Shetland Space Centre

Balloon and Sounding Rocket

Navigational Risk Assessment

May 2020





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Navigational Risk Assessment

May 2020

SHETLAND SPACE CENTRE

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Notice

ABPmer
Quayside Suite, Medina Chambers, Town Quay, Southampton, Hampshire SO14 2AQ
T: +44 (0) 2380 711844 W: http://www.abpmer.co.uk/

Non-Technical Summary

ABPmer has been commissioned by Shetland Space Centre Ltd (SSC) to undertake a Navigational Risk Assessment (NRA) detailing the marine risks associated with the launching and recovery of weather balloons and sounding rockets from their planned facility in Unst, in the Shetland Islands.

Relevant guidance and information published by industry bodies and regulators have been reviewed and incorporated into the NRA. Consultation has been conducted with stakeholders to document and address local marine user opinion. To inform the stakeholder group, information defining the baseline navigational environment has been used, including a traffic assessment drawn from Automatic Identification System (AIS) data collected in 2020, 2019 and 2017.

In total, nine hazard scenarios were identified and assessed. These navigational risks cover the activities associated with both the launch and recovery of weather balloon and sounding rocket operations. From the NRA process, 18 project specific mitigation measures have been identified. Following implementation of the identified mitigation measures by SSC, within the context of the proposed operations, it is concluded that marine risk to navigational receptors can be maintained within a level that is judged to be 'As Low As Reasonably Practicable'.

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1 Introduction

1.1 Background and project

Shetland Space Centre Ltd (SSC) was formed in 2017, the company is working towards developing a multipurpose launch and recovery site for a range of aeronautical and space projects. SSC plans to build and operate a rocket launch site and a number of ground stations located on the island of Unst, in the Shetland Islands, Scotland. Initially this site will be used to launch stratospheric balloons and single stage sounding rockets with the purpose of gathering data to inform the background research for future operations and projects.

1.2 Scope of work

SSC has commissioned ABPmer to carry out a Navigational Risk Assessment (NRA) in support of their marine licence application for the launching and recovery of weather balloons and single stage sounding rockets. The NRA has been commissioned to consider the effects of the proposed project on surface marine navigation within the operational area for the proposed balloon and sounding rocket activity, plus the wider effects on vessel traffic transiting to locations outside of the immediate area of study. The NRA assesses the launch and recovery phases of the project and identifies appropriate mitigation measures. It must be noted that this NRA does not consider the risks associated with air traffic, SSC is in consultation with the Civil Aviation Authority for activities that may have conflict with air traffic.

1.3 Study area boundary

The study area comprises a 90 km radius circle from the SSC launch site in Unst, the study area boundary is shown in Figure 1. This boundary includes the majority of the land mass making up the Shetland Islands, plus Pobie Bank to the east of the islands and Clair Ridge oilfield to the west. The study area is comprised of two Operational Areas, the first is that associated with balloon operations (shown with a green boundary on Figure 2) which has a maximum balloon drop radius of 80 km. The second is the sounding rocket launch safety area of 70 km (shown with a red boundary on Figure 3). The combination of these two areas is referred to collectively within this report as the 'Operational Area'.

1.4 Legislation and guidance

The following section identifies relevant legislation considered in the provision of navigational risk assessments for marine projects.

1.4.1 Primary legislation

International protocols and conventions relating to safety, laws of the sea and pollution apply to shipping and ports. The UK Government has a responsibility to ensure that measures are implemented in order to honour its commitments to these protocols. Not least of these is the UK's responsibility under Article 60 (7) of the United Nations Convention on the Law of the Sea (UNCLOS) relating to provisions for 'Artificial islands, installations and structures in the exclusive economic zone'. An NRA is one process by which the necessary considerations of developments or projects can be evaluated.

Within UK territorial waters, the UK Government uphold the right of innocent passage as defined in Article 17 of UNCLOS; beyond the 12 nm (nautical mile) limit of UK territorial waters shipping has the freedom of navigation. The regulation of shipping should be carried out by the 'flag state control' operated by the country in which the ship is registered. As this has proved unsatisfactory 'port state control' has become common in national jurisdictions. Under this regime the UK Government represented by the inspection division of the Maritime and Coastguard Agency (MCA) exercises the rights of the port state to inspect and, if appropriate, detain sub-standard ships. Sea ports and harbours provide the interface between the land, near shore and open sea. The UK Marine Policy Statement (2011) identifies, in relation to port developments and marine safety, that:

> *"Marine plan authorities and decision makers should take into account and seek to minimise any negative impacts on shipping activity, freedom of navigation and navigational safety; and ensure that their decisions are in compliance with international maritime law"*
>
> HM Government, 2011

The majority of port operations are administered by a Statutory Harbour Authority (SHA). Every SHA is self-governed with specific legislation (Acts of Parliament) creating the SHA as an entity, with further powers and amendments made over time in response to the changing scope and remit of the SHA. Underpinning the powers of a SHA is a range of national legislation which places statutory responsibility on the Harbour Master to ensure navigation and safety within the harbour limits, this includes the 'Harbours, Docks and Piers Clauses Act 1847' and the Harbours Acts 1964. Under such legislation, the Harbour Master may issue general or specific directions to control movements of vessels within their SHA in order to ensure safety. The proposed project is located outside of an established SHA and therefore the competent authority with respect to navigation is the MCA.

1.4.2 Secondary guidance

The following secondary guidance documents have been used in preparation of the NRA. These documents provide information regarding the issues that should be taken into consideration when assessing the effect on navigational safety and have been used to guide the creation of this assessment:

- MCA, Marine Guidance Note (MGN) 543 (Merchant + Fishing (M+F)) Safety of Navigation: Offshore Renewable Energy Installations (OREIs) – Guidance on UK Navigational Practice, Safety and Emergency Response (MCA, 2016);
- Department for Transport (DfT) and MCA; Methodology for Assessing the Marine Navigational Safety and Emergency Response Risks of Offshore Renewable Energy Installations (OREI) (DfT / MCA, 2013);
- International Maritime Organization (IMO) Revised Guidelines for Formal Safety Assessment (FSA) for use in the IMO rule making process (IMO, 2018)
- DfT Port Marine Safety Code (DfT, 2016) ; and
- HM Government, Space Industry Act 2018.

As the competent authority for maritime safety, the MCA has been consulted in the planning and creation of this NRA. In addition, in its capacity as the General Lighthouse Authority, the Northern Light House Board has also been consulted with respect to its operations in the wider study area.

1.4.3 ALARP principle

The term 'ALARP', standing for 'as low as reasonably practicable', is defined within the Port Marine Safety Code. It is an industry wide concept applying to both health and safety and port marine safety. The core concept is that of 'reasonably practicable', which involves weighing up risk against the effort, time and money needed to control it. The PMSC specifically references ALARP in respect of Marine Safety Management Systems (MSMS) and NRAs. The ALARP principle has been applied with respect to each individual assessment, the purpose being, to consider if the identified hazard can be reduced to a point which is both 'reasonable' and practicable' to do so. ALARP has not been defined as a threshold or benchmark target.

2 Data Sources

The following section details the origin of the data used to create the baseline to inform the NRA.

2.1 Automatic identification system data

Given the distance from land, position satellite Automatic Identification System (AIS) data has been used in this study to provide a vessel traffic picture. The data has been, provided by Arkevista Ltd (a specialist spatial data provider). In total, 28 days of satellite derived AIS data has been used, representative of a busy summer period and a quiet winter period. The data was collected in two 14 day blocks, from August 2019 and January 2020 respectively.

The satellite data provides a recent picture of traffic in the area; however, the satellite data was unable to provide sufficient detail to allow the creation of reliable vessel transits lines due to gaps in the satellite reception. To fill the gaps, data has been compared to terrestrial AIS data from 2017, hosted by the Marine Management Organisation (MMO) and decoded by ABPmer to create a geodatabase of anonymised vessel transits. The data was collected by the MCA using its network of AIS receivers. The data represents a composite of 84 days of AIS data collected in 2017, sampled from the first seven days of each month. Vessel types include:

- Non-Port service craft;
- Port service craft;
- Vessels engaged in dredging or underwater operations;
- High speed craft;
- Military or law enforcement vessels;
- Passenger vessels;
- Cargo vessels;
- Tankers;
- Fishing; and
- Recreational.

Through the use of this composite dataset, recent vessel traffic has been compared with vessel traffic from 2017 to provide confidence over routeing and intensity of sea area use.

2.2 Recreational activity

Data for recreational activity in the study area has been collated using a variety of methods. Quantitative data has been derived from AIS-B records; however, it is recognised that this will not represent all recreational craft as many vessels of this type do not carry AIS transceivers as the use of AIS-B is non-mandatory. Therefore, to provide a more comprehensive set of information to define recreational use, anecdotal and website information has been compiled. This included information from the Royal Yachting Association (RYA) routeing information, race route maps and information from yachting guides.

2.3 Navigational features

Navigational features have been considered in this assessment. These features have been obtained from information contained on UK Hydrographic Office (UKHO) Admiralty Chart Number 1233.

2.4 Maritime incidents

To characterise historic maritime incidents occurring within the study area, available data has been collated from a number of sources. This included records held by the Royal National Lifeboat Institution (RNLI) call-out data and Marine Accident Investigation Branch (MAIB) records.

2.5 Environmental conditions

MetOcean conditions for the study area have been compiled using the SEASTATES dataset provided by ABPmer. The hindcast data represents historical hourly wind and wave for a 40 year period to provide a summary of wave and wind conditions prevalent in the study area.

3 Navigation Baseline

The following sections review the navigational baseline conditions for commercial shipping and recreational navigation within the study area. Where relevant, factors relating to the proposed SSC project have been drawn out. The following elements are covered in the baseline:

- Navigational environment;
- Statutory responsibilities and management procedures;
- Fishing activities;
- Oil and gas industry;
- Cruise vessels and leisure;
- Aids to navigation;
- MetOcean conditions;
- Emergency response; and
- Marine incidents.

3.1 Navigational environment

This section presents a description of the navigational features in the study area. The study area encompasses an area with a 90 km radius from the launch site in Unst. This area covers the majority of the Shetland Islands and Pobie Bank to the east and the Clair Ridge to the west. The Shetland Islands Council is the SHA for all but one of the island's ports and harbours. Principal ports in the Shetland Islands include Lerwick which is a Trust port and located on the Shetland Islands' east coast; and Sullom Voe which is an oil terminal located in the north of the islands and handles deep-sea tanker traffic. The port of Scalloway is located on the mainland of the Shetland Islands, on the west facing cost, providing for a range of cargo, fishing and recreational traffic. The remainder of the ports and harbours provide local berthing for smaller marine operations such as local fishing vessels, recreational vessels and the lifeline inter-island ferry services.

The majority of the Shetland Islands are surrounded by deep water mostly 60 to 120 m+ deep. This provides opportunities for shipping traffic to pass close to, and around the Shetland Islands. The majority of routeing for deep sea vessels passes to the south of the Shetland Islands, on passage between Norway, the Baltic and the Atlantic Ocean. A commercial cargo route between the Baltic and the Faeroe Islands runs to the north of the Shetland Islands. A navigational 'Area to be Avoided' is in place which provides for a buffer around the Shetland Islands. This area is in place due to strong tidal currents, offshore obstructions and changing sea states making navigation close to the Shetland Islands hazardous for shipping.

3.2 Statutory responsibilities and management procedures

There are two SHA's within the proposed operating area for SSC launches. These are namely the Shetland Islands Council, which is a Municipal Harbour Authority and Lerwick Port Authority which is a Trust Port. The majority of the proposed SSC Operational Area as shown in Figure 2 and Figure 3 is located outside of an established SHA and therefore the competent authority with respect to navigation is the MCA.

Vessel Traffic Services are provided in the approaches to Sullum Voe by Shetland Islands Council who run a Traffic Organisation Service (TOS) VTS and an Information Service (INS) VTS from their VTS Centre at Sella Ness. The VTS area manages vessel traffic inbound and outbound of Sullom Voe Terminal through Yell Sound.

3.3 Fishing activities

The Shetland Islands has a long history of fishing, which is an important part of the local economy and a way of life for islanders. The study area has both large and small-scale commercial fishing, with recreational fishing boats working closer inshore (see Figure 4 for a plot fishing activity records). In 2011 the Shetland Islands had 170 commercial fishing vessels with 1,000 local jobs linked to the fishing industry. The Islands caught £90 million worth of fish in 2011, which is almost one quarter of Scottish catches and one sixth of UK catches (Shetland Fisherman, 2011).

Lerwick Port Authority accounts for a large portion of the Shetland Islands fishing fleet with 2,300 fishing vessels, including a modern local fleet which land over 38,000 tonnes of pelagic fish, white fish and shellfish annually valued at over £42 million. The Shetland Shellfish Management Organisation has another 103 licensed shellfish vessels operating around the Shetland Islands (Lerwick Port Authority, 2020). Recreational fishing takes place within inshore waters around the Shetland Islands. There are a number of charter boats and privately-owned day boats, fishing for sport and recreation in order to catch mackerel, ling, haddock and bigger fish such as halibut or porbeagle sharks.

3.4 Oil and gas industry

The North Sea oil and gas fields provide a mix of hydrocarbons comprising both liquid petroleum and natural gas. The term 'North Sea' is often used to include areas to the west of the Shetland Islands, which are geographically located in the Norwegian Sea. The presence of rigs generates marine activities with rig support and supply vessels, plus tankers transporting oil and gas to and from local ports. These shore facilities in the Shetland Islands includes the deep-sea terminal at Sullom Voe and support fleet marine services located in Lerwick. There are a number of oil and gas rigs located off the coast of the Shetland Islands. To the west of the study area BP exploration run the 'Clair Ridge' rig, which opened in 2018 and is planned to be operational through to 2050. To the east of the study area, there are a number of established rigs, namely:

- 'Heather and Broom' managed by Enquest;
- The 'Western Isles Floating Production Storage and Offloading (FPSO) Dana Petroleum' managed by Hudson and Harris;
- The 'Tern' oil rig managed by Shell UK Ltd;
- The 'Cheviot' rig managed by Midland and Scottish Energy Ltd; and
- The 'Edradour' managed by Total.

Sullom Voe oil terminal is situated at Calback Ness on the shores of Sullom Voe. 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 1 Gas carrier visit the port (SIC, 2017). The UK Government estimates that as much as 17% of the UK's undiscovered gas reserves are located West of the Shetland Islands. The Shetland Gas Plant located in Sullom Voe Terminal will be used to process the gas reserves and help bring that gas to the country's grid (SIC, 2017).

3.5 Cruise vessels and leisure

Leisure tourism is important to the local economy with 51% of all visitors arriving for leisure, culture and sightseeing (SIC, 2017). Activities include wildlife tourism, boat tours and cultural visits to historic sites. The Shetland Islands are also a popular location for cruise vessel calls, which see around 105 visiting ships with 90,000 passengers each season. Lerwick town is one of the busiest stop-over cruise locations in Scotland (SIC, 2017). Recreational sailing is also another important activity for the

Shetland Islands. See Figure 5 for recreational activity location. There are marina facilities located in the ports of Lerwick and Scalloway. The exposed and interesting shoreline of the islands, with the many inlets and anchorages makes this an attractive sail cruising destination. The activity focuses around the summer periods, with most routeing connecting Lerwick to the Scottish mainland. Vessels then typically sail around and through the islands (Shetland.org, 2020).

3.6 Aids to navigation

A range of Aids to Navigation are used within the study area. These include the lighthouses on Unst, namely: 'Muckle Flugga', 'Holm of Skaw' and 'Balta Sound' (see Figure 1). There is no buoyage north of the Shetland Islands as the seabed shelves quickly providing deep water. Aids to Navigation are typically located relatively close to land or between the islands.

3.7 MetOcean conditions

This section details the wind and wave characteristics of the study area.

3.7.1 Waves

Image 1 shows a wave rose diagram for a point north of Unst. This provides an indication of wave activity in the area of the SSC proposed project. It can be seen from the image that the waves experienced are predominantly from the west and the north, with the most frequent wave height being 1.5 m to 2.25 m. The highest frequency of larger waves (greater than 6.0 m) comes from the west.

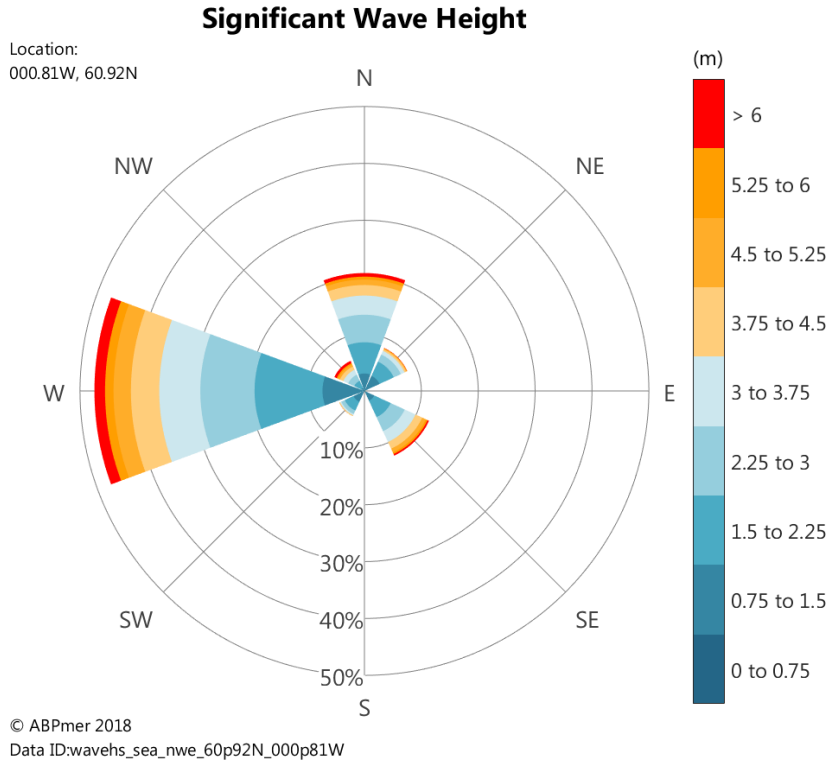

Image 1. Wave rose for North of Unst

3.7.2 Wind conditions

Image 2 shows a wind rose diagram for a location North of Unst. This provides an indication of wind conditions for the area.

