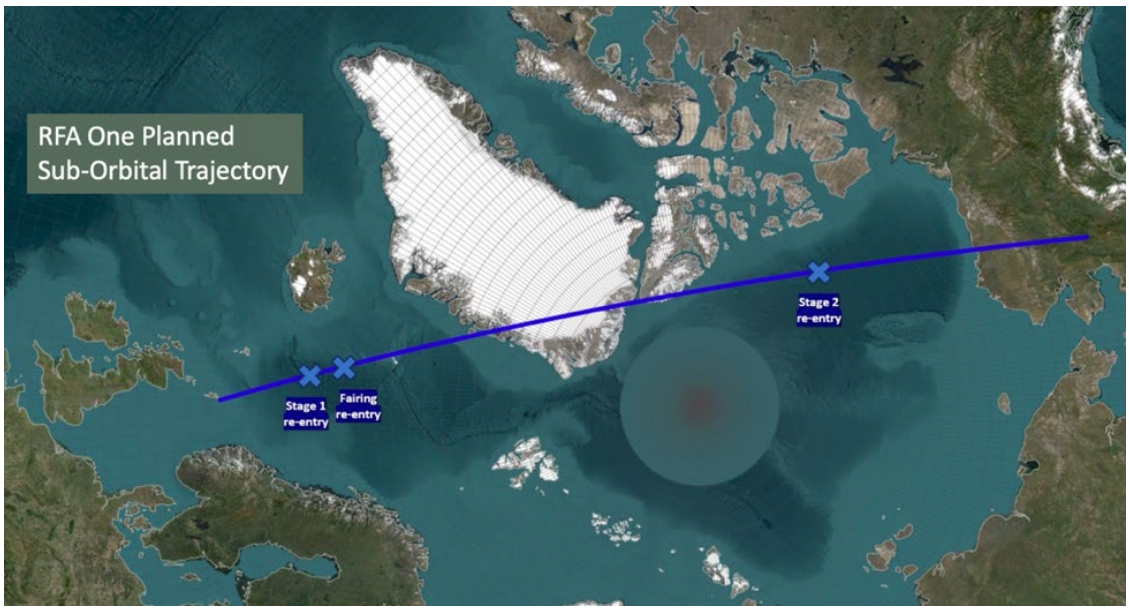
NM4 is the warning zone associated to the risk mitigation to the early phase of flight.</td></tr>
<tr><td>Exact timings of when any restricted areas will be in operation and/or duration of launch process.</td><td>The restricted areas will be in operation up to 6 hours before launch, to allow an evacuation. The restricted areas will be in operation until the confirmation of splash down of the second stage, for each launch attempt.</td><td></td></tr>
<tr><td>The composition of expected equipment entering the marine environment.</td><td>Stainless steel, Aluminium, CFRP, plastics, electronics, copper, Titanium, Cork, Adhesives.</td><td></td></tr>
<tr><td>The expected dimensions of debris and size of debris field.</td><td>Stage 1: cylinder of 20*2.15 m
Stage 2: cylinder of 7*2.15m
Fairing: two shells of 28m² each
Fragmentation of the rocket: 1000 m²</td><td></td></tr>
</table>

Nature of restriction (e.g. *all shipping excluded*) and nature of the danger (e.g. *falling debris* (controlled or uncontrolled).	NM1: exclusion zone due to the inherent hazardous nature of the operation in the vicinity of the launch site. Monitored and enforced, all shipping excluded. NM2: Warning zone due to the inherent hazardous nature of the fall of a rocket stage and fairing from space. Impact at high kinetic energy and risk of propagation of fragments over a wide area. All shipping warned. NM3 Warning zone due to the inherent hazardous nature of the fall of a rocket stage from space. Impact at high kinetic energy and risk of propagation of fragments over a wide area. All shipping warned. N4: Warning zone due to the high risk during the launch of an orbital rocket. Risk of failure during the first phases of flight resulting in a propagation of fragments and blast wave. All shipping warned.	
Contact details for further information including telephone number(s) and radio frequencies. Main point of contact will be the Saxa Range Operations unless otherwise stated.	New phone numbers and radio frequencies TBD Email: rangeops@shetlandspacecentre.com	

Enclosure Two: Saxa NRA Vessel Traffic Analysis 2024

Introduction

1. A comprehensive examination of maritime activity in the Saxa Range areas and Warning Zone over a four-year period (2020-2023) has been undertaken to establish a comparative understanding of patterns, volumes, types and concentrations of vessels routes to support the Navigational Risk Assessment (NRA). The analysis of this data is summarised in Section 5 of the NRA main document. Although the NRA is designed for all Launch Vehicles that may launch from Saxa[1], the analysis extends to include the specific trajectory of the RFA NOM One rocket, scheduled to launch from Saxa in August 2024, as shown at Figure E2-1.



Areas of Analysis

2. The areas for analysis to determine the numbers, concentrations and patterns of vessels cover both the Nordic Sea and Arctic Ocean/Beaufort Sea and include the defined Saxa hazard areas[2]. In both the Nordic Sea and Arctic Ocean the Range areas, in which the warning zones are contained, are analysed as the rocket trajectory passes over this sea space, as illustrated in Figure E2-2. The hazard areas themselves, in which specific risk to life may exist, are also scrutinised for vessel types and numbers and are shown at Figure E2-3.

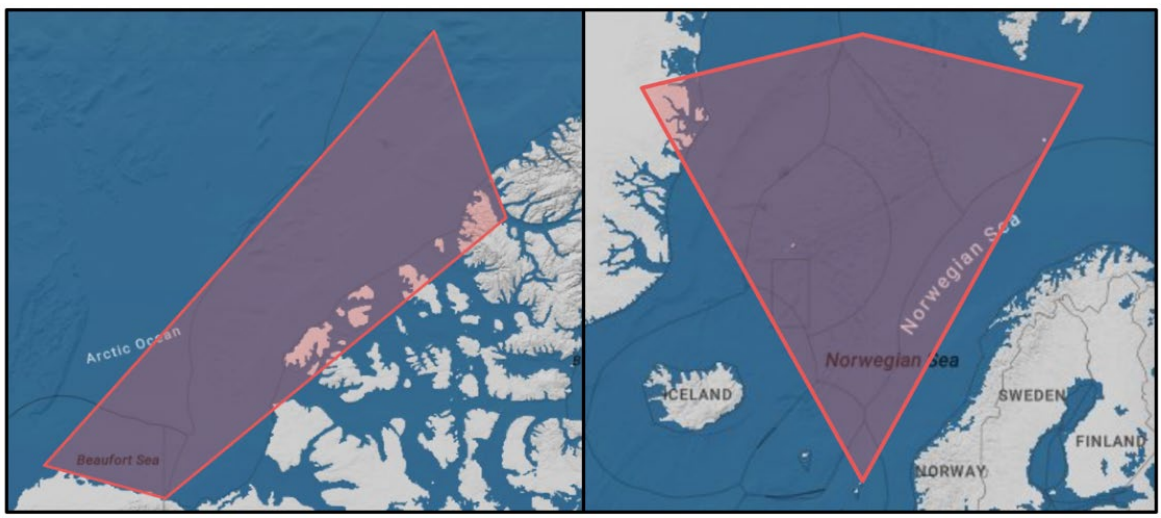


Figure E2-2

[1] As list in NRA main document Table 1, page 48.
[2] The Exclusion Zone and Warning Zones for which Notices to Mariner requests have been submitted.