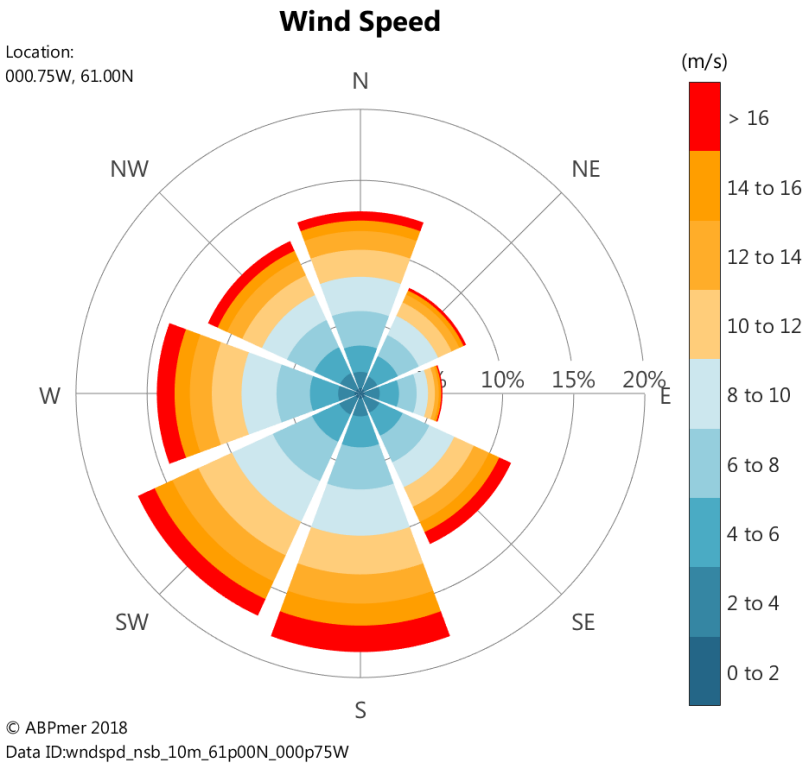

Image 2. Wind rose for North of Unst

Image 2 identifies that the wind is predominantly from the south through to west. The strongest winds of greater than 16 m/s (Beaufort wind force 7) are also predominantly from the south through to west.

3.8 Emergency response

A range of emergency response is available within the study area. The following organisations provide resources to provide assistance in the instance that a marine emergency occurs.

3.8.1 HM Coastguard

The MCA is responsible for the initiation and coordination of all civilian maritime search and rescue operations within the UK Maritime Search and Rescue 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. HM Coastguard has access to a range of resources including aircraft and coastal search teams. The study area falls within the jurisdiction of the Shetland Coastguard Operations Centre (CGOC) located in Lerwick.

3.8.2 Local rescue organisations

There are a number of lifeboat stations in the vicinity of the study area with the closest assets located at Aith and Lerwick; these are shown on Figure 1. The following provides a brief overview:

- **Aith Lifeboat Station** is manned by a voluntary crew providing a 24-hour service and the station operates an all-weather Severn Class lifeboat.
- **Lerwick Lifeboat Station** is manned by a voluntary crew operating providing a 24-hour service with an all-weather Severn Class lifeboat.
- **Sumburgh** is base to the HM coastguard Search And Rescue (SAR) helicopter operating 24/7

3.9 Marine incidents

This section reviews marine incidents that have occurred within the study area over the past 10 years (subject to the availability of data). The analysis is intended to provide a general indication as to whether the study area is in an area of low or high risk in terms of marine incidents. Data from the MAIB and the RNLI has been obtained, covering the following timescale:

- MAIB: information includes accidents to ships and personnel reports to the MAIB within the period of 2008 to 2017 inclusive.
- RNLI: complete dataset of all callouts from 2008 to 2017 inclusive.

Where possible, duplication of data has been removed (as the same incident may have been recorded by both organisations). The complete combined dataset has been presented spatially in Figure 6. Due to the size and complexity of the data record, the tabulated information has been included in Appendix A. Table 1 provides a compiled view of marine incidents within the study area and marine works area addressed by this document.

Table 1. Marine incident summary for the study area (2008 to 2017)

Incident Category	Year											Annual Frequency
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total	
Aircraft crashed	0	0	0	0	2	3	0	0	0	0	5	0.5
Capsize/Sinking	0	1	0	1	0	0	0	0	0	0	2	0.2
Collision	0	0	0	0	0	0	5	0	0	0	5	0.5
Impact with structure	0	0	0	0	0	1	0	0	0	0	1	0.1
Equipment failure (vessel)	5	7	14	11	6	10	8	13	8	1	83	8.3
Fire / Explosion	0	0	2	0	2	0	0	0	2	0	6	0.6
Grounding/Stranding	2	1	3	3	4	2	5	3	1	0	24	2.4
Leaks/Swamping	2	2	1	2	4	3	5	0	3	0	22	2.2
Person(s) in the water	2	1	1	5	1	0	0	1	2	0	13	1.3
Other nautical safety	1	3	0	0	0	0	0	0	0	16	20	2
Person in distress	3	4	5	2	0	4	5	3	4	0	30	3
Total	**15**	**19**	**26**	**24**	**19**	**23**	**28**	**20**	**20**	**17**	**211**	**21.1**

Table 1 shows that there are, on average, 21.1 incidents per year, with the most common incident type being equipment failure (vessel) with 83 reported incidents over the 10-year period with the majority of these incidents involving fishing vessels. The next most common incident type is that of Person in Distress with 30 occurrences in the period.

The 10-year dataset shows that there was one reported incident within the proposed Sounding Rocket Launch Safety Zone. This incident involved a commercial fishing vessel where there was a man overboard reported and the RNLI responded to the scene. It must be noted that a man overboard incident is not geographically specific and could occur anywhere within the study area.

The more serious marine incidents of collisions, groundings and capsize/sinking occur within the proposed Operating Area. There are a number of reported incidents of this category within the study area. These incidents can be seen in greater concentration around the port of Lerwick which are generally in close proximity to the coastline. The locations of these recorded incidents can be seen in in Figure 6. The Figure shows the majority incidents concentration of incidents in the South West of the study area. This is likely due to the frequency and relative density of traffic around the port of Lerwick.

4 Marine Traffic Analysis

This section analyses the vessel traffic routeing through the study area, with AIS data presented on a sequence of Figures with a navigational chart background. A summary of vessel activity is shown as density grids within Figure 7 and Figure 8.

The density Figures were created using a hexagonal grid overlaid on the area. Each hexagonal has a side length of *circa* 620 m providing a 1,000 km^2 grid. The satellite AIS data for the study area was used to indicate vessel positions over the observation period. Each vessel position was plotted as an individual point within each hexagon, which was then aggregated to show the point-density. A colour scale was applied to indicate the number of positions within each hexagon. This is illustrated in Image 3 with the purple points showing vessel positions and the hexagons coloured a deeper shade where more points fall in their perimeter. When considering Figure 7 and Figure 8 it is important to note that each hexagon cell does not represent the size of vessel associated with the positional data.

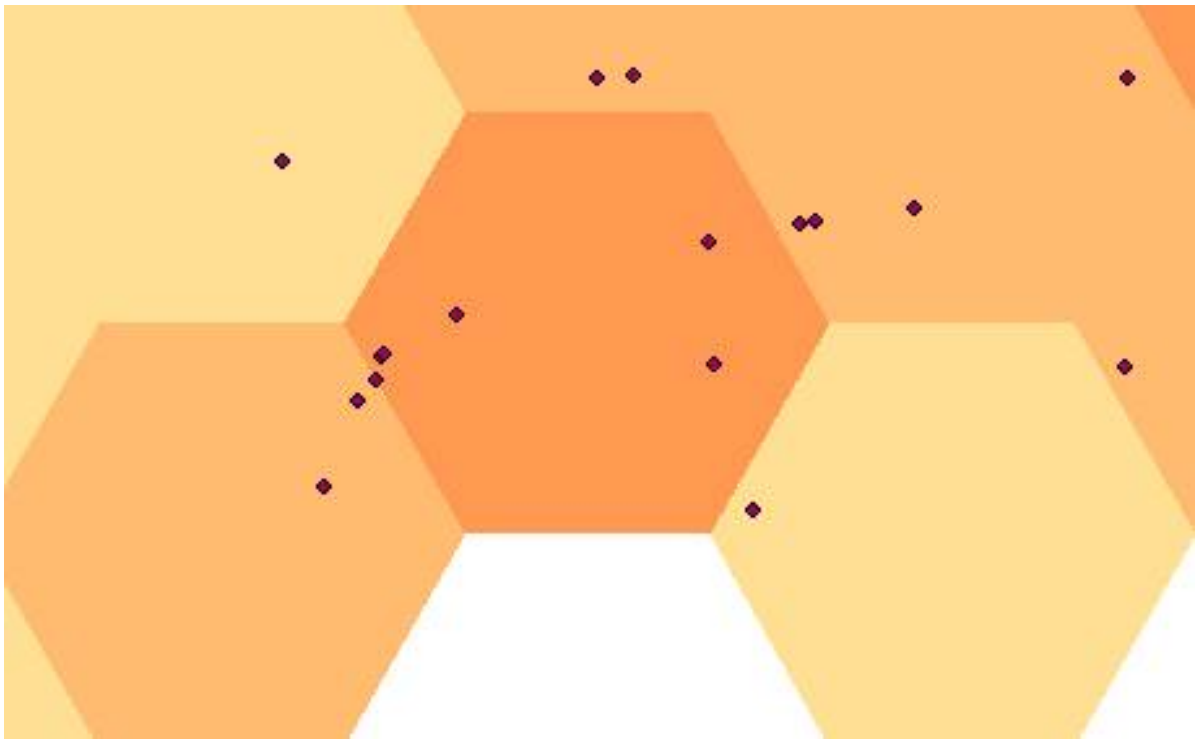

Image 3. Density grid method

Commercial vessel data is presented in Figure 9 to Figure 18 with recreational vessel information presented in Figure 5 and Figure 19.

4.1 Vessel traffic interaction with Operational Areas

Satellite AIS data, representative of two weeks in August 2019 and two weeks in January 2020 has been used for static positions. AIS data collected in 2017, representative of 84 days (sampled from the first seven days of each month) has been used to create transit lines shown in Figure 9 through to Figure 19.

This data identifies vessel routes from south-east to north-west, across the north of island of Unst. These vessels are mainly cargo and tanker vessels, with some passenger vessels. Fishing vessels are also seen in high quantities all around the Shetland Islands with a greater density to the west of the Shetland Islands.

4.1.1 Vessel traffic intersect with balloon Operational Area

Table 2 provides a count of the received vessel positions from the satellite data in the 80 km maximum balloon drop area for the two weeks period in August 2019 and January 2020 collection periods to represent the vessel activity in the summer compared to the winter.

Table 2. Seasonal difference in received vessel positions by ship type group within the maximum balloon drop area

Vessel Category	August 2019	January 2020	Difference ±
Non-port service	5,522	1,200	-4,322
Port service	2,790	1,748	-1,042
Dredging/underwater	152	0	-152
High speed craft	7	0	-7
Military/law	194	0	-194
Passenger	1,304	2,270	966
Cargo	4,110	3,272	-838
Tanker	1,876	1,413	-463
Fishing	10,958	9,479	-1,479
Recreational	729	177	-552
Unknown	3,298	2,433	-865
Grand Total	**30,940**	**21,992**	**-8,948**

* Vessel type 'unknown' is an AIS record which is not correctly transmitting its vessel type at the time of data collection and cannot therefore be assigned a vessel type. It is included in the dataset to ensure full representation of known vessel activity.

Data Source: Data is representative of two weeks of Satellite data of AIS-A and AIS-B data taken. See Section 2 for more information.

From Table 2 it can be seen that there is considerably less activity within the winter period with 8,948 less points recorded in January 2020, compared to August 2019. The only vessel type which saw increased vessel movements in January 2020 was passenger vessels which were transiting to and from the port of Lerwick.

Table 3 provides a count of the vessel transits in the Operational Area matching the 'maximum balloon drop area' for the 84 day collection period, an uplifted figure to represent the full year and a percentage of each vessel type.

Table 3. Vessel transits by ship type group in the maximum balloon drop area

Vessel Category	Transit Line Count (84 days)	Uplifted (Yearly) Transit Count	Transit Count Percentage
Non-port service	106	461	2.9
Port service	118	513	3.2
Dredging / underwater	23	100	0.6
High speed craft	1	4	0.0
Military/law	9	39	0.2
Passenger	234	1,017	6.3

Vessel Category	Transit Line Count (84 days)	Uplifted (Yearly) Transit Count	Transit Count Percentage
Cargo	849	3,689	22.9
Tanker	185	804	5.0
Fishing	1,634	7,100	44.1
Recreational	104	452	2.8
Unknown	442	1,921	11.9
Grand Total	**3,705**	**16,099**	**100**

* Vessel type 'unknown' is an AIS record which is not correctly transmitting its vessel type at the time of data collection, and cannot therefore be assigned a vessel type. It is included in the dataset to ensure full representation of known vessel activity.

Data Source: Data is representative of 84 days of AIS-A and AIS-B data taken from the first 7 days of each month of the year. See Section 2 for more information.

From Table 3 it can be seen that the most frequent vessel type in the study area is fishing vessels (44.1%) followed by Cargo vessels (22.9%). A large majority of the Unknown vessels in Figure 9 are speculated to be vessels involved with oil rig operations and therefore would be classed as non-port service craft, these vessels can be seen transiting to and from oil rigs around the Shetland Islands.

4.1.2 Vessel traffic intersect with Rocket Launch Safety Zone

The vessel transits intersecting the proposed rocket safety zone can be seen in Figure 9 to Figure 19. It can be seen that all vessel types with the exception of high speed vessels have transited this area within the observation period. Cargo and passenger vessels both cross the proposed precautionary area in a south east to north west direction, tanker vessels cross the precautionary are in a west to east direction and fishing vessels can be seen fishing in all directions. Table 2 provides a count of the static vessel points from the satellite data in the rocket safety zone (as shown in Figure 3) for the two week period in August 2019 and the two week period in January 2020.

Table 4. Seasonal difference in vessel positions by ship type group in the Rocket Launch Safety Zone

Vessel Category	August 2019	January 2020	Difference
Non-port service	12	1	-11
Port service	0	4	4
Dredging/underwater	0	0	0
High speed craft	0	0	0
Military/law	0	0	0
Passenger	1	9	8
Cargo	20	43	23
Tanker	0	40	40
Fishing	316	562	-246
Recreational	0	0	0
Unknown	106	13	93
Unknown	106	13	93
Grand Total	**455**	**672**	-217

* Vessel type 'unknown' is an AIS record which is not correctly transmitting its vessel type at the time of data collection and cannot therefore be assigned a vessel type. It is included in the dataset to ensure full representation of known vessel activity.

Data Source: Data is representative of two weeks of Satellite data of AIS-A and AIS-B data taken. See Section 2 for more information.

Table 5 provides a count of the vessel transits in the rocket safety zone for the 84 day collection period, an uplifted figure to represent the full year and a percentage of each vessel type.

Table 5. Vessel transits by ship type group in the proposed rocket safety zone

Vessel Category	Transit Line Count (84 days)	Uplifted (Yearly) Transit Count	Transit Count Percentage
Non-port service	59	256	1.7
Port service	83	361	2.3
Dredging/underwater	298	1,295	8.4
High speed craft	0	0	0.0
Military/law	6	26	0.2
Passenger	82	356	2.3
Cargo	789	3,428	22.2
Tanker	202	878	5.7
Fishing	1,690	7,343	47.6
Recreational	18	78	0.5
Unknown	324	1,408	9.1
Grand Total	**3,551**	**15,430**	**100**

* Vessel type 'unknown' is an AIS record which is not correctly transmitting its vessel type at the time of data collection, and cannot therefore be assigned a vessel type. It is included in the dataset to ensure full representation of known vessel activity.

Data Source: Data is representative of 84 days of AIS-A and AIS-B data taken from the first 7 days of each month of the year. See Section 2 for more information.

It can be seen from Table 5 that there were 3,551 vessel transits through the proposed precautionary area during the 84-day period of the AIS data record. A large proportion of vessels transiting through the proposed area are fishing vessels (48%). The second highest proportion of vessels transiting through the Operational Area are cargo vessels (22%). These vessels are navigating just south of the boundary of the proposed area. The majority of the cargo vessels are navigating through the southern half of the rocket safety zone and the fishing vessels are shown in greater concentration along the coast, but are still substantially present in the rest of the area.

4.2 Oil and gas installation vessel transits

There are a substantial number of vessel transits to, and from offshore infrastructure and areas likely to be associated with the oil and gas industry. These vessels are expected to be platform supply vessels, survey vessels, patrol vessels and tankers which are seen transiting from Sullom Voe and Lerwick. Transits of these vessels can also be seen on Figure 9 and Figure 10 which represent 'unknown' vessel types and Non-port service vessels respectively. It is noted that a number of the unknown vessels are to be involved in these operations as they are seen transiting to and from platform locations. These vessel transits through the rocket safety zone and 383 unknown and non-port service vessels have been observed passing through the area in 2017 (see Table 5). These vessels are seen in much greater density outside of the rocket safety zone.

4.3 Commercial and military vessel activity

The following text provides a description of commercial vessel routeing. Port service craft are shown on Figure 11, the transits of these craft focus around ports such as Lerwick, Sullom Voe and Scalloway. They are mainly tugs, pilot boat and vessel associated with moving port ancillary services.

Figure 12 identifies 'dredging or underwater operations', the activity of this vessel type is focussed between the network of islands, with a notable concentration around the north and west shores of Unst. High Speed craft activity is shown on Figure 13 close to Lerwick. With the exception of these four recorded position reports close to Lerwick, the data suggests this type of vessel does not routinely operate within the study area. Military or government owned vessels (for example, police) are seen to operate around Lerwick, with routes suggesting movement out to the east oil and gas fields. This is show on Figure 14. Passenger vessel activity is shown on Figure 15. A route from the Baltic to the Faeroe Islands passes close to the north of Unst, this is likely to be a Seatruck Ferry Route for commercial cargo. This route passes through the Operational Area. Further ferry activity can be seen between the islands making up the Shetland Islands archipelago, with an intensity of transits around Lerwick. Cargo vessel traffic is shown in Figure 16. This identifies a regular cargo route, from the Baltic and Norway, passing the north coast of Unst, then angling towards the Faeroe Islands. A second, but less well-defined route runs in a north-east, south-west directly between the Clair Oil Field and the west coast of the Shetland Islands. Both of these routes intersect the Operational Area. Figure 17 shows tanker traffic. A distinct pattern can be observed, where tankers remain outside of the navigational 'Area to be Avoided' before making entry to either Sullom Voe or continuing their journey around the Shetland Islands.

4.4 Fishing vessel activity

All UK commercial fishing vessels 12 m or more in overall length must have a UK government-approved satellite-tracking device. The device allows a vessel to be automatically located and identified (MMO, 2014). Figure 4 shows this Vessel Monitoring System (VMS) information obtained from the MMO. The information shows that there are fish landings throughout the entire study area with the highest value of fish landings from the east of the Shetland Island.

Fishing vessel transits in the study area, derived from AIS, is provided on Figure 18. It can be seen that the majority of fishing vessel activity presented by the AIS points occur to the east of the Shetland Islands and with greater density in close proximity to the coast. There is, however, substantial fishing vessel tracks all around the Shetland Islands and to the north-west which is not shown as frequently in the satellite point data.

The information presented in Figure 18 is not representative of smaller fishing vessels under 12 m in length as they are unlikely to use either AIS or VMS. It is noted however that smaller vessels are likely to navigate closer to shore to remain sheltered from weather conditions and interactions with larger vessels.

4.5 Recreational vessel activity

Figure 19 identifies recreational vessel transit information from 2017, along with vessel positions from satellite information. The transit lines show that the majority of vessels transit from the Port of Lerwick with some activity on the South of Unst and some transits can be seen passing through Yell Sound toward the Faroe Islands. It must be noted that only '25% of recreational vessels in Shetland waters transmit an AIS signal (RYA, 2020). Figure 5 presents information from the RYA Coastal Atlas of Recreational Boating (RYA, 2016). The data shows a density grid of recreational movements obtained through AIS to indicate areas of recreational use. Figure 5 shows an increased level of recreational use through the balloon Operational Area from the port of Lerwick outwards in all directions. A few recreational vessels can be seen traveling through the proposed rocket safety zone.