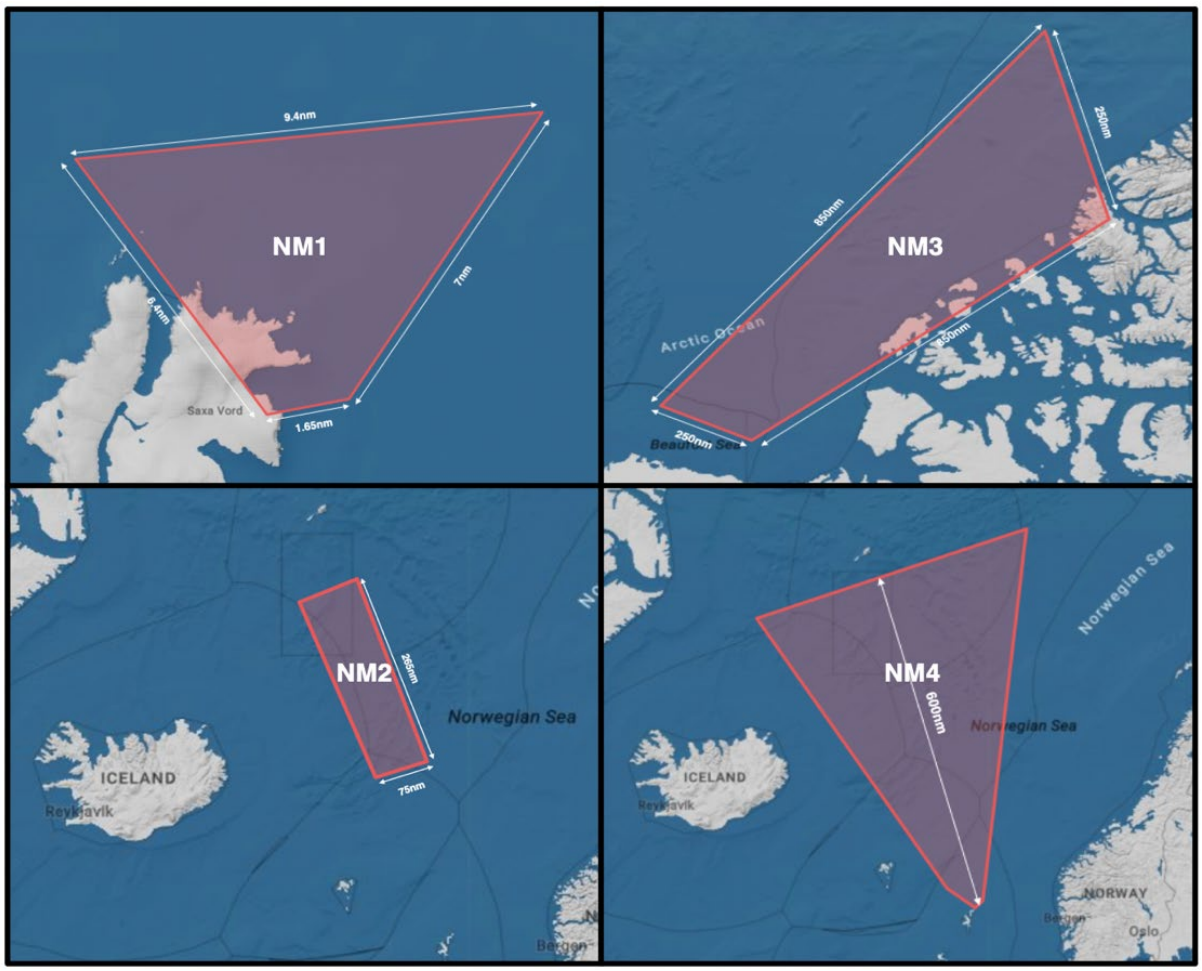


Figure E2-3

3. The following tables both show numbers and types of vessels in each defined area as well as the average over the 4 years. The monthly peak over that 4-year period will be identified from which a daily average will be obtained. The FAA/CAA risk calculations will then be applied to determine how many vessels are present per nm² and therefore the likelihood of a LV Stage or Fairing impacting with a ship.

Saxa Extended Range – Nordic Sea

4. The Saxa extended Range in the Nordic Sea is 505,000nm². Vessel numbers over a 4 year period are shown at Table E2-A. The highest volume of ships in this period was cargo vessels, closely followed by fishing vessels. Cargo vessels will invariably transit through the area quickly, however, fishing vessels will loiter in the same area for extended periods.

5. The overall maritime activity in the Saxa Extended Range is determined to be **extremely low** relative to its size. This is illustrated at Figure E2-4 which displays the total vessel count for 1 August 2023 (August is historically the busiest month of the year for maritime activity and 1 August 2024 is the scheduled date of the RFA NOM One launch) of 163 vessels in the entire extended Range. There is no significant cluster of high vessel concentrations, and the largest single grouping is that of 35 pelagic fishing vessels operating in a large area of approx. 40,000nm².

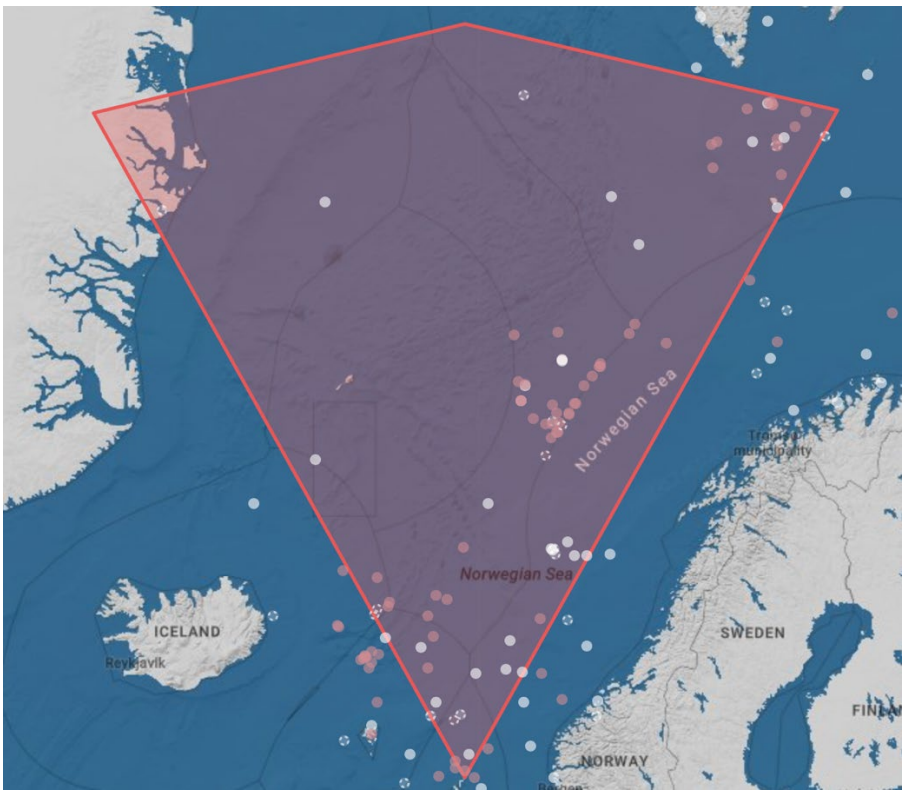


Figure E2-3

6. The 4 year annual average was 2404, equating to 6.58 vessels per day and 0.00001per nm². If the regulatory risk threshold formulae[3] of 1 x 10^{-4} is applied then the risk is ALARP (i.e. the likelihood of a rocket or its debris landing on a vessel and causing injury to its crew is **less** than 1 x 10^{-4} (or 0.0001%).

SAXA EXTENDED RANGE – NORDIC SEA					
Type of Vessel	**2020**	**2021**	**2022**	**2023**	**4 Yr Mean**
Fishing	683	721	755	854	753
Fish Carrier	26	32	31	34	31
Floating Oil Platform	1	1	1	0	0.75
Cargo	738	802	814	955	827
Tanker	267	354	323	467	353
Sailing	61	119	106	145	108
Pleasure Craft	43	53	61	67	56
Tug and Towing Vessels	37	49	44	47	44
Passenger	37	123	135	142	109
Pilot Boat	1	1	1	1	1
Law Enforcement	4	15	17	12	12

[3] If the estimated expected casualty rate exceeds 1×10^{-4} then the risk is not considered ALARP. Sources: FAA & CAA .

Dredging	2	3	3	2	2.5
Search and Rescue	10	14	13	16	13
Coastguard/Research/Survey Vessel	22	26	30	19	24.25
Military	27	39	46	47	40
Offshore Support/Supply	12	23	29	28	23
Pipe/Cable/Buoy Layer	1	1	2	2	1.5
Inshore Work Boat	1	1	1	1	1
Diving ops	1	5	4	5	4
Total	**1974**	**2382**	**2416**	**2844**	**2404**

Table E2-A: 4-year vessel numbers Saxa Extended Range

Arctic Ocean/Beaufort Sea Range

7. The Saxa Arctic Ocean/Beaufort Sea Range is 251,690 nm². Vessel numbers over a 4 year period are shown at Table E2-B. The highest volume of ships in this period were tugs and towing vessels, which operate in the near shore generally servicing the oil and gas industry.