5 Shetland Space Centre Operation

5.1 Concept

SSC is planning to launch stratospheric weather balloons and single stage sounding rockets with the purpose of collecting data which will be used to produce the base line that is vital for the next stages of launch companies development plan. The launch involves multiple steps, including weather predicting, launch preparation, monitoring and payload recovery. The following report section considers each stage of these launch operations.

5.2 Pre-launch preparation

Prior to every launch the weather is monitored to ensure the conditions are appropriate for the operation. The weather predictions and balloon/rocket flight paths are calculated seven days prior to the launch and every day up to the launch to map any variation in metrological conditions.

For the balloon launches the correct helium quantities are calculated to determine the required altitude and ascent rate of the balloon. The operation will only go ahead if the desired balloon trajectory is met and that the flight predictions identify that the balloon will float in a NE to SE direction, as flight paths to the SW towards Sullom Voe and Shetlands commercial air space in the south should be avoided. Balloon launch activity will only be conducted if the prediction models show the landing locations are within the operational area.

Prior to launches to ensure vessels and marine users in the area are notified, a Notice to Mariners will be published, NAVTEX warnings and Sécurité messages will be broadcast. The Sécurité message will be broadcasted over Very High Frequency (VHF) radio to warn maritime users. In addition, monitoring of AIS and Radar is carried out from land to ensure navigational safety in the area of operation. A rocket launch will not exceed 45 minutes in length.

5.3 Equipment

5.3.1 Stratospheric weather balloon

For most balloon launches, a stratospheric weather balloon of *circa* 1500 grams will be used. This balloon when inflated is 7 m in diameter and increases in size to 20 m as the balloon reaches higher altitudes (see Image 4).

The balloon can be filled with either hydrogen or helium as determined by the prediction software to meet a specific flight pattern and altitude.

Image 4. Weather balloon

5.3.2 Single stage sounding rocket

Image 5 shows an example of a single stage sounding rocket to be used by SSC. The rocket consists of a main body (fuselage), which contains a solid fuel which is completely burnt up during launch. The nose cone contains the scientific equipment and a parachute in order to return the rocket to sea level in a controlled manner.

Image 5. Single stage sounding rocket

The rocket travels up to speeds of Mach one. On decent, the rocket deploys a parachute roughly 1 km above the earth's surface in order to return safely and be collected by a surface vessel. This will allow the rocket to be used multiple times. SSC plan to use sounding rockets up to 7.5 m in height with an initial weight of 230 kg, noting that the majority of this weight will be in solid rocket fuel which is burnt in the first 5 minutes of the launch.

5.3.3 Payload

The weather balloon payload is shown in Image 6. The Payload holds the scientific equipment during the launch and records the data required for future launches. The payload itself must meet a specific specification in order to be observed by mariners and aircraft. The payload is of a specific colour with reflective stripes and an identification light (flashing Yellow) in order to be visible to mariner operating in proximity to the launch. The payload is made from Styrofoam in order to protect the scientific equipment inside, the equipment consists of cameras, a particle collector, Global Positioning System (GPS), stratospheric sampling equipment and a frequency tracker as a secondary location device if the GPS fails.

Image 6. Balloon payload

The payload in the rocket is located in the nose cone and will be returned to sea level by parachute along with the entire rocket, the rocket payload is also tracked via satellite GPS and frequency tracker.

5.4 Monitoring

To monitor the Operational Area, SSC will be making use of AIS to track and monitor vessel traffic. This will identify if there are any vessels in close proximity of the balloon drop zone or the rocket safety zone. AIS receivers will be used by the patrol vessel to ensure vessel approaching the drop zones are detected. During rocket launches SSC will also make use of a radar station to monitor the sounding rocket safety zone. The launches will also be monitored by a patrol vessel which can notify vessels transiting in the area of a launch. Both operations will also be monitored visually with the use of spotters with binoculars from the base station and recovery/patrol vessel to confirm that the predicted trajectories are followed. The Sécurité notices will be broadcasted over VHF until the operations have been completed.

5.5 Launch and recovery

As the balloon is being launched, the vessel recovery team will proceed to the predicted touchdown location to ensure quick recovery of the payload. SSC intend to subcontract the recovery of the payload to local maritime companies who can provide appropriate recovery vessels and crew to ensure safe collection of the payload.

As the balloon follows its predicted flight path the recovery team will be notified of any variation in the touchdown location. When the balloon reaches the desired altitude and shreds, it will begin to descend via parachute where the recovery team will be on location to allow for a quick recovery of both the payload and remnants of the balloon. The payload will be identifiable by high-visual yellow

paint and will carry a yellow flashing light to comply with IALA guidelines and notify any marine users of an object in the water. The recovery team will track the payloads via GPS in order to locate them quickly. If the GPS were to fail or be inoperative due to the orientation of the payload, there is a secondary location device which is a frequency tracker. The recovery vessel will carry a frequency tracker enabling them to pinpoint the payload even if the payload is upside down and not transmitting GPS.

5.5.1 Vessel specification

For the recovery of the payload, balloon and sounding rocket a recovery/patrol vessel will be used. The vessel commissioned for this task meets specific standards to ensure that it is capable of operating in the conditions off the coast of the Shetland Islands and must carry AIS. The crew are also required to be certificated and appropriately trained in order to reduce any unnecessary risk. SSC will contract a vessel of appropriate specification prior to any launches.

To ensure an appropriate vessel and manning is utilised for the patrol/recovery vessel a minimum requirement must be met. SSC will ensure that vessels will meet the minimum requirement for vessels operating in a category 2 area; as defined by the 'Code of Practice for the safety of small commercial motor vessels' (MCA, 1999).

6 Hazard Consultation

This section identifies consultation with local stakeholders and the wider marine community

6.1 Maritime and Coastguard Agency

A conference call with the MCA in their role as Regulator was held on 24 March 2020, which was attended by the MCA, SSC and ABPmer. The aim of this meeting was to present the proposed SSC operations and to discuss the required supporting evidence. Table 6 lists the attendees at the meeting.

Table 6. MCA Teams meeting attendees

Attendee	Organisation
Jacques Meheut	SSC
Helen Croxson	MCA
Nick Salter	MCA
Thomas Bulpit	MCA
Adam Fitzpatrick	ABPmer
Harry Aitchison	ABPmer

The scheme outline was described to the attendees, the MCA provided technical comments on the scale and scope of the NRA and consultations to be considered. The full meeting minutes are available in Appendix C .

6.2 Stakeholder consultation

The aim of the stakeholder consultation was to gather local marine user thoughts and concerns relating to the proposed SSC operations. In so doing, it is expected that impacts on local marine users can be removed or mitigated. The organisations which were contacted during the consultation are detailed below:

- Shetland Islands Council;
- Sullom Voe VTS;
- Sullom Voe Terminal;
- The MCA;
- Lerwick Port Authority;
- Shetland Shellfish Management Organisation;
- Shetland Fishermen Association;
- National Fisherman Federation;
- Local sailing clubs (Lerwick boating club);
- RNLI;
- RYA;
- Oil and Gas Association;
- Oil and Gas UK;
- Cruising Association;
- Chamber of Shipping;
- North Link Ferries;
- UKHO; and
- The Northern Lighthouse Board.

The aim of the consultations was to identify navigational safety concerns related to SSC's operations. In addition, consultees provided anecdotal information regarding marine use of the study area, which enhanced the level of detail collected through the navigation baseline activities. The output from the consultations has been documented and is presented in Appendix B. Views and comments of consultees have been considered and incorporated into the NRA where possible. Appendix B provides cross references to relevant NRA document sections.

7 Navigational Risk Assessment

This NRA has been carried out to determine the navigational risks, associated with the proposed SSC operations (launch and recovery of weather balloons and single stage sounding rockets). To assess navigational risk, the specifics of the operation have been assessed in relation to the impacts during the recovery phases of both operations. This requires the recovery vessel to transit from its home port for a maximum distance of 80 km. From this point, the recovery of the weather balloon and payload, or sounding rocket and parachute will be carried out. The vessel then completes a return transit.

A potential hazard is the temporary floating obstruction of the balloon or sounding rocket on the water surface and potential entanglement in the parachute strapping or contact with a vessel or marine structure immediate before touch-down. The process for carrying out an NRA follows the methodology from the DfT/MCA (2013); Methodology for Assessing the Marine Navigational Safety and Emergency Response Risks of Offshore Renewable Energy Installations (OREI); plus, the process identified in the PMSC 'Guide to Good Practice' (DfT/MCA, 2018). The following outlines the steps to carrying out an NRA:

1. Identification of hazard definitions;
2. Listing of potential hazard scenarios (i.e. descriptions of hazard and outcome);
3. Identification of causes that may lead to one of the described hazard scenarios (i.e. an accident or incident outcome);
4. Consideration of existing (embedded) mitigation measures, which either control or address the outcome of an accident or incident; and
5. Additional (future) risk controls, which are not currently in place, but could be used to further reduce or eliminate risk.

The following sections identify the outcomes from the above steps, carried out within this NRA.

7.1 Hazard definitions

The first step in the NRA process is the consideration of potential hazards resulting from the proposed scheme. Table 7 provides hazard category definitions, taken from the DfT and MCA; 'Methodology for Assessing the Marine Navigational Safety and Emergency Response Risks of Offshore Renewable Energy Installations' (DfT/MCA, 2013). Eight of these hazard categories have been scoped out of this NRA; these are shown in Table 8, along with the reason. The rationale considers the methodology for the proposed SSC operations and the potential outcomes, in terms of navigational hazards.

Table 7. Hazard category definitions

Category	Description
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 vessel and a fixed structure.
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.

Category	Description
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 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.

Table 8. Hazards categories scoped out

Scoped Out: Hazard Category	Rationale
Allision	It is not considered likely that impact forces between the balloon, rocket or recovery vessel would be great enough to result in an Allision.
Foundering	Given the type of vessels involved in the recovery operation, any small craft that grounds will be refloated as soon as practical, on the next or subsequent tide. All vessels involved in the scheme will be capable of taking-the-bottom.
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. In terms of a navigational risk assessment, the recovery vessel will not affect shore-side safety. This assessment (an NRA) does not cover risks associated with the general public ashore resulting from SSC 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 SSC's operations as the rocket/balloon and payload are not of significant size and will have very little affect on a vessel's stability.

7.2 Hazard scenarios

From the hazard categories scoped into the NRA (Table 7), the study team at ABPmer has identified the following specific hazard scenarios (listed in Table 9), which relate to the Balloon recovery operation. In total, 9 hazard scenarios are identified for the NRA.

Table 9. Hazard scenarios

Assessment Number	Hazard Category	Hazard Scenario Title
1	Machinery related accidents	Balloon or parachute from the sounding rocket lands in water and becomes entangled in small craft's propeller(s) or steering gear (rudder)
2	Machinery related accidents	Balloon, or parachute from the sounding rocket and payload land on marine infrastructure, such as an oil rig
3	Other	Balloon, or parachute from the sounding rocket and payload land on a vessel berthed at Sullom Voe oil terminal
4	Accidents to personnel	Man Overboard when collecting balloon, sounding rocket or payload from the sea surface
5	Loss of hull integrity / Flooding	Adverse weather disrupting patrol vessel operations.
6	Other nautical safety	Parachute does not deploy and sounding rocket or balloon strikes vessel
7	Collision	Patrol vessel collides with other traffic
8	Other nautical safety	Sounding rocket or balloon debris get caught in fisherman's nets
9	Other nautical safety	Spectator vessels: sightseeing, day boats and other recreational craft

The hazard scenarios identified in Table 9 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. The full working and outcome description of each scenario, presented as a full NRA, is provided in table format in Appendix D.

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, the environment and port business. This approach follows the best practice guidance from the PMSC 'Guide to Good Practice' (DfT/MCA, 2018). 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.

7.3 Hazard scenario causes

Each hazard scenario was considered to determine the possible causes both individually, or in combination. Table 10 give a frequency (count of) of the causes identified during the hazard scenario process for the launch and recovery phase.

Table 10. Cause frequency

Cause	Frequency
Human error/fatigue - commercial vessel	5
Adverse weather conditions	5
Human error/fatigue - recreational vessel	4
Weather & hydro failure - equipment	3
Inadequate bridge resource management	3
Unplanned interaction with recreational/fishing craft	3
Inadequate training/competence - Others	3
Human error/fatigue - shore staff	2
Equipment failure - steering/propulsion	2
Communication failure - operational/procedural	2
Restricted visibility	2
Inadequate procedures shoreside	2
Notice to Mariners failure to observe	2
Competence	2
Inadequate procedures in place onboard vessel	2
COLREGS failure to comply	2
Human error/fatigue - marine personnel	1
Communication failure - equipment	1
Failure of payload Navigation light (Unlit)	1
Failure to comply with safe systems of work	1
Radar coverage inadequate	1
Risk Assessment, Incomplete/not reviewed	1
Inadequate maintenance/inspection	1
Unexpected change in schedule	1
Vessel breakdown or malfunction	1

The top selected causes for the operation are 'Human error/fatigue - commercial vessel' and 'Adverse weather conditions' are joint first with a frequency of five. 'Human error/fatigue - recreational vessel' is the 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.

7.4 Embedded risk controls

Each hazard scenario has been considered in light of embedded risk controls. It should be noted that embedded risk controls, in the context of marine safety, relate to process, practices and available safety resources that are currently in existence and items identified as part of the proposed operations. These might include for example, international regulations (such as the International Regulations for Preventing Collisions at Sea (COLREGS)), or search and rescue provision (such as the UK Coastguard service or RNLI). In addition, any controls planned as part of the scheme have been considered as embedded within the project design. Table 11 presents the embedded risk controls with a frequency count of the number of assessments to which they apply.

Table 11. Embedded risk controls

Control	Frequency
Emergency services equipment - third party	5
Standards of Training, Certification and Watchkeeping for Seafarers (STCW)	3
SOLAS	2
International COLREGS 1972 (as amended)	2
Vessel maintenance	2
Patrol/ Recovery vessel	1
Lights and reflective tape on payload	1
Vessel safety management system (ISM code)	1
Safe Access	1
Emergency equipment available	1
Passage planning	1

7.5 Risk evaluation: embedded

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

Table 12 show the hazard scenarios ranked by current risk after embedded risk controls have been considered. The risk scores associated with each of the nine hazard scenarios has been set on a scale of No Risk to Very High Risk. The classification of each score is given in Table 13.

Table 12. Ranked hazard scenarios for the operational phase

No.	Hazard Category	Hazard Scenario	Baseline Risk	Current Risk
7	Collision	Patrol vessel collides with other traffic	Sig	Sig
1	Machinery related accidents	Balloon or parachute from the sounding rocket lands in water and becomes entangled in small craft's propeller(s) or steering gear (rudder)	Mod	Mod
4	Accidents to personnel	Man Overboard when collecting balloon, sounding rocket or payload from the sea surface	Mod	Mod
5	Loss of hull integrity /Flooding	Adverse weather disrupting patrol vessel operations.	Mod	Mod
6	Other nautical safety	Parachute does not deploy and sounding rocket or balloon strikes vessel	Mod	Mod
9	Other nautical safety	Spectator vessels: sightseeing, day boats and other recreational craft	Mod	Mod
2	Machinery related accidents	Balloon, or parachute from the sounding rocket and Payload land on marine infrastructure, such as an oil rig	Low	Low
3	Other	Balloon, or parachute from the sounding rocket and payload land on a vessel berthed at in Sullom Voe oil terminal	Low	Low
8	Other nautical safety	Sounding rocket or balloon debris get caught in fisherman's nets	Low	Low

Table 13. Risk score rating

Classification	Outcome
Very High Risk	VHi
High Risk	Hig
Significant Risk	Sig
Moderate Risk	Mod
Low Risk	Low
Negligible Risk	Neg
No Risk	Non

7.6 Additional (future) risk controls

Additional controls have been identified to ensure that risk levels are reduced to a level which is considered to be ALARP (see Section 0 for a description of ALARP). These additional controls are safety recommendations which were then assigned a likelihood and consequence reduction to allow the calculation of a Future risk score.

The identified measures, if fully adopted, should be incorporated into SSC's operational plans for the recovery of the balloons, rockets and payload.

Table 14 details the additional controls which were identified as recommendations for potential mitigation for the recovery operation along with the frequency in which they were applied to the hazard scenarios.

Table 14. Additional controls for the operation

Control	Frequency
Operation zones	5
Notices to mariners	5
Predicted balloon/rocket runs	4
Local Notice to Mariners	4
Weather forecasting	3
Emergency Response Plan	3
Nav Warnings	3
Patrol/ Recovery vessel	2
Operational planning	2
Training of operations personnel	2
Lights and reflective tape on payload	2
Precautionary area	2
Vessel inspection/survey	2
VHF Sécurité Messages	2
Lights and reflective tape on payload	1
Visual confirmation (clear line of sight)	1
Contractor risk assessment method statement (RAMS)	1
Promulgation of information	1
Standard Operating Procedure	1

7.7 Risk evaluation: future

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 consequence reduction from each proposed risk control. Table 15 present the future risk level for the hazard scenarios after the additional controls have been applied.

Table 15. Future risk for the construction phase

No	Hazard Category	Hazard Scenario	Baseline Risk	Current Risk	Future Risk
7	Collision	Patrol vessel collides with other traffic	Sig	Sig	Mod
5	Loss of hull integrity /Flooding	Adverse weather disrupting patrol vessel operations.	Mod	Mod	Mod
9	Other nautical safety	Spectator vessels: sightseeing, day boats and other recreational craft	Mod	Mod	Mod
1	Machinery related accidents	Balloon or parachute from the sounding rocket lands in water and becomes entangled in small craft's propeller(s) or steering gear (rudder)	Mod	Mod	Low
4	Accidents to personnel	Man Overboard when collecting balloon, sounding rocket or payload from the sea surface	Mod	Mod	Low
6	Other nautical safety	Parachute does not deploy and sounding rocket or balloon strikes vessel	Mod	Mod	Low
2	Machinery related accidents	Balloon, or parachute from the sounding rocket and Payload land on marine infrastructure, such as an oil rig	Low	Low	Low
3	Other	Balloon, or parachute from the sounding rocket and payload land on a vessel berthed at in Sullom Voe oil terminal	Low	Low	Low
8	Other nautical safety	Sounding rocket or balloon debris get caught in fisherman's nets	Low	Low	Low

8 NRA Discussion

This section expands upon the assessments and comments on future risk controls, as part of the operation. Section 8.1 provides a commentary on the operations hazard scenarios.

8.1 Hazard Scenarios

The assessments which have a current risk score of 'moderate' or higher have been taken forward into this section for further consideration. These hazard scenarios are listed in Table 16 and discussed in each of the subsequent numbered sections.

Table 16. NRAs brought forward into the impact assessment

No.	Hazard Category	Hazard Scenario	Current Risk	Future Risk
1	Machinery related accidents	Balloon or parachute from the sounding rocket lands in water and becomes entangled in small craft's propeller(s) or steering gear (rudder)	Mod	Low
4	Accidents to personnel	Man Overboard when collecting balloon, sounding rocket or payload from the sea surface	Mod	Low
5	Loss of hull integrity /Flooding	Adverse weather disrupting patrol vessel operations.	Mod	Mod
6	Other nautical safety	Parachute does not deploy and sounding rocket or balloon strikes vessel	Mod	Low
7	Collision	Patrol vessel collides with other traffic	Sig	Mod
9	Other nautical safety	Spectator vessels: sightseeing, day boats and other recreational craft	Mod	Mod

8.1.1 Machinery related accidents – Balloon lands in water and becomes entangled in small crafts Props or rudder

Following the touch-down of the balloon, rocket and payload into the water, floating or partly submerged material could remain in the water for a length of time before it is collected by the SSC's recovery vessel. Considering the size of the items that would be in the sea it may be difficult for passing vessels to see the items depending on the sea state. Recreational and fishing vessels would be more likely to be affected by the risk of entanglement. The payload getting entangled in a vessels rudder or props could result in loss of propulsion and/or steering. This would lead to the vessel be turned side on to swell and rolls uncontrollably in the swell leading to injuries or fatalities if the vessel was to capsize, damage to both vessels and has the potential for injuries to crew. This type of incident therefore assessed to be Moderate.

To reduce the risk identified, the following further mitigation measures would need to be introduced by SSC:

- Predicted balloon/sounding rocket runs – Prediction software to determine flight paths.
- Local Notice to Mariners – Information about the launches and zones of operation promulgated to local users specifically recreational users.
- AIS/Radar coverage – Monitoring of sea area for other vessels transiting in the drop zone or precautionary area.
- Patrol/Recovery vessel – Recovery of payload and warning of other sea users of SSC's activities.
- Notices to mariners – Information about the project and timings sent to UKHO to be published in Notices to mariners.
- Precautionary area – Sounding rocket firing range to ensure vessels are aware of potential risks.
- Operation zones – Zones clearly defined by SSC of areas where rockets or balloons could potentially land.
- Nav Warnings – Information to inform mariners of activity in the area.
- Lights and reflective tape on payload – Navigational light and reflective tape so mariners can identify an object in the water.

Following the implementation of mitigation measures, specifically monitoring carried out by AIS/Radar, SSC will be able to warn vessels that they are approaching the payload giving greater opportunity for collision avoidance. The Notice to Mariners and Nav Warnings is important allowing scheduled activities to be promulgated to the wider community. With the mitigation measures, the risk is reduced to Low.

8.1.2 Accidents to personnel – Man Overboard when collecting payload from sea surface

During recovery of the payload a crew member will have to reach overboard to hook-up material before recovering them to the patrol vessel. If the vessel rolls or the payload snags in the prop of the vessel; the crew member could be pulled overboard and potentially injured. Immediate action by the crew in response to a man overboard is the most effective measure to prevent a more server outcome. The likelihood of this hazard scenario creates a moderate risk due to the implications it would have for crew safety. This type of incident has the potential to occur at any time but is more likely if the sea state is rough, the risk presented is concluded to be moderate risk.

To reduce the risk identified, the following further mitigation measures would need to be introduced by SSC to reduce the risk:

- Vessel inspection/survey – A review of all subcontracted craft and crew to ensure that they hold the correct certifications and experience for the work required.
- Standard Operating Procedure – A safe and repeatable recovery method should be developed, based on a risk assessment method statement (RAMS), by the vessel operator in collaboration with SSC.
- Emergency response plan – SSC's Emergency Response Plan contains actions to be taken by the base station personnel in an emergency situation.

Following the implementation of mitigation measures, specifically the Vessel inspection/survey which ensures the crew are well trained and the vessel is fit for purpose the risk is reduced to low.

8.1.3 Flooding – Adverse weather disrupting patrol vessel operations.

The area of operations experiences large swell heights, therefore any vessels transiting to and from the Shetland Islands to the recover site may be subject to adverse sea state and weather affecting patrol boat operation. The patrol vessel contracted by SSC must be of an appropriate design and crew competences for the operations required. Vessels conducting operations in significant weather run the risk of flooding which in turn could compromised the stability of the vessel which could cause loss of equipment or even a capsize. This event would result in injury to personnel loss of vessel and pollution. This effect will be present with all vessel operation in adverse weather conditions, this cause is assessed to be a Moderate level of risk.

To reduce the risk identified, the following further mitigation measures would need to be introduced by SSC to reduce the risk to a level that could be considered as ALARP:

- Vessel inspection/survey – A review of all subcontracted craft and crew to ensure that they hold the correct certifications for the work required.
- Emergency response plan – SSC's Emergency Response Plan contains actions to be taken by the base station personnel in an emergency situation.
- Operational planning – Prediction software to determine flight paths.
- Weather forecasting – Monitored to indicate periods of adverse weather conditions.
- Contractor risk assessment method statement (RAMS) – Carried out to identify risks and detail planned operations.

Following the implementation of mitigation measures, specifically the weather forecasting and operational planning, detailing the conditions in which operates are permitted, the risk level is reduced to Low.

8.1.4 Other nautical safety – Parachute does not deploy and sounding rocket or balloon strikes vessel

Failure of the rocket parachute could result in the rocket returning to earth ballistically. Similarly, the balloon's payload could also return to earth but would have considerably less impact than the rocket. There is a possibility that a vessel or platform could be struck by a ballistic rocket or the balloon's payload leading to a danger to life and structural damage. However the likelihood of a rocket or a balloon's payload impacting a vessel or rig is considered to be low. This risk will exist throughout all operations and is assessed to be a Moderate level of risk.

To reduce the risk identified, the following further mitigation measures would need to be introduced by SSC to reduce the risk further:

- Operational planning – Prediction software to determine flight paths.
- Predicted balloon/rocket runs – Prediction software to determine flight paths.
- Local Notice to Mariners – Information about the launches and zones of operation promulgated to local users specifically recreational users.
- Patrol/ Recovery vessel – Recovery of payload and warning of other sea users of SSC's activities.
- Notices to mariners – Information about the project and timings sent to UKHO to be published in Notices to mariners.
- Visual confirmation (clear line of sight) – During a launch clear line of sight from the base station and patrol vessel is required to ensure the rocket follows the planned trajectory.
- Precautionary area – Rocket firing range to ensure maritime vessels are kept at a safe distance during a launch.

- VHF Sécurité Messages – Broadcast navigational warnings to give information about the operations being undertaken to transiting vessels.
- Operation zones – Zones clearly defined by SSC of areas where rockets or balloons could potentially land.
- Nav Warnings – Information to inform mariners of activity in the area and precautions to take when transiting the rocket/balloon area during a launch (for example, crew to remain inside).

Whilst the potential for a rock or balloon payload making contact with a maritime vessel or rig cannot be removed, it should be recognised that the likelihood is low. Following the implementation of mitigation measures, specifically a predicted balloon or rocket runs which estimates the drop/impact zones and the precautionary area, the likelihood is reduced as far as practical. A combination of information and warnings of actions to take (for example, crew to remain inside) reduced the risk to a point which is considered to be as low as reasonably practicable.

8.1.5 Collision – Patrol vessel collides with other traffic

During operations there will be vessel moves to and from the drop site for balloons and rockets. The vessel will be involved in patrols during rocket launches to ensure that other vessels are aware of the precautionary area and advise them during launches. When the vessel is recovering the payload, it will be transiting to a drop point to collect the item and observing the flight paths before impact. This vessel operation could increase the risk of collision as personnel are observing the flight path of a rocket or balloon and could distract from sea navigation. Which could increase potential interactions with other vessels and so the risk of vessel collision.

When the SSC craft is manoeuvring to collect the payload, its aspect may change quickly causing confusion to other vessels transiting the area and result in in a close quarters situation. A collision would result in damage to both vessels and has the potential for injuries to crew, pollution and significant delays to operations. This type of incident has the potential to occur the recovery and patrol operations, and therefore presents a significant risk.

To reduce the risk identified, the following further mitigation measures would need to be introduced by the SSC to reduce the risk to a level that could be considered as ALARP:

- Vessel inspection/survey – A review of all subcontracted craft and crew to ensure that they hold the correct certifications for the work required.
- Emergency response plan – SSC's Emergency Response Plan contains actions to be taken by the base station personnel in an emergency situation.
- Training of operations personnel – Personnel involved in the launch are appropriately trained
- Notices to mariners – Information about the project and timings sent to UKHO to be published in Notices to mariners.
- Promulgation of information – Information regarding the project and intended vessel movements promulgated to stakeholders.

Following the implementation of mitigation measures, specifically the use of Vessel inspection/survey to ensure crew and vessel are of the appropriate standard will provide greater competence within the operation. The liaison with stakeholders is important allowing movements to be scheduled to avoid interactions. With the mitigation measures, the risk is reduced to Moderate which recognises the new risks generated by the operations.

8.1.6 Other nautical safety – Spectator vessels: sightseeing, day boats and other recreational craft

The activities undertaken by SSC may increase local interest, specifically tourism and attract recreational vessels on rocket launch days. Should this happen, it will introduce vessels into areas with a subsequent increase in vessel transit frequency. This will increase the possibility of interaction between vessels as they would be increased traffic density in the area. This hazard leads to an assessed risk of Moderate.

To reduce the risk identified, the following further mitigation measures would need to be introduced by SSC to reduce the risk:

- Local Notice to Mariners – Information about the launches and zones of operation promulgated to local users specifically recreational users.
- Notices to mariners – Information about the project and timings sent to UKHO to be published in Notices to mariners.
- VHF Sécurité Messages – Broadcast navigational warnings to give information about the operations being undertaken to transiting vessels.
- Operation zones – Zones clearly defined by SSC of areas where rockets or balloons could potentially land.

Following the implementation of mitigation measures, specifically the Local Notice to Mariners to mariners, the risk level is reduced, but remains as a moderate risk as a result of the frequency of minor events.

9 Mitigation Measures Summary

The following section summarises existing industry standard risk controls and project-specific mitigation measures identified in Section 7.4. The NRA process has recognised both existing industry standard risk controls and project-specific mitigation; to view mitigation and controls assigned to individual NRAs, see Appendix D. Existing risk controls are listed in Table 11 'embedded risk controls'.

9.1 Project-specific mitigation measures

The following sections expand upon the additional (future) risk controls identified in Section 7.6. The context of the description is drawn from the assessments in Appendix D; it should be noted that the comments shown in the following section are an amalgamation. The title of each section is the 'additional control' name.

9.1.1 Predicted balloon/sounding rocket runs

SSC is to use prediction software in order to predict the trajectory and flight path of the sounding rocket and balloon respectively. The prediction software will consider wind and atmospheric variations in order to produce an accurate drop/impact zone to collect the payload.

9.1.2 Operation Areas (zones)

The Operational Areas (zones) should be clearly marked and promulgated through notice to mariners through the United Kingdom Hydrographic Office (UKHO). If the zones remain active for an extended period of time, consult with the UKHO to enquire whether zones can be marked on Admiralty paper and electronic charts.

9.1.3 Local Notice to Mariners

Information regarding the project including coordinates should be promulgated to the local maritime community through local SHA's, Marinas and fishing organisations. This information is to provide information to those navigating locally though the area of operation.

9.1.4 Nav Warnings

Information regarding the project including coordinates should be provided to the UKHO at least five days in advance. This information will be provided to marine traffic via NAVTEX to the specific NAVAREA relevant to the operations to be undertaken by SSC.

9.1.5 Operational planning

All operations are to be planned in advance giving time to notify the relevant stakeholders of the launch schedule and to produce operational limits for the launches and recovery of the payload.

9.1.6 Precautionary area

The precautionary area is an area in which sounding rocket launches will take place with defined limits where ships must navigate with particular caution in order to reduce the risk of a maritime casualty. This area will be in place for periods of time up to 45 minutes for a launch. The defined limits of the area will be provided to the UKHO for notice to mariners and to be printed on to admiralty charts if the range size is to be fixed for a long period of time.

9.1.7 Patrol / Recovery vessel

For all activities undertaken by SSC a patrol / recovery vessel is to be used in order to collect the payload and balloon/rocket material from the launch and ensure other vessels do not enter the precautionary area for rocket launches during the operation.

9.1.8 VHF Sécurité Messages

Information is to promulgated on VHF via a Sécurité message in order to inform transiting vessels fitted with Digital Selective calling (DSC) import navigation information regarding the current operation being undertaken by SSC.

9.1.9 Lights and reflective tape on payload

SSC will ensure that payloads are light and marked with reflective tape.

9.1.10 Notices to mariners

Information regarding the project including coordinates should be provided to the UKHO so that a notice to mariners can be issued to update charts and sailing information. This information should also be provided to local SHAs so that local notices to mariners can be issued to inform the port community.

9.1.11 RAMS

Any discrete operations associated with launch or recover of the balloons, sounding rockets or payload should have a RAMS. The RAMS method results in the risk associated with an operation being determined and a method to carry out the operation safely.

9.1.12 Emergency response plan

An emergency plan will be created by SSC detailing the response to emergency situations involving the project. The plan must interface with available emergency services and provide appropriate contact details. The detailed responses should include step-by-step procedures appropriate to the emergency situation. The emergency plan should be made available to all marine personnel, with a copy stored on all vessels associated with the project.

9.1.13 Weather forecasting

There are a range of services available to provide weather information (wind and wave) for the Space Centre. A weather forecasting service should be regularly monitored to indicate any periods of upcoming adverse weather conditions. Appropriate actions should then be taken to mitigate or postpone operations. These actions should be documented in SSC operational plans listing the weather conditions which necessitates specific actions.

9.1.14 Promulgation of information

Information on the operations and upcoming launches should be provided to local stakeholders. This can be achieved through establishing lines of communication with local Harbour Authorities fishing Associations as well as the Shetland Islands Council. A website for the project, providing information and a method to contact the project would allow any vessels in the area to obtain information.

9.1.15 Training of operational personnel

All roles associated with the project should be considered to determine the training that will be required to ensure that personnel have the required level of competence to carry out their functions. Nationally accepted qualifications should be considered alongside training in project specific plans and procedures.

9.1.16 Standard Operating Procedure

All operations required by personal should have considered the safest procedures relevant to the activities undertaken. Specifically, for the recovery of items from the water a safe and repeatable method should be developed by SSC in collaboration with the vessel operator

10 Summary

In total, nine hazard scenarios were identified and assessed. Consultation has been conducted with stakeholders to draw out local user opinion. To inform the consultees, information defining the baseline navigational environment has been used, including a traffic assessment drawn from AIS data collected in 2017, 2019 and 2020.

For SSC operations the risk assessment for 'Patrol vessel collides with other traffic' produced the highest risk 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 Moderate.

From the NRA process, 19 additional mitigation measures were identified for the rocket and balloon launching and recovery operations for SSC's proposed operations. Following implementation of appropriate mitigation by SSC within the context of the proposed operations, marine risk to navigational receptors can be maintained within a level that is 'As Low As Reasonably Practicable'.

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12 Abbreviations/Acronyms

AIS	Automatic Identification System
ALARP	As Low As Reasonably Practicable
BEIS	Business, Energy and Industrial Strategy
CGOC	Shetland Coastguard Operations Centre
COLREGS	International Regulations for Preventing Collisions at Sea 1972 (as amended)
DfT	Department for Transport
DSC	Digital Selective Calling
ENCs	Electronic Navigational Chart's
FPSO	Floating Production Storage and Offloading
FSA	Formal Safety Assessment
GPS	Global Positioning System
Hig	High Risk
HM	Her Majesty's
HSE	Health and Safety Executive
ID	Identity
IMO	International Maritime Organisation
INS	Information Service
ISM	International Safety Management
LAT	Lowest Astronomical Tide
LHA	Local Harbour Authority
LNtM	Local Notice to Mariners
Low	Low Risk
M+F	Merchant and Fishing
MAIB	Marine Accident Investigation Branch
MCA	Maritime and Coastguard Agency
MGN	Marine Guidance Notes
MMO	Marine Management Organisation
Mod	Moderate Risk
MSMS	Marine Safety Management System
NAVAREA	Navigational Areas
NAVTEX	NAVigational TEleX
Neg	Negligible Risk
NFFO	National Federation of Fishermen's Organisation
NLB	Northern Lighthouse Board
Nm	Nautical Mile
NMPi	National Marine Plan Interactive
Non	No Risk
NRA	Navigational Risk Assessment
NtM	Notice to Mariners
OGA	Oil and Gas Association
OPRC	International Convention on Oil Pollution Preparedness, Response and Co-operation
OPRED	Offshore Petroleum Regulator for Environment and Decommissioning
OREI	Offshore Renewable Energy Installations
PMSC	Port Marine Safety Code
RAMS	Risk Assessment Method Statement
RNLI	Royal National Lifeboat Institution
RYA	Royal Yachting Association

SAR	Search and Rescue
SHA	Statutory Harbour Authority
SIC	Shetland Islands Council
Sig	Significant Risk
SMS	Safety Management System
SOLAS	Safety of Life at Sea
SSC	Shetland Space Centre
SSF	Shetland Fisherman Federation
STCW	Standards of Training, Certification and Watchkeeping
TOS	Traffic Organisation Service
UK	United Kingdom
UKHO	United Kingdom Hydrographic Office
UNCLOS	United Nations Convention on the Law of the Sea
VHF	Very High Frequency
VHi	Very High Risk
VMS	Vessel Monitoring System
VTS	Vessel Traffic Service

Cardinal points/directions are used unless otherwise stated.

SI units are used unless otherwise stated.

13 Glossary

AIS	Automatic Identification System. Used for identifying and locating vessels by electronically exchanging data with other nearby ships, AIS base stations, and satellites.
AIS-A	Class A AIS is a carriage requirement for commercial ships of 300 gross tonnage and upwards engaged on international voyages, cargo ships of 500 gross tonnage and upwards not engaged on international voyages and all passenger ships irrespective of size.
AIS-B	Class B AIS is a more simple and lower cost version developed for use on smaller vessels.
Beaufort	A system of estimating and reporting wind speeds using a numerical scale ranging from 0 (calm) to 12 (hurricane).
COLREGS	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.
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.
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. They produce legislation and guidance on maritime matters and provide certification to seafarers.
Marine-SMS	Marine Safety Management System. Manages hazards and risks for a port or marine facility. It should document any practices which are the standard approach to port marine operations.
OPRC	Convention stating the requirements for a facility's oil spill contingency plan.
SOPs	Standard Operating Procedures. A detailed set of instructions for a vessels crew to perform tasks.
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.