8. The overall maritime activity in the Early Phase Flight Warning Zone is determined to be **extremely low** relative to its size. The 4 year annual average over this period was 124, equating to 0.34 vessels per day and 0.000001 per nm². If the regulatory risk threshold formulae of 1×10^{-4} is applied then the risk is ALARP (i.e. the likelihood of a rocket or its debris landing on a vessel and causing injury to its crew is **less** than 1×10^{-4} (or 0.0001%).

SAXA ARCTIC OCEAN/BEAUFORT SEA RANGE					
Type of Vessel	**2020**	**2021**	**2022**	**2023**	**4 Yr Mean**
Fishing	10	10	12	14	12
Fish Carrier	1	1	1	1	4
Cargo	17	11	20	25	19
Tanker	4	1	5	8	4.5
Sailing	1	2	8	7	5
Pleasure Craft	9	12	14	11	11.5
Tug and Towing Vessels	28	26	31	28	29
Passenger	8	7	10	16	11
Law Enforcement	2	2	2	2	2
Dredging	1	0	0	2	0.75
Search and Rescue	6	6	8	5	6.25
Coastguard Vessel/Ice Breaker	7	9	8	9	8.25

Research Vessel	6	6	6	8	6.5
Military	1	3	1	2	2
Hovercraft	1	1	1	1	1
Anti-Pollution	1	1	1	1	1
Inshore Work Boat	6	3	2	1	3
Drilling Vessel	0	0	0	1	0.25
Offshore Supply Ship	0	0	0	1	0.25
Total	**109**	**101**	**130**	**143**	**124**

Table E2-B: 4-year vessel numbers Arctic Ocean/Beaufort Sea Range

NM1 – Launch Exclusion Zone

9. The Saxa Launch Exclusion Zone (LEZ) is 30nm², of which 28nm² is sea area. Vessel numbers over a 4 year period are shown at Table E2-C. The highest volume of ships in this period was fishing vessels, closely followed by cargo vessels. Fishing vessels will loiter in the same area for extended periods, particularly the local, inshore shellfish vessels.

10. The overall maritime activity in the Saxa LEZ is determined to be **low** relative to its size. The 4 year annual average over this period was 164, equating to 0.45 vessels per day and 0.016 per nm². If the regulatory risk threshold formulae of 1×10^{-4} is applied then the risk is not ALARP (i.e. the likelihood of a rocket or its debris landing on a vessel and causing injury to its crew is **higher** than 1×10^{-4} (or 0.0001%). Therefore, control measures in the form of an Exclusion Zone must be implemented during launch operations to reduce the risk to less than 1×10^{-4} and ALARP.

RFA LEZ VESSEL ANALYSIS					
Type of Vessel	**2020**	**2021**	**2022**	**2023**	**4 Yr Mean**
Fishing	61	54	73	84	68
Fish Carrier	3	4	6	3	4
Floating Oil Platform	0	0	0	1	0.25
Cargo	53	52	55	47	52
Tanker	4	2	1	3	2.5
Sailing	1	6	5	12	6
Pleasure Craft	0	4	0	6	2.5
Tug and Towing Vessels	1	5	5	5	4
Passenger	1	1	8	10	5
Law Enforcement/Coast Guard	1	1	0	2	1
Search and Rescue	3	1	3	1	2
Research/Survey Vessel	2	2	2	5	2.2

Military	0	0	0	5	1.25
Offshore Support/Supply	10	8	11	18	11.75
Pipe/Cable/Buoy Layer	1	1	1	1	1
Diving ops	0	1	0	1	0.5
Total	**140**	**142**	**170**	**204**	**164**

Table E2-C: 4-year vessel numbers Saxa LEZ

Warning Zone NM2 – Stage 1 & Fairing Dispersion Area

11. The Saxa Stage 1 and Fairing Dispersion Area is 20,200 nm². Vessel numbers over a 4 year period are shown at Table E2-D. The highest volume of ships in this period was fishing vessels, followed by cargo vessels.

12. The overall maritime activity in the Stage 1 and Fairing Dispersal Area is determined to be **extremely low** relative to its size. The 4 year annual average over this period was 252, equating to 0.69 vessels per day and 0.00003 per nm². If the regulatory risk threshold formulae of 1×10^{-4} is applied then the risk is ALARP (i.e. the likelihood of a rocket or its debris landing on a vessel and causing injury to its crew is **less** than 1×10^{-4} (or 0.0001%).

SAXA FAIRING AND STAGE ONE AREA VESSEL ANALYSIS					
Type of Vessel	**2020**	**2021**	**2022**	**2023**	**4 Yr Mean**
Fishing	103	157	145	130	133
Fish Carrier	1	2	3	9	4
Cargo	59	79	59	69	66
Tanker	9	9	17	29	16
Sailing	3	2	12	13	7
Pleasure Craft	0	2	7	4	3
Tug and Towing Vessels	0	1	3	5	2
Passenger	1	1	19	19	10
Port Tender	0	0	2	0	0.5
Law Enforcement/Coast Guard	2	1	1	0	1
Dredging	0	1	0	0	0.25
Search and Rescue	1	0	0	0	0.25
Research/Survey Vessel	6	2	2	3	3
Military	2	4	3	4	13
Offshore Support/Supply	0	1	0	2	0.75
Diving ops	0	0	0	1	0.25

Total	**187**	**262**	**273**	**288**	**252**

Table E2-D: 4-year vessel numbers Stage 1 and Fairing Warning Zone

Warning Zone NM3 – Stage 2 Dispersion Area

13. The Saxa Stage 2 Dispersion Area is 172,853 nm². Vessel numbers over a 4 year period are shown at Table E2-E. The highest volume of ships in this period were Coastguard Vessels/Ice Breakers/Research Vessels, which were categorised together.

14. The overall maritime activity in the Stage 2 Dispersion Area is determined to be **extremely low** relative to its size. The 4 year annual average over this period was 9.5, equating to 0.026 vessels per day and 0.00000015 per nm². If the regulatory risk threshold formulae of 1 x 10^{-4} is applied then the risk is ALARP (i.e. the likelihood of a rocket or its debris landing on a vessel and causing injury to its crew is **less** than 1 x 10^{-4} (or 0.0001%).

STAGE 2 VESSEL ANALYSIS					
Type of Vessel	**2020**	**2021**	**2022**	**2023**	**4 Yr Mean**
Fishing	2	1	1	2	1.5
Fish Carrier	1	1	1	1	1
Tug and Towing Vessels	0	1	0	1	0.5
Passenger	1	1	1	1	1
Coastguard Vessel/Ice Breaker/Research Vessel	4	5	4	5	4.5
Military	1	1	1	1	1
Total	**9**	**10**	**7**	**11**	**9.5**

Table E2-E: 4-year vessel numbers Stage 2 Warning Zone

Warning Zone NM4 – Early Phase Flight

15. The Saxa Early Phase Flight Warning Zone is 145,648 nm². Vessel numbers over a 4 year period are shown at Table E2-F. The highest volume of ships in this period were cargo vessels, closely followed by fishing vessels.

16. The overall maritime activity in the Early Phase Flight Warning Zone is determined to be **extremely low** relative to its size. The 4 year annual average over this period was 1,430, equating to 3.9 vessels per day and 0.00002 per nm². If the regulatory risk threshold formulae of 1 x 10^{-4} is applied then the risk is ALARP (i.e. the likelihood of a rocket or its debris landing on a vessel and causing injury to its crew is **less** than 1 x 10^{-4} (or 0.0001%).

SAXA EARLY PHASE FLIGHT WARNING ZONE ANALYSIS					
Type of Vessel	**2020**	**2021**	**2022**	**2023**	**4 Yr Mean**
Fishing	317	385	447	498	412
Fish Carrier	16	26	23	25	23
Floating Oil Platform	1	0	1	0	0.5
Cargo	547	625	588	726	622
Tanker	152	168	191	264	194

Sailing	15	19	26	37	25
Pleasure Craft	11	16	17	19	16
Tug and Towing Vessels	12	13	25	33	21
Passenger	9	10	62	129	53
Pilot Boat	0	1	0	0	0.25
Law Enforcement	4	8	9	12	8
Dredging	2	3	3	2	3
Search and Rescue	5	6	7	13	8
Coastguard Vessel /Research/Survey Vessel	20	15	15	3	13
Military	7	9	21	25	16
Offshore Support/Supply/Drilling	10	13	21	3	12
Pipe/Cable/buoy Layer	1	1	2	2	1.5
Diving ops	0	2	0	3	1.25
Inshore Work Boat	1	1	1	1	1
Total	**1130**	**1321**	**1459**	**1795**	**1430**

Table E2-F: 4-year vessel numbers Early Phase Flight Warning Zone

Summary

17. From the above analysis the vessel numbers in all but one of the areas of analysis meet the FAA/CAA threshold for the risk to be classified as ALARP.