Figures





Innovative Thinking - Sustainable Solutions

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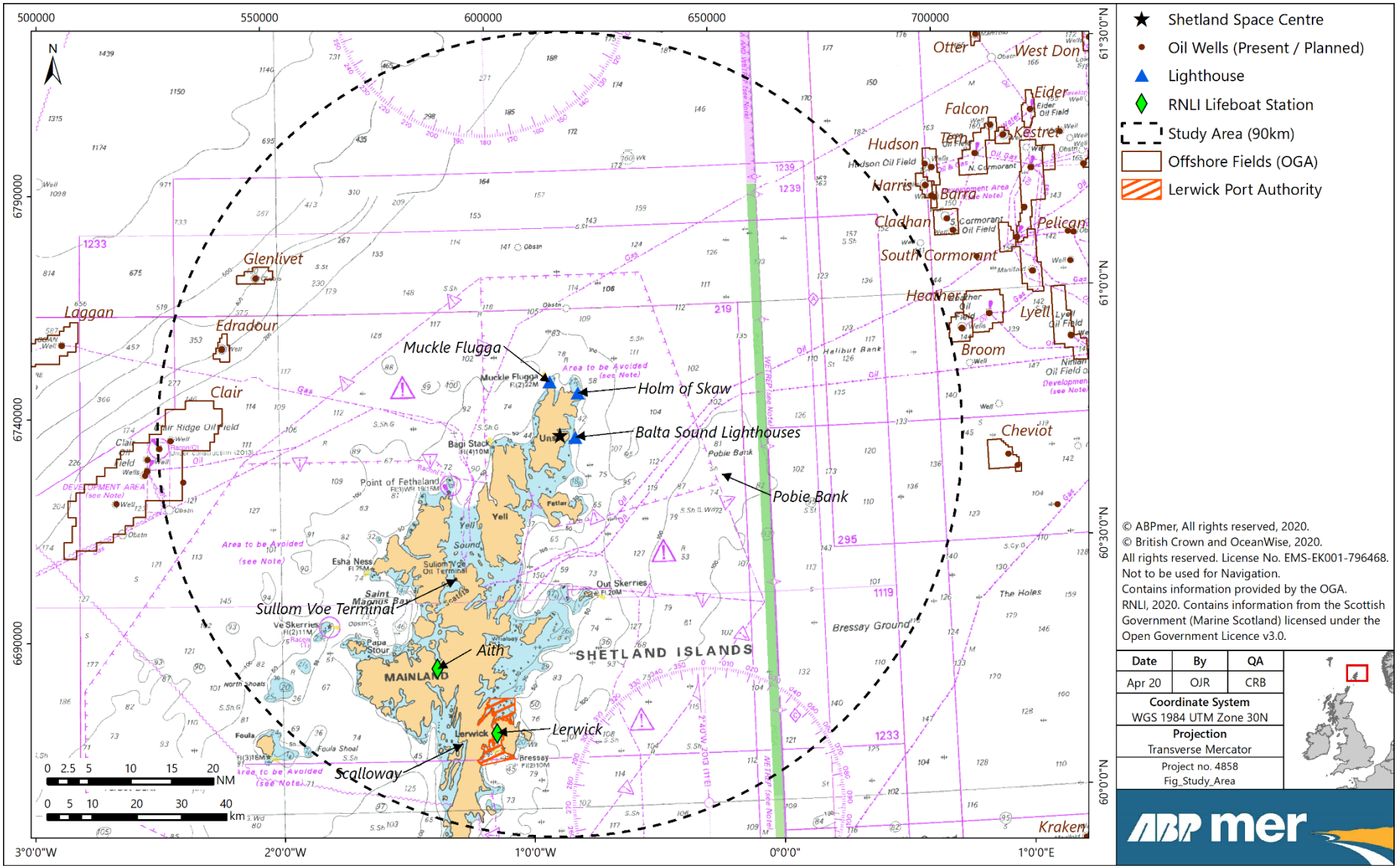

Figure 1. Study Area

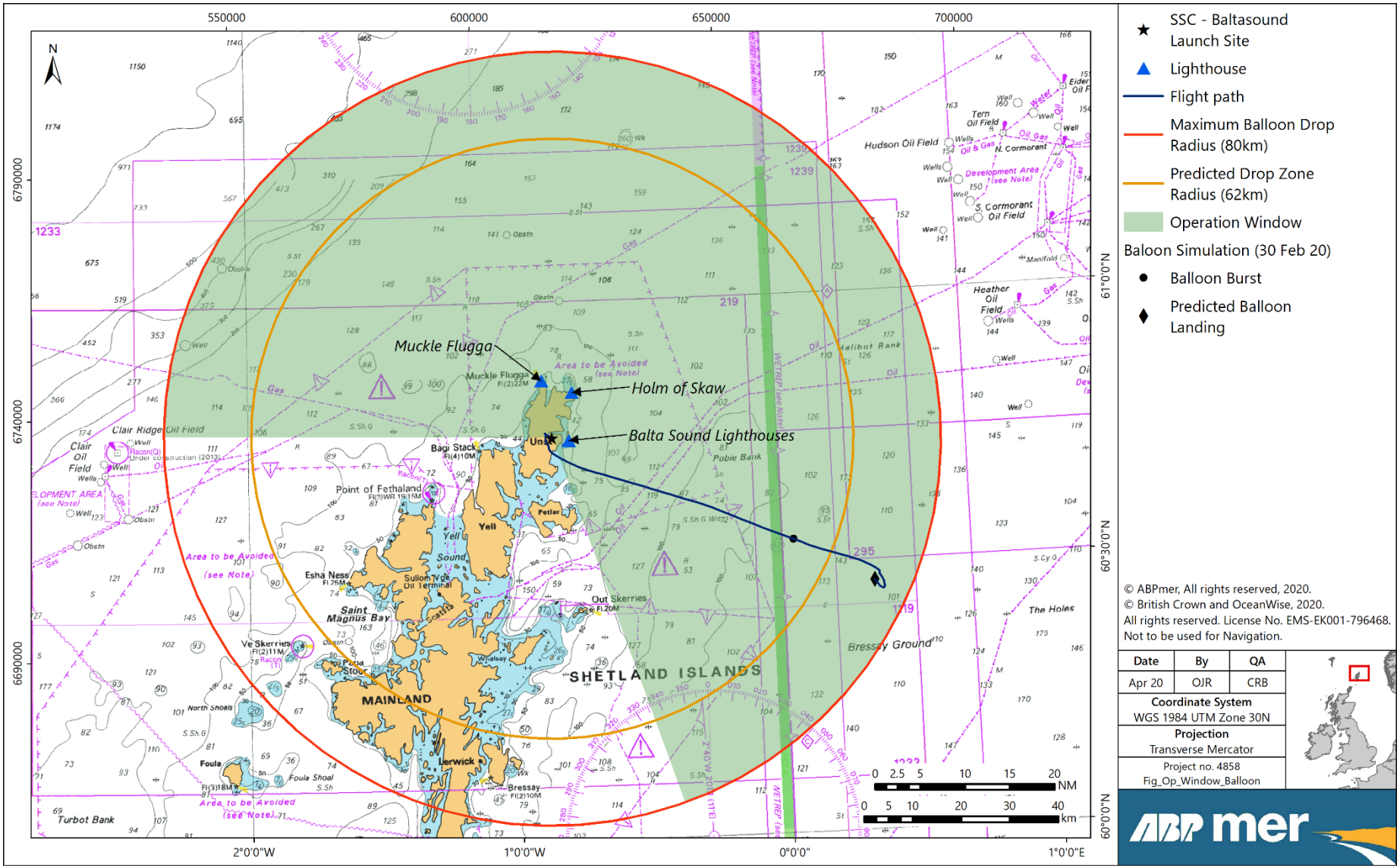

Figure 2. Balloon Operational Area

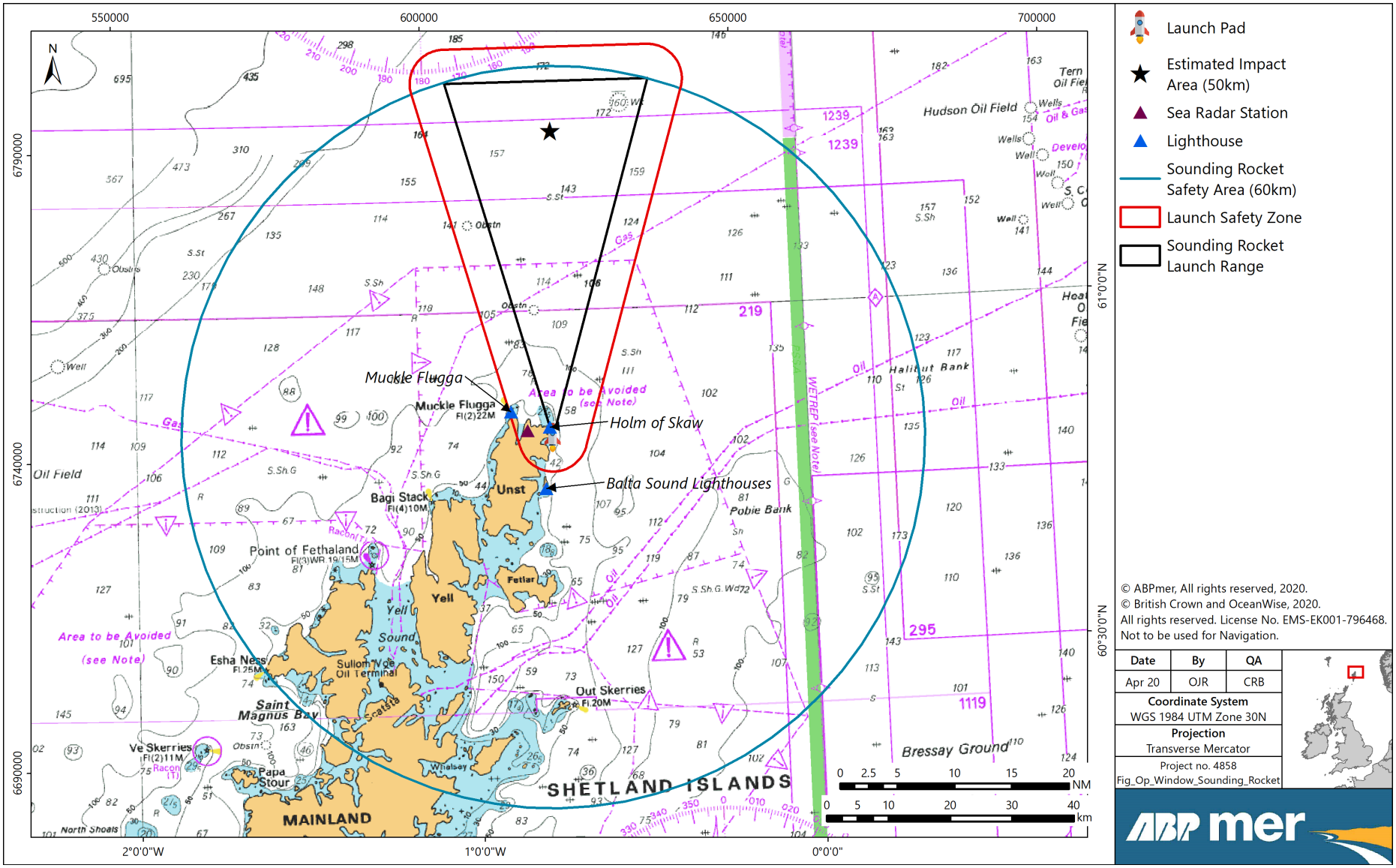

Figure 3. Sounding Rocket Area

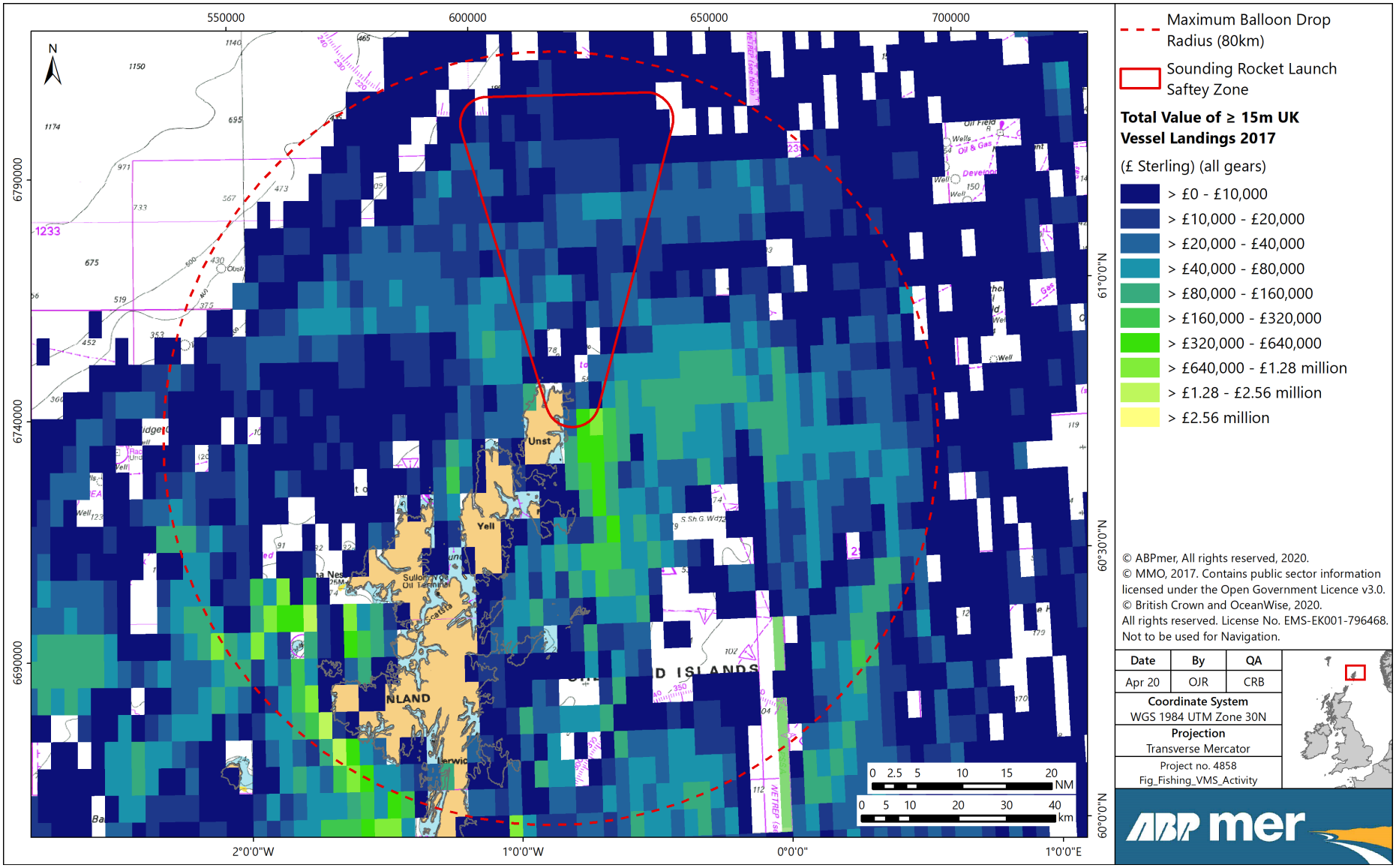

Figure 4. Vessel Monitoring System (Fishing)