SAXAVORD UK SPACEPORT NAVIGATIONAL RISK ASSESSMENT 2024 ENCLOSURE 3 - HAZARD TABLES

Assessment Number	Hazard Category	Hazard Scenario Title	Context	Consequence: People	Consequence: Property	Consequence: Environment	Baseline Risk	Future Risk	Control ID	Embedded Controls: Control	Embedded Controls: Comment	Likelihood Reduction	Consequence Reduction	Current Risk	Control ID	Future Controls: Control	Future Controls: Comment	Likelihood Reduction	Consequence Reduction	Final Risk
1	Contact	A rocket fails/is terminated soon after launch and debris lands on vessel at sea.	It is determined that one of the higher risks to Saxa space rocket operations is at or immediately after launch, where a rocket is most vulnerable to failing or exploding. This could happen after the rocket exits the Launch Exclusion Zone but is in its first few seconds of flight as it commences its northerly trajectory. Should a rocket fail or be terminated soon after launch it may hit a vessel as it lands on the sea surface where there is a higher proportion of maritime traffic relative to the wider Range.	2	2	1	MODERATE	LOW	E-1	High standards of rocket equipment serviceability, maintenance and testing.	Robust equipment maintenance and testing will be in place. Any concerns on serviceability will result in mission abort.	10%	0%	MOD	F-1	Promulgation of information through robust and effective communications plan to Shetland Islands, maritime communities and Saxa stakeholder groups.	Promulgation of launch activity will commence well in advance to provide maximum warning to maritime community and stakeholder groups.	50%	0%	LOW
									E-2	Availability and implementation of weather forecasting data.	One of the causes of launch vehicles being terminated prior to reaching orbit is adverse wind/weather forcing the rocket off its intended trajectory. This can be almost always avoided by utilising an accurate and frequently updated weather forecast as part of launch planning.	75%	0%		F-2	Introduce space launch hazard areas/zones (Launch Exclusion Zone, Warning Zone).	Control zones, in particular the LEZ, will significantly reduce risk to life.	80%	0%	
									E-3	Equipment redundancy – structural redundancy in technical systems.	Redundancy is built in to launch vehicles and supporting equipment as standard.	10%	0%		F-3	Temporary Notices to Mariners, Local Notice to Mariners and Navigational Warnings promulgating details of space vehicle launch operations, including splash points and IDAs.	MSI will be effective with the majority of professional mariners, but recreational boaters may not be aware of safety information or where to find it.	50%	0%	
									E-4	Emergency Services Equipment.	If maritime emergency response services (RNLI, HMCG) on scene then with the correct equipment they will be able to assist in managing any incident.	0%	10%		F-4	Installation of multi-sensor maritime surveillance system.	Saxa will have effective surveillance of LEZ and situational awareness of wider area around launch site. This will also assist swifter consequence management.	80%	10%	
									E-5	Emergency Response Plan.	Saxa's Range Operations Team will implement the Emergency Response Plan immediately on occasion of any incident.	0%	10%		F-5	Annotation of admiralty charts with space port operations warning information.	This will provide local, regional and international maritime communities situational awareness of Saxa Range. Recreational boaters may not have access to charts.	20%	0%	
									E-6	Implementation and practice of Standards of Training, Certification and Watchkeeping for Seafarers (STCW).	Formal training, certification and standards will ensure proper navigational planning processes are followed and traffic intermixed in Hazard Area during launch operations.	10%	0%		F-6	VHF Sécurité and GMDSS messages promulgating details of space vehicle launch operations, including through all relevant JRCCs.	This will be particularly important for recreational and occasional boaters who may not have charts or access to NTMs/NAVWARNs, etc.	0%	80%	
									E-7	Implementation and practice of SOLAS regulations.	Will ensure a minimum standard for consequence management.	0%	5%		F-7	Boundary Boat in Launch Exclusion Zone prior to and during launch operations.	This will serve to both provide a visual deterrence and communicate with vessels to exit the LEZ. It will also be on site for swift reaction to any incidents.	80%	20%	
									E-10	Operational planning.	Operational planning will include a vessel's incident response plan, therefore a swifter and more effective response to incidents should be possible.	10%	10%		F-9	Visual confirmation (clear line of sight).	Part of the pre-launch safety sequence. If LEZ is fouled launch approval will not be given. Only applicable to LEZ control zone and not wider hazard area.	40%	0%	
									E-11	Training of operations personnel.	SQEP personnel will implement emergency and incident response plans more effectively.	0%	10%							
									E-14	Emergency equipment available.	Sufficient quantities of appropriate emergency equipment in Boundary Boats will allow SQEP personnel to manage incidents effectively.	0%	10%							
									E-15	Passage planning.	Passage planning will allow a vessel to avoid control zones and the launch vehicle trajectory at the time of launch, therefore reducing this risk.	10%	0%							
									E-17	Standard Operating Procedures.	SOPs will ensure pre-planned and practiced emergency and incident response plans are in place and fully understood by all Boundary Boat crews.	0%	10%							
2	Contact	A vessel is struck by a falling that has been intentionally detached from the rocket as part of the stages of **separation during a routine** launch and has fallen to the sea surface.	This event would most likely occur further out from the coast once the rocket has begun its northern trajectory. When a failing is released upon separation during a routine launch, there is a **small chance that it strikes a vessel as it lands on the sea** surface	1	1	1	LOW	NEGLIGIBLE	E-6	Implementation and practice of Standards of Training, Certification and Watchkeeping for Seafarers (STCW).	Formal training, certification and standards will ensure proper navigational planning processes are followed and minimise traffic in Impact Dispersion Areas during launch operations.	5%	0%	LOW	F-1	Promulgation of information through robust and effective communications plan to Shetland Islands, maritime communities and Saxa stakeholder groups.	Promulgation of launch activity will commence well in advance to provide maximum warning to international maritime community and stakeholder groups.	50%	0%	NEG
									E-7	Implementation and practice of SOLAS regulations.	Will ensure a minimum standard for consequence management.	0%	5%		F-2	Introduce space launch hazard areas/zones (Launch Exclusion Zone, Warning Zone).	Linked with F1 - IDAs will be in the Hazard Area.	20%	0%	
									E-10	Operational planning.	Operational planning will include a vessel's incident response plan, therefore a swifter and more effective response to incidents should be possible.	0%	10%		F-3	Temporary Notices to Mariners, Local Notice to Mariners and Navigational Warnings promulgating details of space vehicle launch operations, including splash points and IDAs.	MSI will be effective with professional mariners in the wider Saxa Range/Hazard Area.	80%	0%	
									E-15	Passage planning.	Passage planning will allow a vessel to avoid Warning Zones during launch operations, therefore reducing this risk.	10%	0%		F-5	Annotation of admiralty charts with space port operations warning information.	This will provide local, regional and international maritime communities situational awareness of Saxa Range and wider Hazard Area. Charts will not be annotated with splash points and IDAs as they will change for each launch operation.	10%	0%	
															F-8	VHF Sécurité and GMDSS messages promulgating details of space vehicle launch operations.	Vessels beyond VHF/DSC range of Shetlands will not receive these messages, however, broadcast relays will be possible through JRCCs/MRCCs.	50%	0%	
3	Contact	A vessel strikes rocket debris floating on or just under the sea surface if a rocket fails/is terminated prior to reaching orbit.	This hazard scenario is in the event of a rocket failing/being terminated 'down range' in the Nordic/Beaufort Sea. If rocket debris is floating on or just under the sea surface, or is not easily visible, a vessel may strike the debris and inflict significant damage to its hull. This could affect hull integrity and endanger the crew. Furthermore, if the vessel is transiting through the area at night-time the likelihood of observing the debris would be significantly reduced, thus increasing the risk of impact.	2	2	1	MODERATE	LOW	E1	High standards of rocket equipment serviceability, maintenance and testing.	Robust equipment maintenance and testing will be in place. This will reduce likelihood of a launch vehicle failure in flight.	10%	0%	MOD	F-1	Promulgation of information through robust and effective communications plan to Shetland Islands, maritime communities and Saxa stakeholder groups.	This will be a useful mitigation measure but may not be received by vessels already at sea.	20%	20%	LOW
									E-2	Availability and implementation of weather forecasting data.	One of the causes of launch vehicles being terminated prior to reaching orbit is adverse wind/weather forcing the rocket off its intended trajectory. This can be almost always avoided by utilising an accurate and frequently updated weather forecast as part of launch planning.	75%	0%		F-2	Temporary Notices to Mariners, Local Notice to Mariners and Navigational Warnings promulgating details of splash point and dynamic potential area of debris dispersion.	NAVWARNS/WZs will be the most expeditious and effective means of promulgating the danger to vessels not within VHF/DSC range of Saxa.	50%	0%	
									E-4	Emergency Services Equipment.	If maritime emergency response services (RNLI, HMCG) are first on scene then with the correct equipment they may be able to retrieve the debris before it is a hazard to shipping.	0%	10%		F-6	VHF Sécurité and GMDSS messages promulgating details of space vehicle launch operations.	VHF messages will be promulgating critical MSI about any incident. Broadcasts can be relayed through JRCCs/MRCCs so that vessels further away from land can receive the information.	30%	0%	
									E-5	Emergency Response Plan.	Saxa's Range Operations Team will implement the Emergency Response Plan immediately on occasion of any incident, thus warning the maritime community of the danger, informing the emergency services and deploying a Boundary Boat to recover debris.	0%	10%							
									E-6	Implementation and practice of Standards of Training, Certification and Watchkeeping for Seafarers (STCW).	Formal training, certification and standards will ensure proper navigational planning processes are followed to avoid the splash down point or debris dispersion area of a failed/terminated launch vehicle.	10%	0%							
									E-7	Implementation and practice of SOLAS regulations.	Will ensure a minimum standard for consequence management.	0%	5%							
									E-10	Operational planning.	Operational planning will include a vessel's incident response plan, therefore a swifter and more effective response to incidents should be possible.	0%	10%							
									E-13	Vessel Safety Management Plan.	A VSMP will mitigate the impact and consequences of colliding with rocket debris through robust safety management procedures.	0%	10%							
									E-14	Emergency equipment available.	Sufficient quantities of appropriate emergency equipment in a vessel that collides or comes into contact with debris will allow SQEP personnel to manage incidents effectively.	0%	20%							
									E-15	Passage planning.	Passage planning will allow a vessel to avoid the Hazard Area during launch operations, therefore reducing this risk.	10%	0%							
4	Contact	A fixed offshore structure (oil/gas platform or wind turbine) is struck by a failing that has been intentionally detached from the rocket as part of the stages of separation during a routine launch.	The payload fairing is the equipment used to protect the spacecraft that is intentionally detached from the rocket as part of stage separation during any routine launch. As it is a frequent process, therein lies a risk of fairing striking a fixed offshore structure such as an oil, gas or fixed turbine platform.	1	1	1	LOW	NEGLIGIBLE						LOW	F-8	Saxa Operational Range arcs to be modified to avoid fixed maritime infrastructure.	As per para. 3.25 of the NRA only one offshore platform (the Aasta Hansteen terminal) lies within the original Range arcs of 330° to 030°. Saxa staff will modify the right hand arc from 030° to 022° to avoid this platform by a margin of 20nm. For all launch planning the Saxa Range staff will liaise closely with the launch provider to determine intended launch parameters, ensure that both the trajectory falls within the Saxa Range and that no fixed infrastructure is impacted by the trajectory or IDAs.	100%	0%	NEG
5	Contact	A rocket fails/is terminated prior to reaching orbit and the debris falls on a fixed structure (oil/gas platform or offshore wind turbine).	The Saxa Areas of Interest (AOI) contain numerous offshore energy platforms in both the UK and Norwegian EEZ. The intended arc of operations for rocket launches is 330° to 030° out to a range of 900nm. Present within this arc of operations is the Greenland coast, Jan Mayen Island and the Norwegian Aastra Hansteen oil platform.	1	1	1	LOW	NEGLIGIBLE	E-1	High standards of rocket equipment serviceability, maintenance and testing.	Robust equipment maintenance and testing will be in place. Any concerns on serviceability will result in mission abort.	10%	0%	LOW	F-8	Saxa Operational Range arcs to be modified to avoid fixed maritime infrastructure.	As per para. 3.25 of the NRA only one offshore platform (the Aasta Hansteen terminal) lies within the original Range arcs of 330° to 030°. Saxa staff will modify the right hand arc from 030° to 022° to avoid this platform by a margin of 20nm. For all launch planning the Saxa Range staff will liaise closely with the launch provider to determine intended launch parameters, ensure that both the trajectory falls within the Saxa Range and that no fixed infrastructure is impacted by the trajectory.	100%	0%	NEG
									E-2	Availability and implementation of weather forecasting data.	One of the causes of launch vehicles being terminated prior to reaching orbit is adverse wind/weather forcing the rocket off its intended trajectory. This can be almost always avoided by utilising an accurate and frequently updated weather forecast as part of launch planning.	75%	0%							
									E-3	Equipment redundancy – structural redundancy in technical systems.	Redundancy is built into launch vehicles and supporting equipment as standard. Should all reversionary modes fail the rocket would be terminated immediately.	80%	0%							
									E-5	Emergency Response Plan.	Saxa's Range Operations Team will implement the Emergency Response Plan immediately on occasion of any incident.	0%	10%							
									E-7	Implementation and practice of SOLAS regulations.	Will ensure a minimum standard for consequence management.	0%	5%							
									E-11	Training of operations personnel.	SQEP personnel will implement emergency and incident response plans more effectively.	0%	10%							
									E-14	Emergency equipment available.	Sufficient quantities of appropriate emergency equipment in offshore infrastructure will allow SQEP personnel to manage incidents effectively.	0%	10%							
									E-17	Standard Operating Procedures.	SOPs will ensure pre-planned and practiced emergency and incident response plans are in place and fully understood by all offshore platform crews.	0%	10%							
6	Contact	Spectator and fishing vessels sightseeing, day boats and other fishing and recreational craft are not detected in the Launch Exclusion Zone during a launch and are struck by rocket debris.	As part of routine launch activity there is a risk of debris being dispersed at high velocity in the vicinity of the Saxa launch pads. Analysis has shown that the most likely point at which a rocket will fail is on initial launch. Therefore, to account for this risk a Launch Exclusion Zone will in place prior to and during launch operations to ensure no persons or vessels are endangered by the launch debris or an explosion from a defective rocket. The LEZ will be monitored and patrolled thoroughly and robustly to ensure no person or vessel are within the zone during a launch. Launch activity will undoubtedly attract much interest from spectators. To maximise the experience the general public is likely to want to be as close as possible to the launch site. There are a number of bays, coves and headlands in the LEZ that could contain small vessels such as kayaks, paddleboards and canoes not easily visible from the sea. The most likely launch spot for small recreational craft will be Norwick - the bay closest to Saxa. Additionally, because the bay is a sheltered and designated anchorage within sight of the Saxa launch site, it is the most probable lster area for waterborne spectators.	4	3	3	SIGNIFICANT	LOW	E-4	Emergency Services Equipment.	If maritime emergency response services (RNLI, HCMG) on scene then with the correct equipment they will be able to assist in managing any incident.	0%	10%	SIG	F-1	Promulgation of information through robust and effective communications plan to Shetland Islands, maritime communities and Saxa stakeholder groups.	This will be a useful mitigation measure but may not be received by vessels already at sea.	20%	20%	LOW
									E-5	Emergency Response Plan.	Saxa's Range Operations Team will implement the Emergency Response Plan immediately on occasion of any incident.	0%	10%		F-2	Introduce space launch hazard areas/zones (Launch Exclusion Zone, Warning Zone).	Control zones, in particular the LEZ, will significantly reduce risk to life.	80%	0%	
									E-6	Implementation and practice of Standards of Training, Certification and Watchkeeping for Seafarers (STCW).	Formal training, certification and standards will ensure proper navigational planning processes are followed and the LEZ is avoided during launch operations.	10%	0%		F-3	Temporary Notices to Mariners, Local Notice to Mariners and Navigational Warnings promulgating details of splash point and dynamic potential area of debris dispersion.	MSI will be effective with the majority of professional mariners, but recreational boaters may not be aware of safety information or where to find it.	50%	0%	
									E-7	Implementation and practice of SOLAS regulations.	Will ensure a minimum standard for consequence management.	0%	5%		F-4	Installation of multi-sensor maritime surveillance system.	Saxa will have effective surveillance of LEZ and situational awareness of wider area around launch site. This will also assist swifter consequence management.	80%	10%	
									E-10	Operational planning.	Operational planning will include a vessel's incident response plan, therefore a swifter and more effective response to incidents should be possible.	0%	10%		F-5	Annotation of admiralty charts with space port operations warning information.	This will provide local, regional and international maritime communities situational awareness of Saxa Range. Recreational boaters may not have access to charts.	10%	0%	
									E-11	Training of operations personnel.	SQEP personnel will implement emergency and incident response plans more effectively.	0%	10%		F-6	VHF Sécurité and GMDSS messages promulgating details of space vehicle launch operations.	This will be particularly important for recreational and occasional boaters who may not have charts or access to NTMs/NAVWARNs, etc.	30%	0%	
									E-14	Emergency equipment available.	Sufficient quantities of appropriate emergency equipment in Boundary Boats will allow SQEP personnel to manage incidents effectively.	0%	10%		F-1	Boundary Boat in Launch Exclusion Zone prior to and during launch operations.	This will serve to both provide a visual deterrence and communicate with vessels to exit the LEZ. It will also be on site for swift reaction to any incidents.	80%	10%	
									E-15	Passage planning.	Passage planning will allow a vessel to avoid the LEZ during launch operations, therefore reducing this risk.	10%	0%		F-9	Visual confirmation (clear line of sight).	Part of the pre-launch safety sequence. If LEZ is fouled launch approval will not be given. Only applicable to LEZ control zone and not wider hazard area.	40%	0%	
									E-17	Standard Operating Procedures.	SOPs will ensure pre-planned and practiced emergency and incident response plans are in place and fully understood by all Boundary Boat crews.	0%	10%							
Assessment Number	Hazard Category	Hazard Scenario Title	Context	Consequence: People	Consequence: Property	Consequence: Environment	Baseline Risk	Future Risk	Control ID	Embedded Controls: Control	Embedded Controls: Comment	Likelihood Reduction	Consequence Reduction	Current Risk	Control ID	Future Controls: Control	Future Controls: Comment	Likelihood Reduction	Consequence Reduction	Final Risk

Assessment Number	Hazard Category	Hazard Scenario Title	Context	Consequence: People	Consequence: Property	Consequence: Environment	Baseline Risk	Future Risk	Control ID	Embedded Controls: Control	Embedded Controls: Comment	Likelihood Reduction	Consequence Reduction	Current Risk	Control ID	Future Controls: Control	Future Controls: Comment	Likelihood Reduction	Consequence Reduction	Final Risk
7	Foundering/ Hazardous Substance Accidents	A rocket falls/is terminated soon after launch and debris lands in a Marine or Special Protected Area (MPA/SPA) and sinks below the surface.	The Sea Vord Area of Interest (AOI) contains several large Marine Protected Areas (MPA). Debris sinking below the surface can lead to damaging marine pollution. A Boundary Boat will be on standby in the vicinity of the LEZ to collect any debris that may become harmful to marine life in any of these areas. However, floating debris as attachment for pelagic organisms and the ingestion of debris is generally considered unlikely in best practise for ecological risk assessment for rocket launches. Furthermore, MPAs are not necessarily areas with denser ecosystems than their surroundings. Instead, they are defined areas where human activities are managed to protect important natural or cultural resources. It would be likely that the governing bodies, such as the Joint Nature Conservation Committee (JNCC) and Norwegian Environment Agency, could provide support in the event of materials/debris landing in an MPA in the Sasa AOI.	0	0	3	LOW	LOW	E-1	High standards of rocket equipment serviceability, maintenance and testing.	Robust equipment maintenance and testing will be in place. Any concerns on serviceability will result in mission abort.	10%	0%	LOW	F-2	Boundary Boat in Launch Exclusion Zone prior to and during launch operations.	Should a launch vehicle fail in the LEZ or ino Shetlands the Boundary Boat will be in situ for swift reaction to any incidents, including recovering any rocket debris.	0%	10%	LOW
									E-2	Availability and implementation of weather forecasting data.	One of the causes of launch vehicles being terminated prior to reaching orbit is adverse wind/weather forcing the rocket off its intended trajectory. This can be almost always avoided by utilising an accurate and frequently updated weather forecast as part of launch planning.	75%	0%		F-1	Boundary Boat equipped with rocket propellent firefighting equipment.	In the very unlikely event of the rocket debris still being on fire when it lands on the sea surface in the LEZ or ino Shetlands the Boundary Boat will be equipped to extinguish the propellent.	0%	10%	
									E-3	Equipment redundancy – structural redundancy in technical systems.	Redundancy is built in to launch vehicles and supporting equipment as standard.	10%	0%							
									E-5	Emergency Response Plan.	Sasa's Range Operations Team will implement the Emergency Response Plan immediately on occasion of any incident. This will include the recovery of rocket debris thus reducing the likelihood of any	0%	10%							
8	Fire	A rocket explodes soon after launch and combustible materials/chemicals that are on fire land on the sea surface, causing a hazard to shipping.	In the event of a rocket exploding soon or immediately after launch, and the burning flammable material is not extinguished upon landing on the sea surface, it could become a danger to personnel and vessels in the vicinity of its splash down point. Unused fuel could potentially feed the fire for a sustained period. However, rocket debris is not designed to float and has a negative buoyancy, therefore is most likely to sink on impact with the sea surface and any residual fire/flames would be extinguished on impact or when the debris starts to sink.	1	2	1	LOW	LOW	E-1	High standards of rocket equipment serviceability, maintenance and testing.	Robust equipment maintenance and testing will be in place. Any concerns on serviceability will result in mission abort.	10%	0%	LOW	F-1	Promulgation of information through robust and effective communications plan to Shetland Islands, maritime communities and Sasa stakeholder groups.	This will be a useful mitigation measure but may not be received by vessels already at sea.	50%	10%	NEG
									E-2	Availability and implementation of weather forecasting data.	One of the causes of launch vehicles being terminated prior to reaching orbit is adverse wind/weather forcing the rocket off its intended trajectory. This can be almost always avoided by utilising an accurate and frequently updated weather forecast as part of launch planning.	75%	0%		F-2	Introduce space launch hazard areas/zones (Launch Exclusion Zone, Warning Zones).	Control zones, in particular the LEZ, will significantly reduce risk to life. For this risk the control zones will reduce/negate the likelihood of vessels being ivo the launch vehicle trajectory.	30%	0%	
									E-3	Equipment redundancy – structural redundancy in technical systems.	Redundancy is built in to launch vehicles and supporting equipment as standard.	10%	0%		F-3	Temporary Notices to Mariners, Local Notice to Mariners and Navigational Warnings promulgating details of splash point and dynamic potential area of debris dispersion.	MSI will be effective with the majority of professional mariners, but recreational boaters may not be aware of safety information or where to find it.	20%	40%	
									E-4	Emergency Services Equipment.	If maritime emergency response services (RNLI, HCMG) on scene then with the correct equipment they will be able to assist in managing any incident.	0%	10%		F-4	Installation of multi-sensor maritime surveillance system.	Sasa will have effective surveillance of LEZ and situational awareness of wider area around launch site. This will also assist swifter consequence management.	80%	10%	
									E-5	Emergency Response Plan.	Sasa's Range Operations Team will implement the Emergency Response Plan immediately on occasion of any incident.	0%	10%		F-5	Annotation of admiralty charts with space port operations warning information.	This will provide local, regional and international maritime communities situational awareness of Sasa Range, but not of this specific risk. Recreational boaters may not have access to charts.	10%	0%	
									E-6	Implementation and practice of Standards of Training, Certification and Watchkeeping for Seafarers (STCW).	Formal training, certification and standards will ensure proper navigational planning processes are followed and traffic minimised in Hazard Area during launch operations, and, such as this occasion, if the launch vehicle fails.	10%	10%		F-6	VHF Sécurité and GMDSS messages promulgating details of space vehicle launch operations.	This will be particularly important for recreational and occasional boaters who may not have charts or access to NTMs/NAVWARNs etc.	20%	40%	
									E-7	Implementation and practice of SOLAS regulations.	Will ensure a minimum standard for consequence management.	0%	5%		F-7	Boundary Boat in Launch Exclusion Zone prior to and during launch operations.	This will serve to both provide a visual deterrence and communicate with vessels to exit the LEZ. It will also be on site for swift reaction to any incidents.	40%	40%	
									E-11	Training of operations personnel.	SQEP personnel will implement emergency and incident response plans more effectively.	0%	10%		F-8	Visual confirmation (clear line of sight).	Part of the pre-launch safety sequence. If LEZ is fouled launch approval will not be given. Only applicable to LEZ control zone and not wider hazard area.	10%	0%	
									E-13	Vessel Safety Management Plan.	A VSMP will mitigate the impact and consequences of colliding with rocket debris through robust safety management procedures.	0%	10%		F-9	Boundary Boat equipped with rocket propellent firefighting equipment.	In the very unlikely event of the rocket debris still being on fire when it lands on the sea surface in the LEZ or ino Shetlands the Boundary Boat will be equipped to extinguish the propellent.	0%	40%	
									E-14	Emergency equipment available.	Sufficient quantities of appropriate emergency equipment in a vessel that collides or comes into contact with debris will allow SQEP personnel to manage incidents effectively.	0%	10%							
									E-15	Passage planning.	Passage planning will allow a vessel to avoid the Hazard Area during launch operations, therefore reducing this risk.	10%	0%							
									E-17	Standard Operating Procedures.	SOPs will ensure pre-planned and practiced emergency and incident response plans are in place and fully understood by all offshore platform crews.	0%	10%							
9	Contact / Machinery Related Accidents	A rocket falls/is terminated soon after launch and debris and material, including parachutes, wires and cables, on or just under the sea surface foul a propeller and disable a vessel's propulsion system or a fishing vessel's nets.	The potential debris and materials from rocket launch or mid-launch failures, including sounding rockets, could contain parachutes, wires and cables. These materials laying on or just under the sea surface may foul a propeller and disable the vessel's propulsion system or entangle a fishing vessel's nets. Furthermore, if the vessel is transiting through the area at night-time the likelihood of observing and floating debris would be significantly reduced, thus increasing the risk of impact.	2	2	1	MODERATE	LOW	E-1	High standards of rocket equipment serviceability, maintenance and testing.	Robust equipment maintenance and testing will be in place. Any concerns on serviceability will result in mission abort.	10%	0%	MOD	F-1	Promulgation of information through robust and effective communications plan to Shetland Islands, maritime communities and Sasa stakeholder groups.	This will be a useful mitigation measure but may not be received by vessels already at sea.	30%	10%	LOW
									E-2	Availability and implementation of weather forecasting data.	One of the causes of launch vehicles being terminated prior to reaching orbit is adverse wind/weather forcing the rocket off its intended trajectory. This can be almost always avoided by utilising an accurate and frequently updated weather forecast as part of launch planning.	75%	0%		F-2	Introduce space launch hazard areas/zones (Launch Exclusion Zone, Warning Zone).	Control zones, in particular the LEZ, will significantly reduce risk to life. For this risk the control zones will reduce/negate the likelihood of vessels being ivo the launch vehicle trajectory.	30%	0%	
									E-3	Equipment redundancy – structural redundancy in technical systems.	Redundancy is built in to launch vehicles and supporting equipment as standard.	10%	0%		F-3	Temporary Notices to Mariners, Local Notice to Mariners and Navigational Warnings promulgating details of splash point and dynamic potential area of debris dispersion.	MSI will be effective with the majority of professional mariners, but recreational boaters may not be aware of safety information or where to find it.	20%	40%	
									E-4	Emergency Services Equipment.	If maritime emergency response services (RNLI, HMCG) on scene then with the correct equipment they will be able to assist in managing any incident.	0%	10%		F-4	Installation of multi-sensor maritime surveillance system.	Sasa will have effective surveillance of LEZ and situational awareness of wider area around launch site. This will also assist swifter consequence management.	10%	10%	
									E-5	Emergency Response Plan.	Sasa's Range Operations Team will implement the Emergency Response Plan immediately on occasion of any incident.	0%	10%		F-5	Annotation of admiralty charts with space port operations warning information.	This will provide local, regional and international maritime communities situational awareness of Sasa Range, but not of this specific risk. Recreational boaters may not have access to charts.	10%	0%	
									E-6	Implementation and practice of Standards of Training, Certification and Watchkeeping for Seafarers (STCW).	Formal training, certification and standards will ensure proper navigational planning processes are followed and traffic minimised in Hazard Area during launch operations, and, such as this occasion, if the launch vehicle fails.	10%	10%		F-6	VHF Sécurité and GMDSS messages promulgating details of space vehicle launch operations.	This will be particularly important for recreational and occasional boaters, who may not have charts or access to NTMs/NAVWARNs, etc., to be made aware of the incident.	20%	40%	
									E-7	Implementation and practice of SOLAS regulations.	Will ensure a minimum standard for consequence management.	0%	5%		F-7	Boundary Boat in Launch Exclusion Zone prior to and during launch operations.	This will serve to both provide a visual deterrence and communicate with vessels to exit the LEZ. It will also be on site for swift reaction to any incidents. If the launch vehicle is a sub-orbital rocket, it is likely to involve a pre-planned recovery operation, and a second Boundary Boat would be present in the vicinity of the splash down point, therefore, if the failure is at distance from the launch site, it would be well-	40%	40%	
									E-11	Training of operations personnel.	SQEP personnel will implement emergency and incident response plans more effectively.	0%	10%		F-8	Visual confirmation (clear line of sight).	Part of the pre-launch safety sequence. If LEZ is fouled launch approval will not be given. Only applicable to LEZ control zone and not wider hazard area.	10%	0%	
									E-13	Vessel Safety Management Plan.	A VSMP will mitigate the impact and consequences of colliding with rocket debris through robust safety management procedures.	0%	10%							
									E-14	Emergency equipment available.	Sufficient quantities of appropriate emergency equipment in a vessel that collides or comes into contact with debris/wires/cables will allow SQEP personnel to manage incidents effectively.	0%	10%							
									E-15	Passage planning.	Passage planning will allow a vessel to avoid the Hazard Area during launch operations, therefore reducing this risk.	10%	0%							
									E-17	Standard Operating Procedures.	SOPs will ensure pre-planned and practiced emergency and incident response plans are in place and fully understood by all offshore platform crews.	0%	10%							
10	Contact	A rocket falls/is terminated outside theEarly Phase Flight of Area but prior to reaching orbit and the debris and lands on vessel at sea.	Unlike Hazard 1, this scenario is in the event of a rocket falling/being terminated 'down range' in the Nordic Sea outside the Launch Area. Should a rocket fail or be terminated prior to reaching orbit it may hit a vessel as it lands on the sea surface, which could potentially be catastrophic to personnel and the vessel.	1	1	1	LOW	LOW	E-1	High standards of rocket equipment serviceability, maintenance and testing.	Robust equipment maintenance and testing will be in place. Any concerns on serviceability will result in mission abort.	10%	0%	LOW	F-1	Promulgation of information through robust and effective communications plan to Shetland Islands, maritime communities and Sasa stakeholder groups.	This will be a useful mitigation measure but may not be received by vessels already at sea.	50%	10%	NEG
									E-2	Availability and implementation of weather forecasting data.	One of the causes of launch vehicles being terminated prior to reaching orbit is adverse wind/weather forcing the rocket off its intended trajectory. This can be almost always avoided by utilising an accurate and frequently updated weather forecast as part of launch planning.	75%	0%		F-2	Introduce space launch hazard areas/zones (Launch Exclusion Zone, Warning Zones).	Control zones, particularly in this instance the warning zone, will significantly reduce risk to life. For this risk the control zones will reduce/negate the likelihood of vessels being ivo the launch vehicle trajectory.	30%	0%	
									E-3	Equipment redundancy – structural redundancy in technical systems.	Redundancy is built in to launch vehicles and supporting equipment as standard.	10%	0%		F-3	Temporary Notices to Mariners, Local Notice to Mariners and Navigational Warnings promulgating details of splash point and dynamic potential area of debris dispersion.	MSI will be effective with the majority of professional mariners, but recreational boaters may not be aware of safety information or where to find it.	20%	40%	
									E-4	Emergency Services Equipment.	If maritime emergency response services (RNLI, HMCG) on scene then with the correct equipment they will be able to assist in managing any incident, noting that this hazard scenario occurs further offshore.	0%	10%		F-5	Annotation of admiralty charts with space port operations warning information.	This will provide local, regional and international maritime communities situational awareness of Sasa Range, but not of this specific risk.	10%	0%	
									E-5	Emergency Response Plan.	Sasa's Range Operations Team will implement the Emergency Response Plan immediately on occasion of any incident.	0%	10%		F-6	VHF Sécurité and GMDSS messages promulgating details of space vehicle launch operations.	Vessels beyond VHF/DSC range of Shetlands will not receive these messages, however, broadcast relays will be possible through JRCCs/MRCCs.	20%	40%	
									E-6	Implementation and practice of Standards of Training, Certification and Watchkeeping for Seafarers (STCW).	Formal training, certification and standards will ensure proper navigational planning processes are followed and traffic minimised in Hazard Area during launch operations, and, such as this occasion, if the launch vehicle fails.	10%	10%							
									E-7	Implementation and practice of SOLAS regulations.	Will ensure a minimum standard for consequence management.	0%	5%							
									E-10	Operational planning.	Operational planning will include a vessel's incident response plan, therefore a swifter and more effective response to incidents should be possible.	10%	10%							
									E-11	Training of operations personnel.	SQEP personnel will implement emergency and incident response plans more effectively.	0%	10%							
									E-13	Vessel Safety Management Plan.	A VSMP will mitigate the impact and consequences of colliding with rocket debris through robust safety management procedures.	0%	10%							
									E-14	Emergency equipment available.	Sufficient quantities of appropriate emergency equipment in a vessel that collides or comes into contact with debris will allow SQEP personnel to manage incidents effectively.	0%	10%							
									E-15	Passage planning.	Passage planning will allow a vessel to avoid the Hazard Area during launch operations, therefore reducing this risk.	10%	0%							
									E-17	Standard Operating Procedures.	SOPs will ensure pre-planned and practiced emergency and incident response plans are in place and fully understood by all offshore platform crews.	0%	10%							