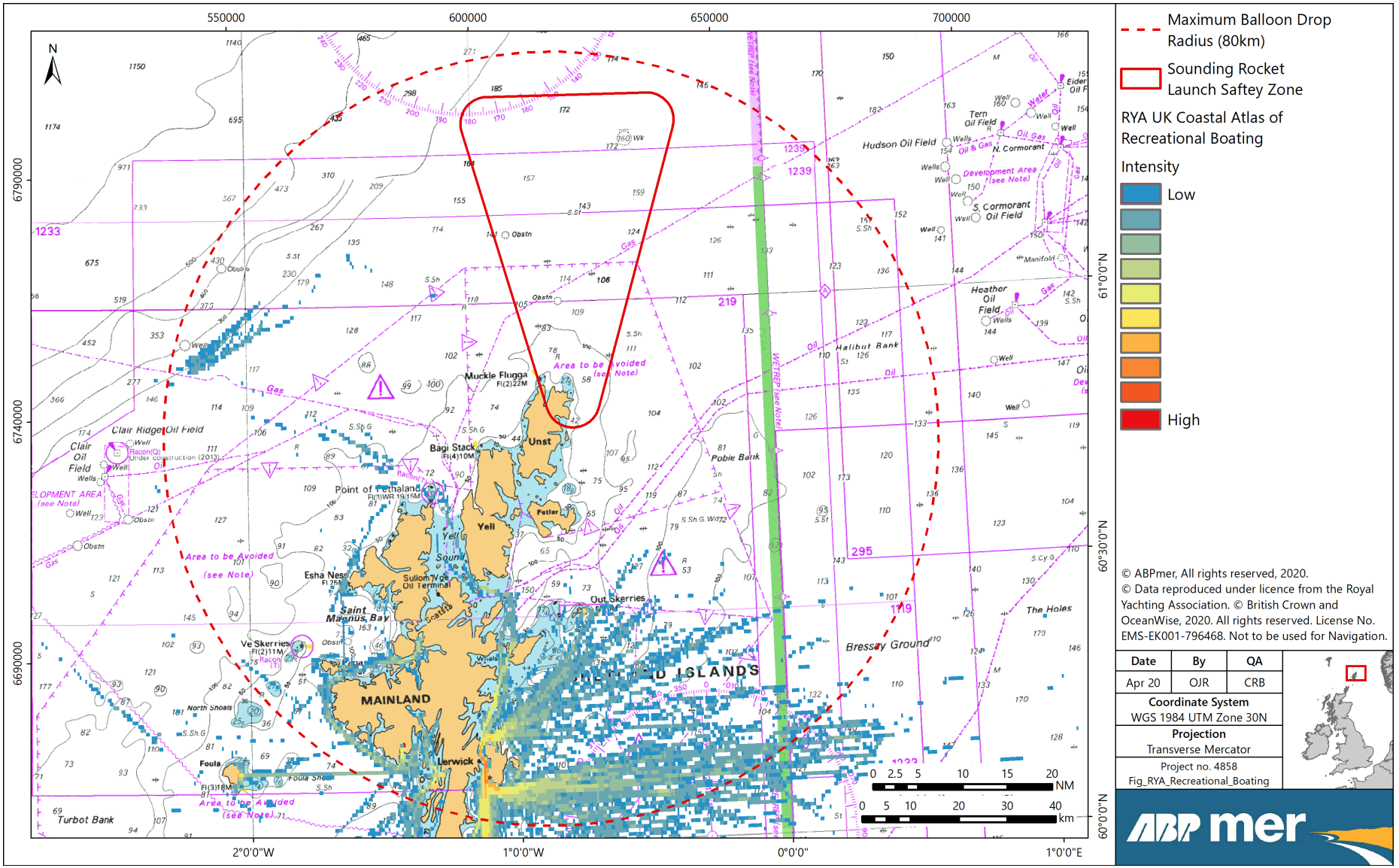

Figure 5. RYA Recreational Boating

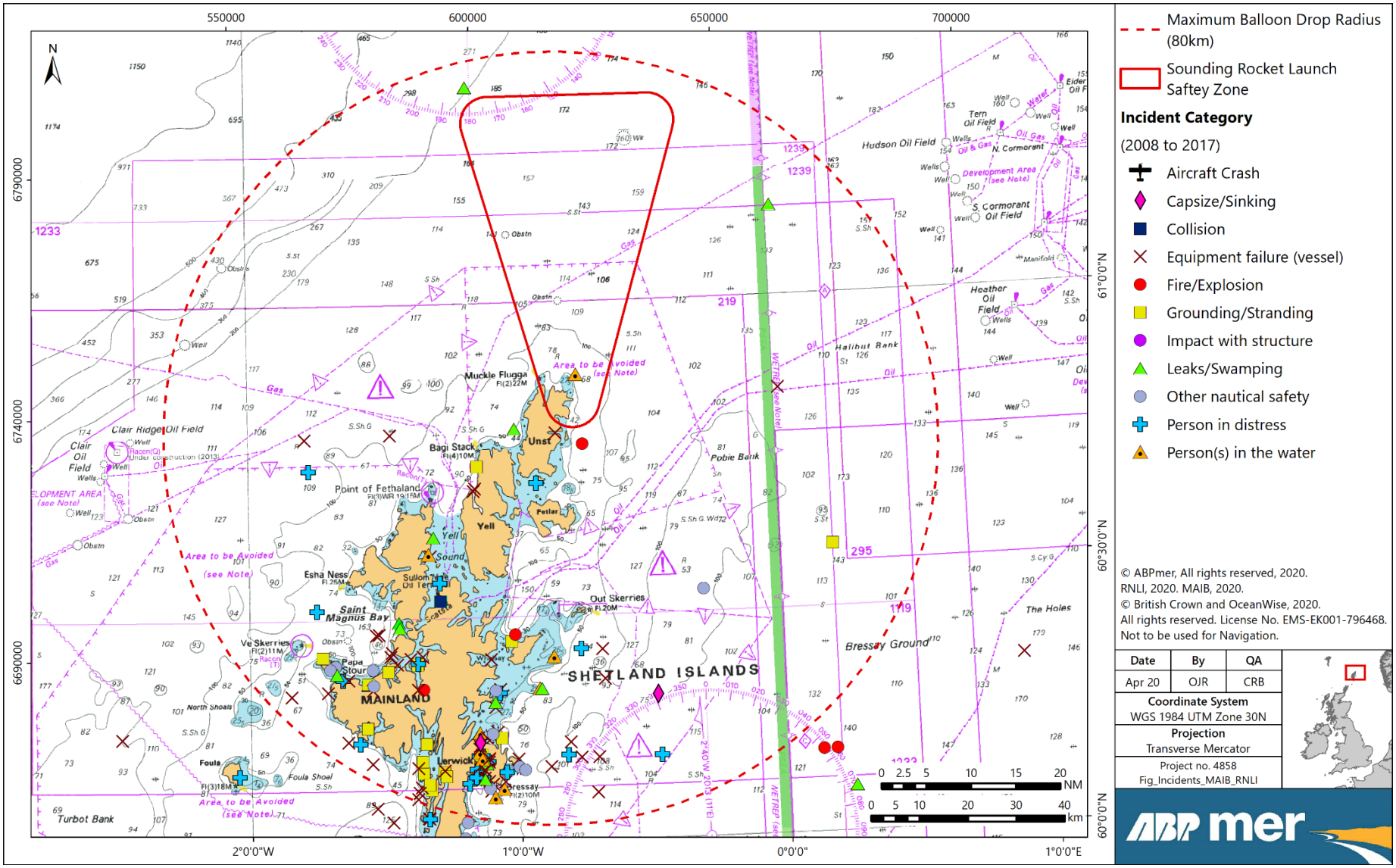

Figure 6. Marine Accidents/Incidents

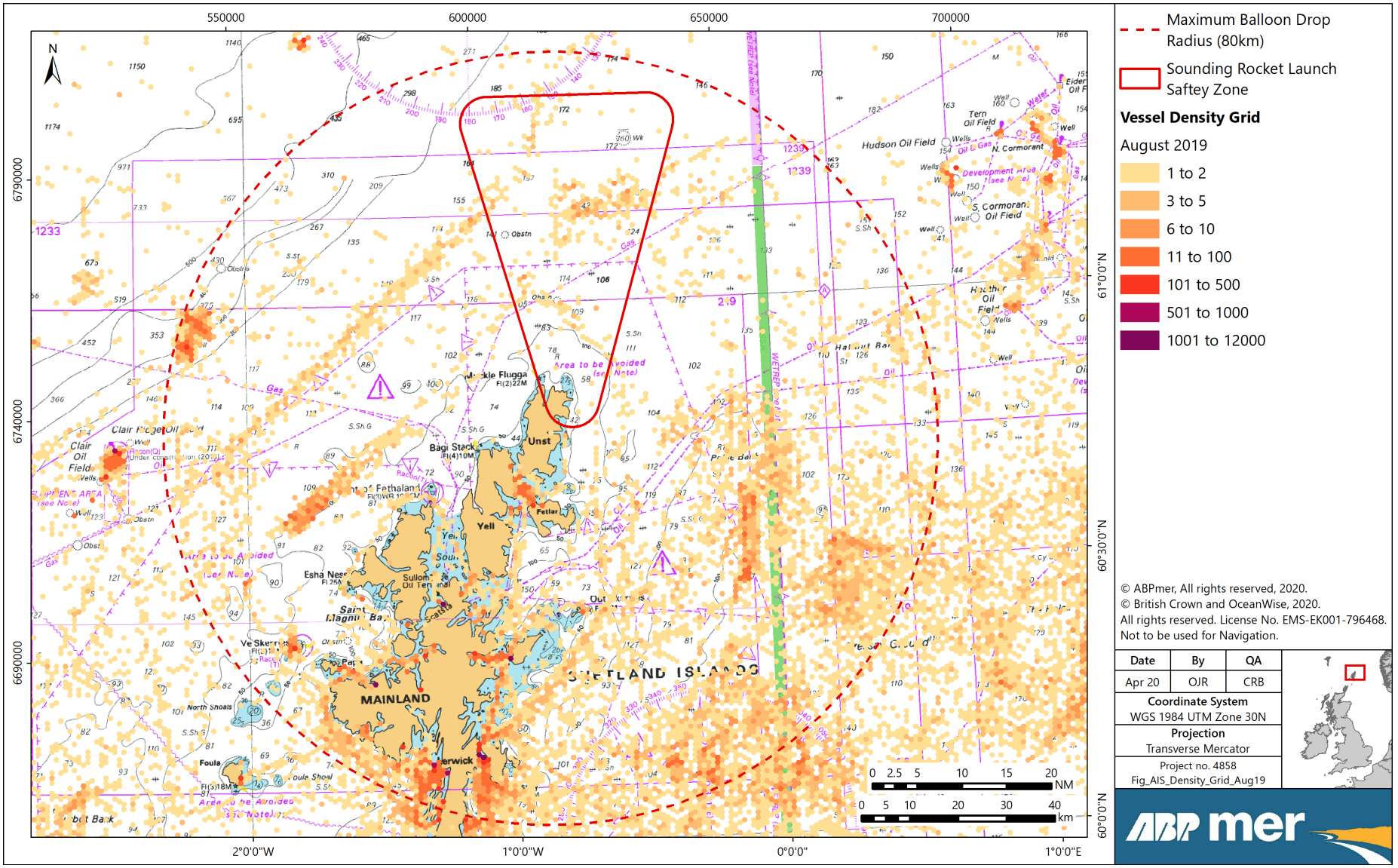

Figure 7. Vessel Density Grid August 2019

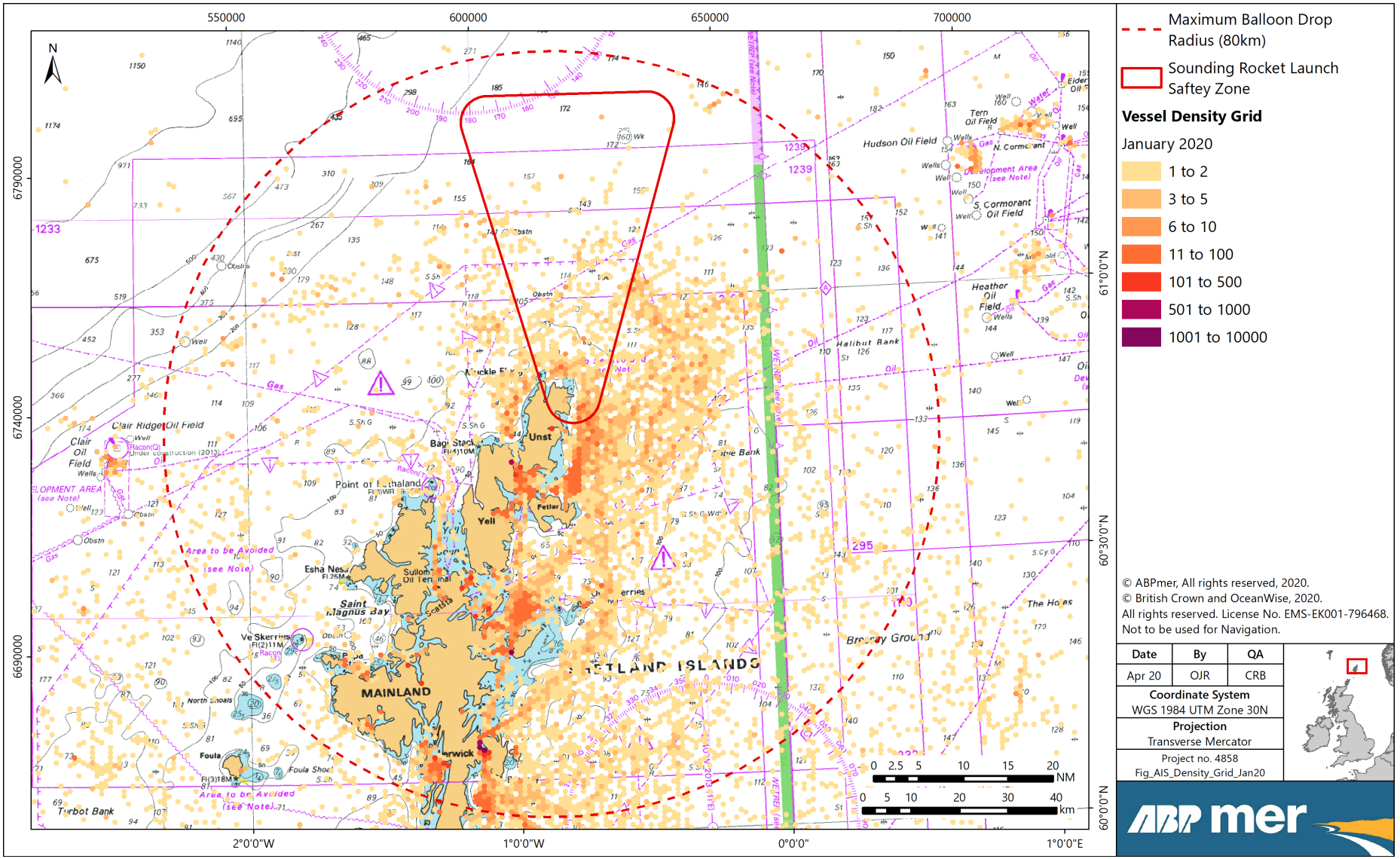

Figure 8. Vessel Density Grid January 2020

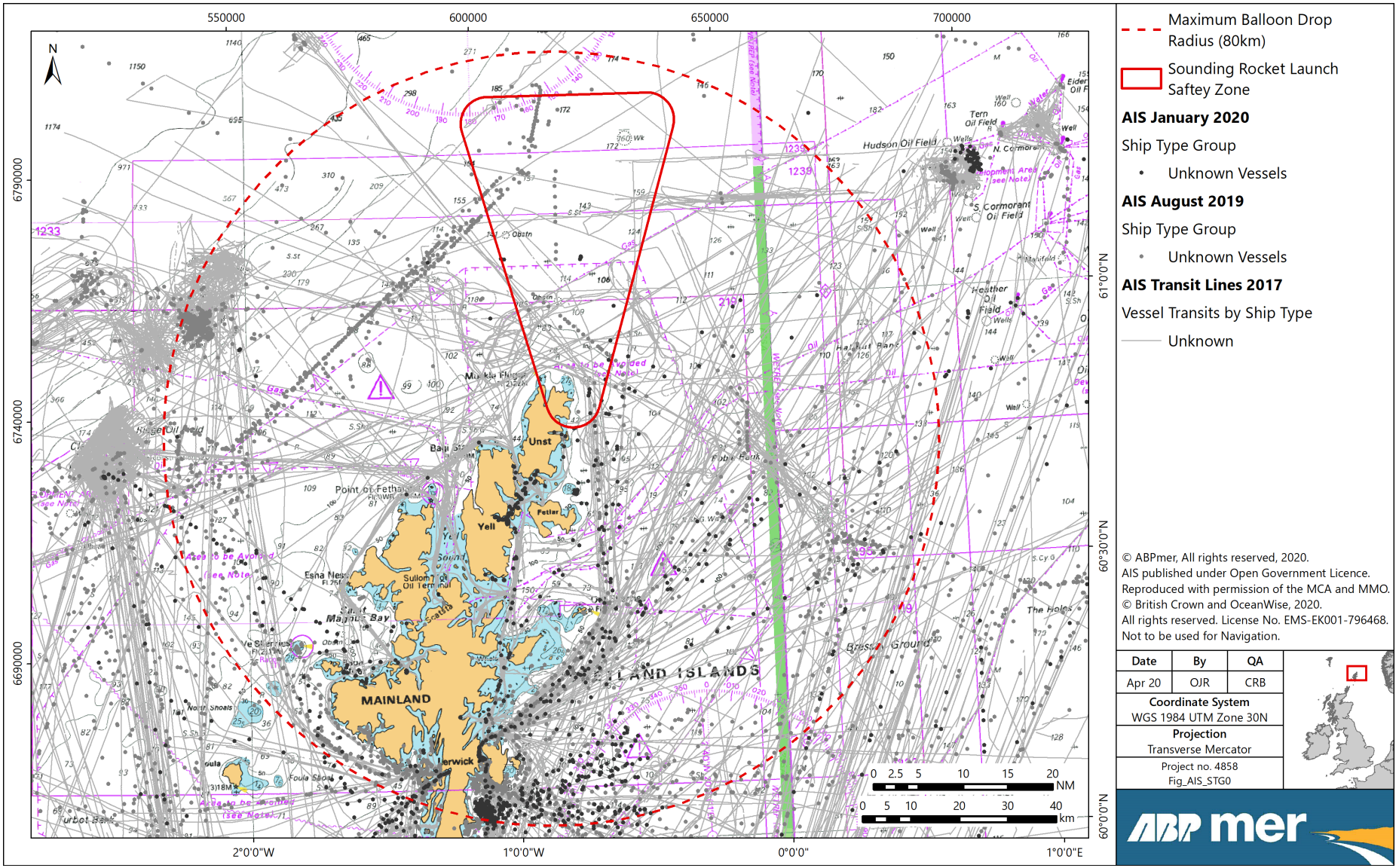

Figure 9. AIS Transits – Unknown Vessels

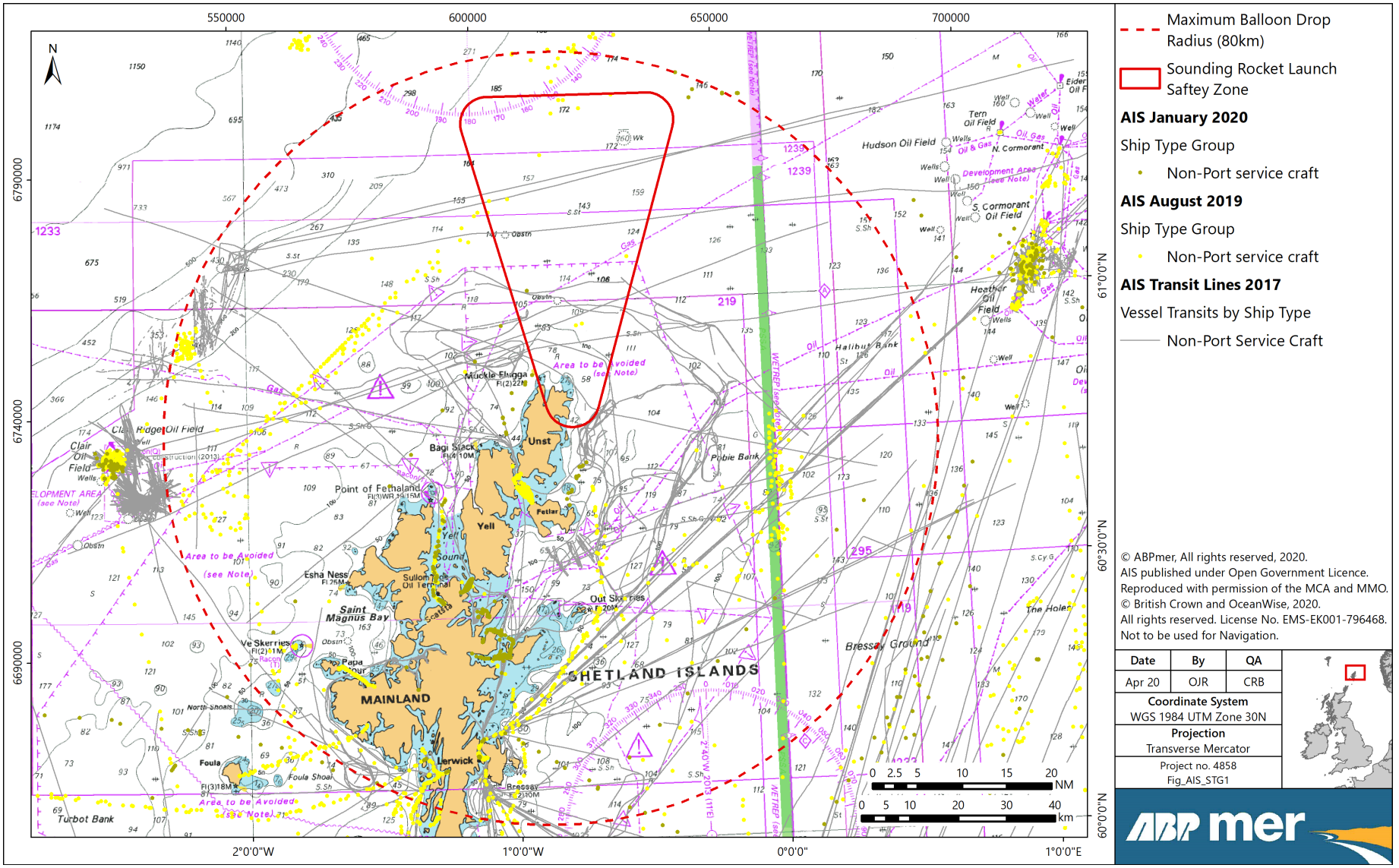

Figure 10. AIS Transits – Non-Port Service Craft

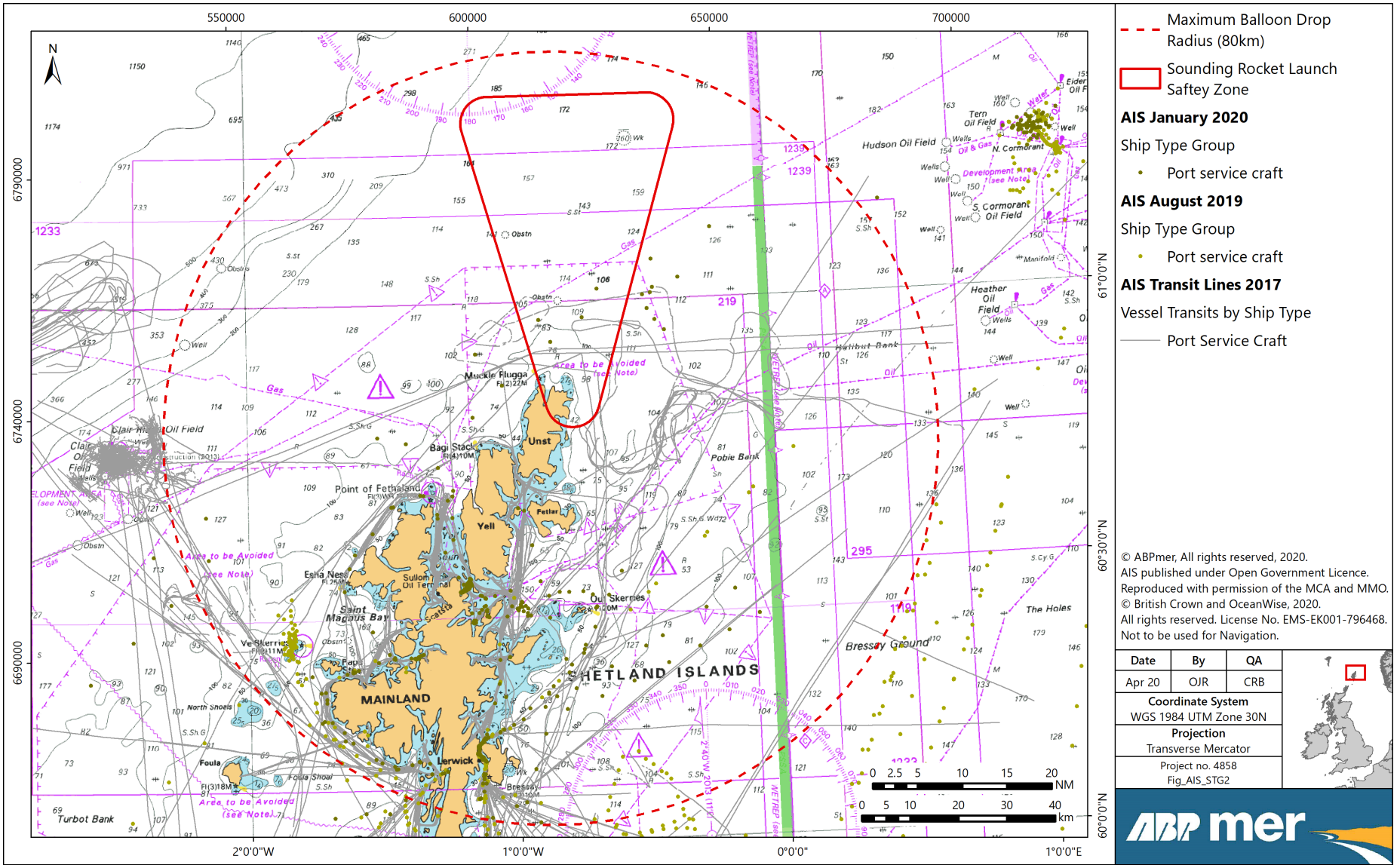

Figure 11. AIS Transits – Port Service Craft

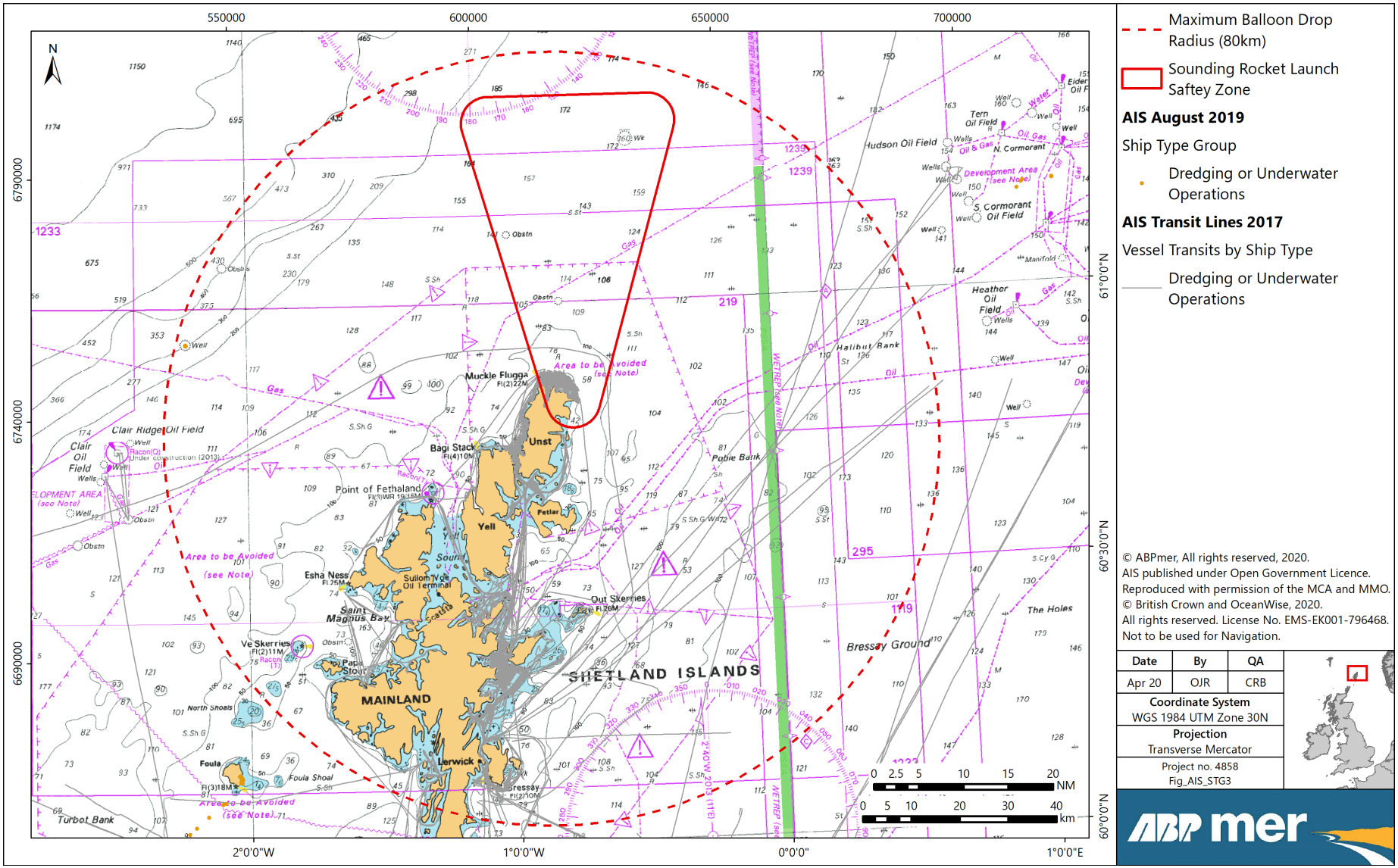

Figure 12. AIS Transits – Dredging or Underwater Operations

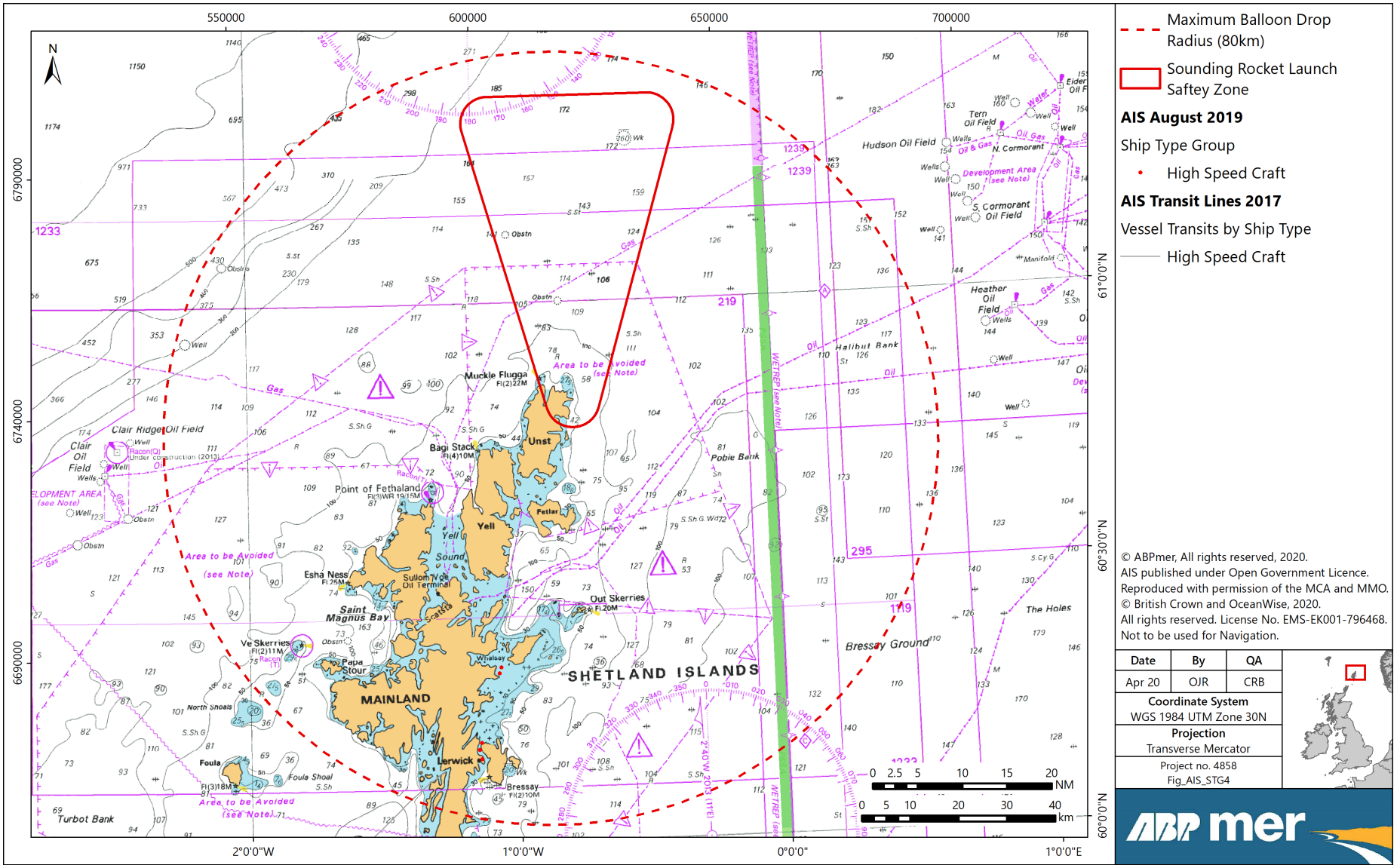

Figure 13. AIS Transits – High Speed Craft

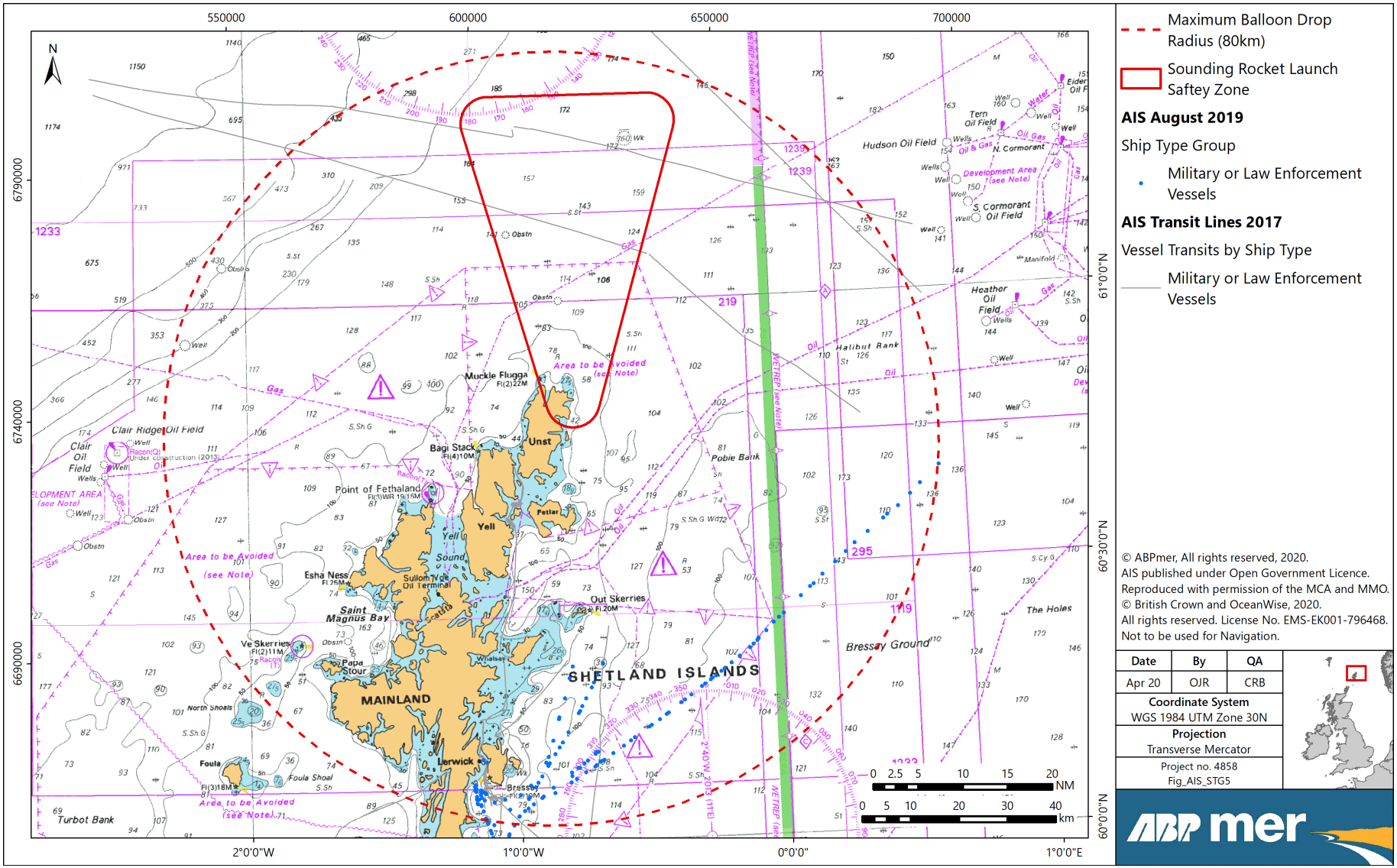

Figure 14. AIS Transits – Military and Law Enforcement Vessels

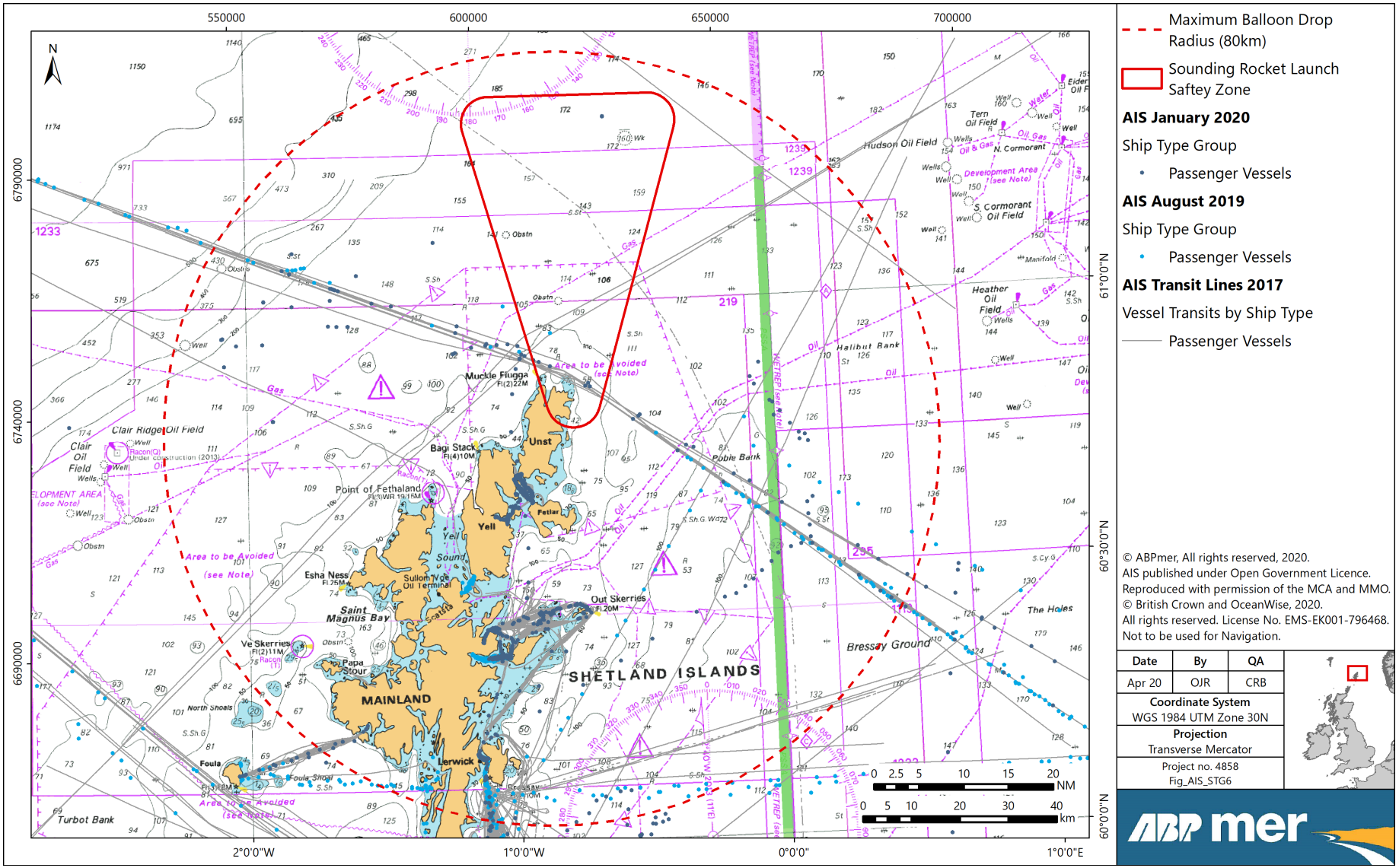

Figure 15. AIS Transits – Passenger Vessels

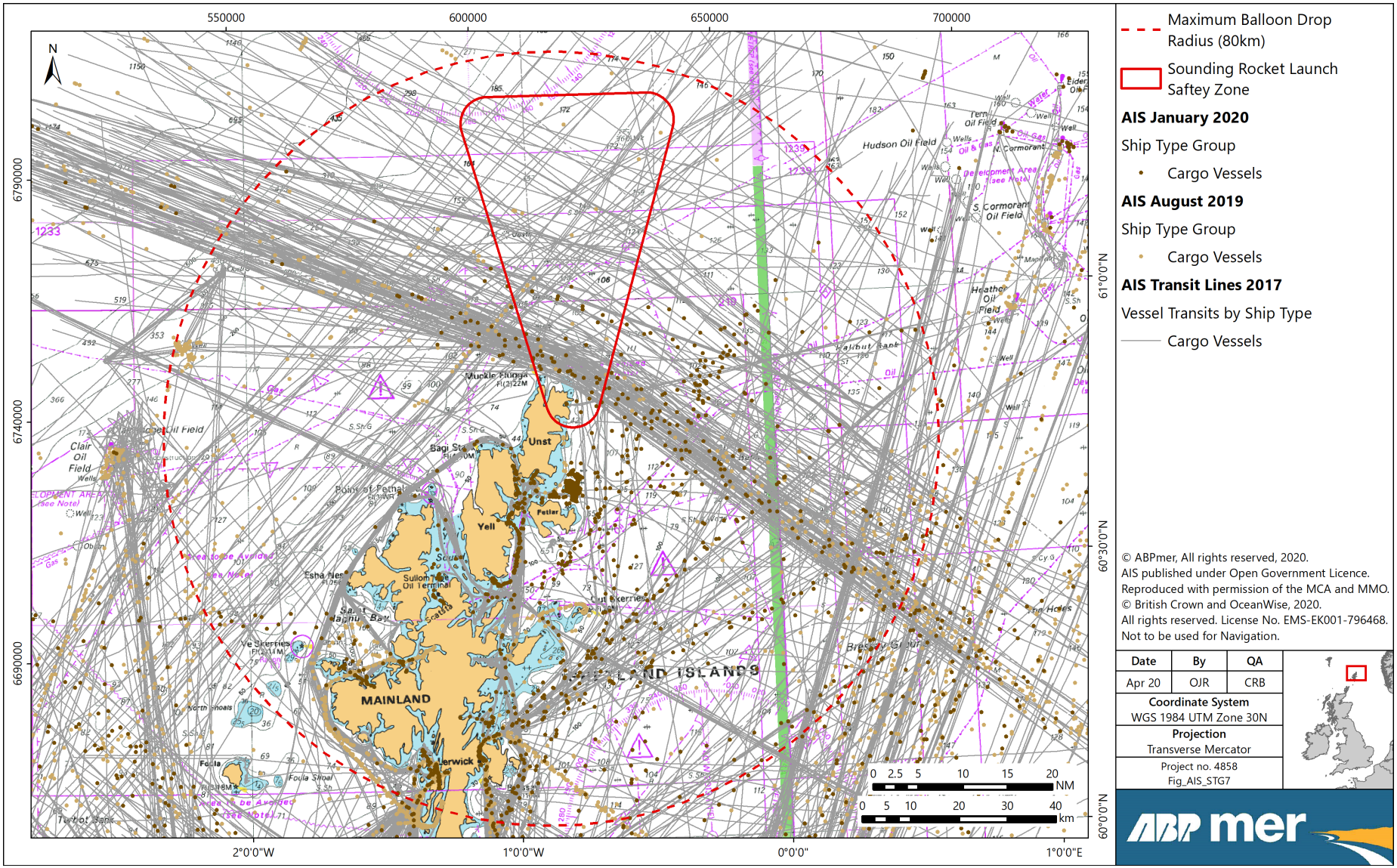

Figure 16. AIS Transits – Cargo Vessels

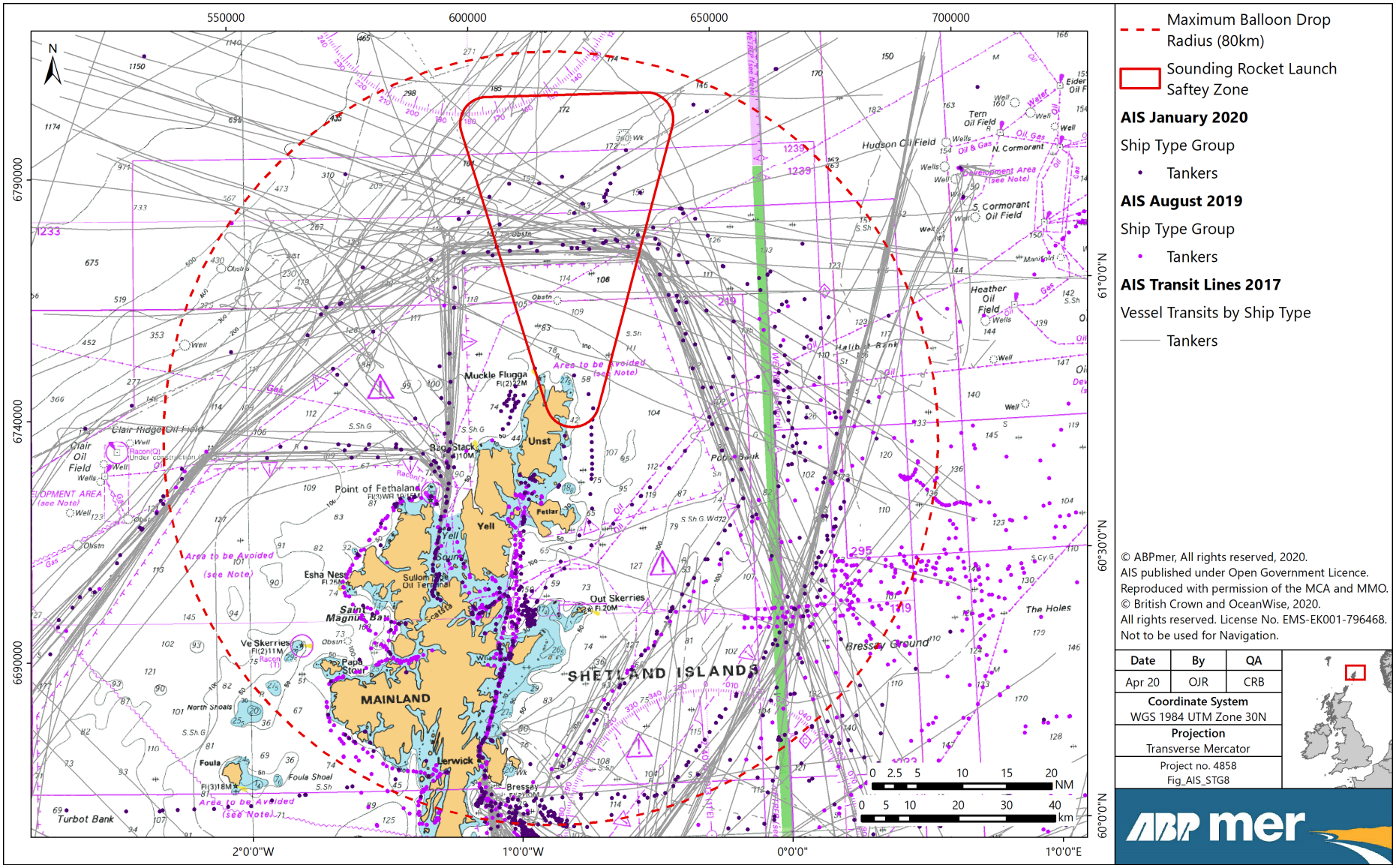

Figure 17. AIS Transits – Tankers

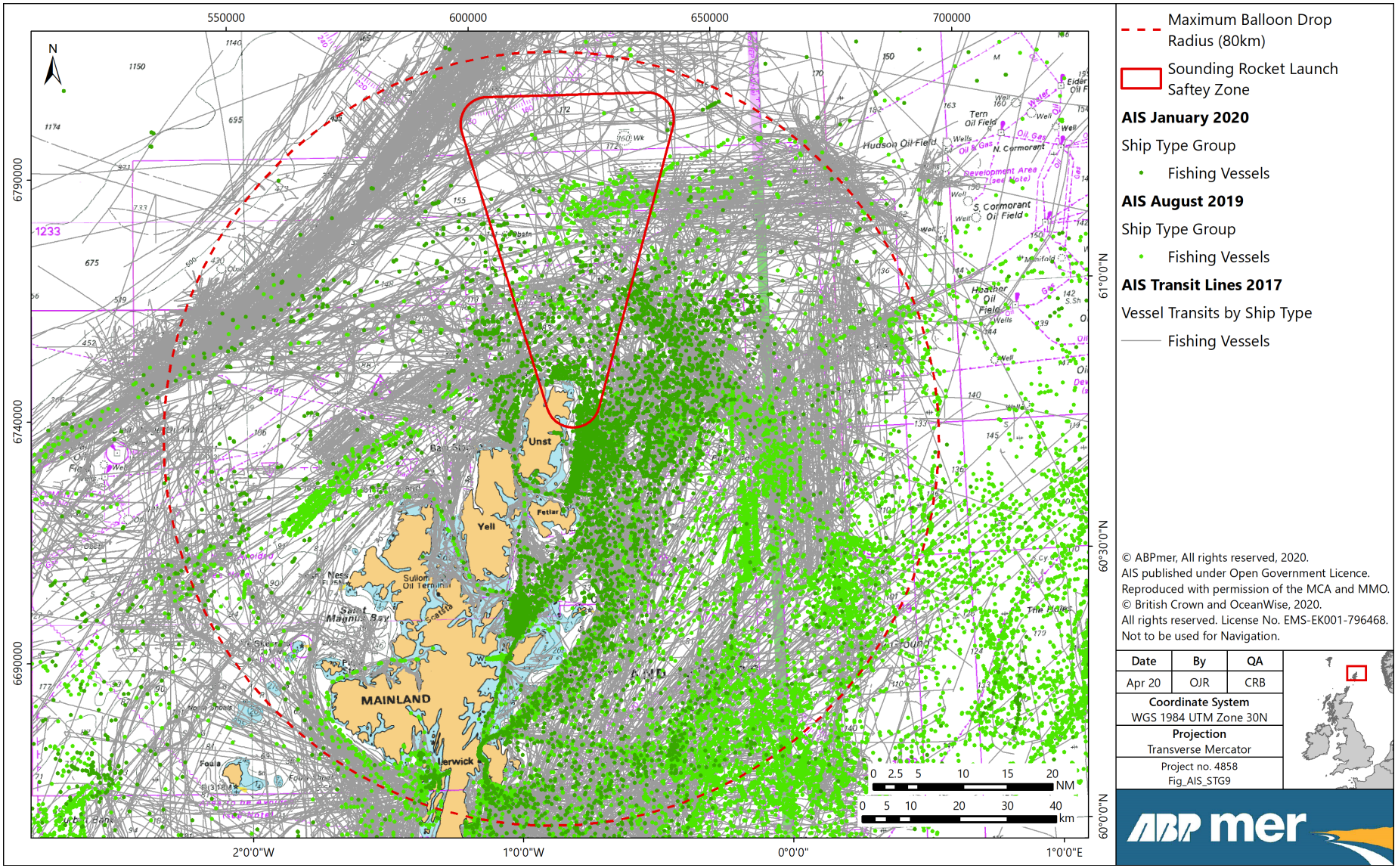

Figure 18. AIS Transits – Fishing Vessels

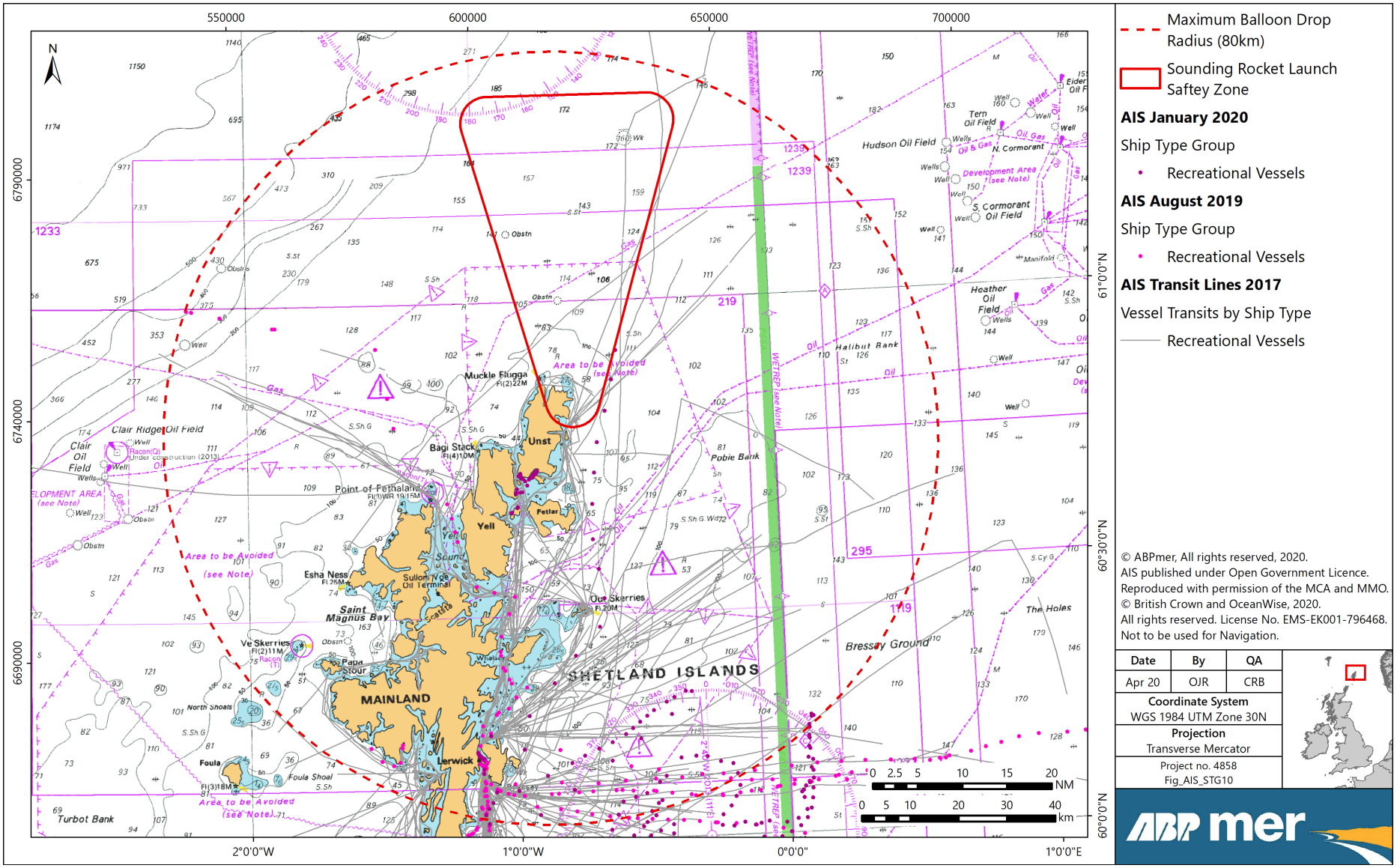

Figure 19. AIS Transits – Recreational Vessels

Appendices





Innovative Thinking - Sustainable Solutions

ABP mer

A Accident-Incident Table

Record Origin	Incident Date	Incident Type	Latitude	Longitude
RNLI	15/02/2008	Grounding	60.3213	-1.4845
RNLI	11/05/2008	Person in distress	60.1299	-1.0516
MAIB	18/05/2008	Grounding/Stranding	60.3483	-1.7283
RNLI	19/06/2008	Other	59.7207	-0.7935
RNLI	20/06/2008	Man Overboard	59.9394	-0.6657