Hazard Categories	
Category	**Descripton**
Foundering	To sink below the surface of the water.
Collision	Collision is defined as a vessel striking, or being struck by, another vessel, regardless of whether either vessel is under way, anchored or moored, but excludes hitting underwater wrecks.
Allision	Defined as a violent contact between a moving and stationary vessel or fixed object.
Contact	Contact is defined as a vessel striking, or being struck by, an external object that is not another vessel or the sea bottom. Sometimes referred to as impact.
Fire	Fire is defined as the uncontrolled process of combustion, characterised by heat or smoke or flame or any combination of these.
Explosion	An explosion is defined as an uncontrolled release of energy, which causes a pressure discontinuity or blast wave.
Loss of hull integrity	Loss of hull integrity is defined as the consequence of certain initiating events that result in damage to the external hull, or to internal structure and sub-division, such that any compartment or space within the hull is opened to the sea or to any other compartment or space (where it is not designed to be).
Flooding	Flooding is defined as sea water, or water ballast, entering a space, from which it should be excluded, in such a quantity that there is a possibility of loss of stability leading to capsizing or sinking of the vessel.
Grounding	Grounding is defined as the ship coming to rest on, or riding across, underwater features or objects, but where the vessel can be freed from the obstruction by lightening and/or assistance from another vessel (e.g. tug) or by floating off on the next tide.
Stranding	Stranding is defined as being a greater hazard than grounding and is defined as the ship becoming fixed on an underwater feature or object such that the vessel cannot readily be moved by lightening, floating off, or with assistance from other vessels (e.g. tugs).
Capsizing	The overturning of a vessel after attaining negative stability.
Machinery-related accidents	Machinery-related accidents are defined as any failure of equipment, plant and associated systems which prevents, or could prevent if circumstances dictate, the ship from manoeuvring or being propelled or controlling its stability.
Payload related accidents	Payload related accidents include loss of stability due to cargo shifting and damage to the vessel's structure resulting from the method employed for loading or discharging the cargo. This category does not include incidents which can be categorised as Hazardous substance, Fires, Explosions, Loss of hull integrity, Flooding accidents, etc.
Hazardous substance accidents	Hazardous substance accidents are defined as any substance which - if generated as a result of a fire, accidental release, human error, failure of process equipment, loss of containment, or overheating of electrical equipment - can cause impairment of the health and/or functioning of people or damage to the vessel. These materials may be toxic or flammable gases, vapours, liquids, dusts or solid substances.
Accidents to the general public	Accidents to the general public are defined as those accidents which lead to injury, death or loss of property amongst the population ashore resulting from one of the other ship accident categories.
Accidents to personnel	Accidents to personnel are defined as those accidents which cause harm to any person on board the vessel, e.g. crew, passengers, stevedores, which do not arise as a result of one of the other accident categories. Essentially, it refers to accidents to individuals, though this does not preclude multiple human casualties as a result of the same hazard, and typically includes harm caused by the movement of the vessel when underway, slips, trips, falls, electrocution and confined space accidents, food poisoning incidents, etc.