RNLI	29/06/2008	Person in distress	60.1215	-1.1648
RNLI	14/07/2008	Equipment failure (vessel)	59.9827	-0.1492
RNLI	20/07/2008	Person in distress	59.8814	-1.0640
RNLI	13/08/2008	Equipment failure (vessel)	60.1202	-1.1344
RNLI	14/09/2008	Man Overboard	60.1550	-1.1413
RNLI	14/09/2008	Leaks/Swamping	60.3181	-1.6774
RNLI	17/09/2008	Leaks/Swamping	60.1909	-2.9378
RNLI	25/10/2008	Equipment failure (vessel)	60.7569	-0.8322
RNLI	23/11/2008	Equipment failure (vessel)	60.1350	-1.2826
RNLI	07/12/2008	Equipment failure (vessel)	60.1556	-1.1155
RNLI	23/01/2009	Capsize/Sinking	60.1860	-1.1482
RNLI	16/02/2009	Person in distress	60.1306	-2.0458
RNLI	25/02/2009	Person in distress	60.2769	-1.0688
RNLI	28/02/2009	Other	60.0087	-1.2124
RNLI	03/04/2009	Person in distress	59.3735	-1.6082
RNLI	22/05/2009	Equipment failure (vessel)	59.8740	-1.3319
RNLI	29/06/2009	Equipment failure (vessel)	60.3554	-1.4697
RNLI	19/07/2009	Equipment failure (vessel)	60.1409	-1.1494
RNLI	19/07/2009	Grounding	59.9796	-1.1706
RNLI	23/07/2009	Equipment failure (vessel)	59.9829	-1.1342
RNLI	29/07/2009	Person in distress	60.3351	-1.3721
RNLI	05/08/2009	Leaks/Swamping	60.1181	-1.1328
RNLI	20/08/2009	Man Overboard	60.0831	-1.0971
RNLI	07/09/2009	Leaks/Swamping	60.2601	-1.0866
RNLI	13/09/2009	Equipment failure (vessel)	60.3434	-1.4000
MAIB	16/10/2009	Equipment Failure	60.2000	-2.4833
RNLI	03/11/2009	Other	60.2820	-1.0851
RNLI	03/11/2009	Other	60.3249	-1.5427
RNLI	24/11/2009	Equipment failure (vessel)	60.1334	-1.1331
RNLI	14/01/2010	Equipment failure (vessel)	60.8265	0.0184
RNLI	16/01/2010	Person in distress	60.1548	-1.1421
MAIB	21/01/2010	Grounding/Stranding	60.1317	-1.2833
RNLI	21/01/2010	Grounding	60.1638	-1.1424