Control ID	Embedded Risk Controls
E-1	High standards of rocket equipment serviceability, maintenance and testing
E-2	Availability and implementation of weather forecasting data
E-3	Equipment redundancy – structural redundancy in technical systems
E-4	Emergency services equipment
E-5	Emergency Response Plan
E-6	Implementation and practise of Standards of Training, Certification and Watchkeeping for Seafarers (STCW)
E-7	Implementation and practise of SOLAS regulations
E-8	Implementation and practise of International COLREGS 1972 (as amended)
E-9	Vessel maintenance
E-10	Operational planning
E-11	Training of operations personnel
E-12	Vessel inspection/survey
E-13	Vessel safety management system
E-14	Emergency equipment available
E-15	Passage planning
E-16	Contractor risk assessment method statement (RAMS)
E-17	Standard Operating Procedure

Control ID	Additional (Future) Risk Controls
F-1	Promulgation of information through robust and effective communications plan to Shetland Islands, maritime communities and Saxa stakeholder groups.
F-2	Introduce space launch hazard areas/zones (Launch Exclusion Zone, Warning Zone).
F-3	Temporary Notices to Mariners, Local Notice to Mariners and Navigational Warnings promulgating details of space vehicle launch operations, including Impact Dispersion Areas.
F-4	Installation of multi-sensor maritime surveillance system.
F-5	Annotation of admiralty charts with space port operations warning information.
F-6	VHF Sécurité and GMDSS messages promulgating details of space vehicle launch operations.
F-7	Boundary Boat in Launch Exclusion Zone prior to, and immediately adjacent to during, launch operations.
F-8	Saxa Operational Range arcs to be modified to avoid fixed maritime infrastructure.
F-9	Visual confirmation (clear line of sight).
F-10	Boundary Boat equipped with rocket propellent firefighting equipment.