RNLI	21/01/2010	Grounding	60.1244	-1.2761
RNLI	11/03/2010	Person in distress	60.1359	-1.1630

Record Origin	Incident Date	Incident Type	Latitude	Longitude
RNLI	12/03/2010	Equipment failure (vessel)	59.7843	-0.5462
RNLI	13/03/2010	Person in distress	60.1496	-1.1180
RNLI	23/03/2010	Equipment failure (vessel)	60.1045	-1.3691
RNLI	25/03/2010	Equipment failure (vessel)	59.7136	-1.1555
MAIB	01/04/2010	Man Overboard	59.9967	-1.3600
RNLI	10/04/2010	Leaks/Swamping	60.5690	-1.3046
RNLI	24/04/2010	Equipment failure (vessel)	60.7593	-1.4602
RNLI	30/06/2010	Equipment failure (vessel)	60.2503	-1.0879
MAIB	04/07/2010	Equipment Failure	59.6500	-1.8500
MAIB	07/07/2010	Equipment Failure	60.3883	-1.5267
RNLI	07/07/2010	Equipment failure (vessel)	60.3899	-1.5170
MAIB	11/07/2010	Equipment Failure	60.5333	-1.3167
RNLI	16/07/2010	Equipment failure (vessel)	59.3479	-0.5337
RNLI	19/07/2010	Equipment failure (vessel)	60.3132	0.8974
RNLI	13/08/2010	Equipment failure (vessel)	60.1122	-1.0574
RNLI	14/08/2010	Person in distress	60.1534	-0.4704
RNLI	17/09/2010	Fire/Explosion	60.1534	0.1827
RNLI	18/09/2010	Fire/Explosion	60.1534	0.1324
RNLI	30/09/2010	Equipment failure (vessel)	60.6572	-1.1441
RNLI	03/10/2010	Person in distress	59.8535	-1.2781
RNLI	20/01/2011	Man Overboard	60.3422	-0.8630
RNLI	21/01/2011	Man Overboard	60.2836	-0.9198
RNLI	22/01/2011	Man Overboard	60.2032	-1.1490
RNLI	23/01/2011	Man Overboard	60.0988	-1.0635
RNLI	26/01/2011	Person in distress	60.1608	-1.1536
RNLI	28/02/2011	Leaks/Swamping	60.2837	-0.9117
RNLI	17/03/2011	Equipment failure (vessel)	60.1952	-1.1009
MAIB	09/04/2011	Equipment Failure	60.0467	-1.3433
RNLI	09/04/2011	Equipment failure (vessel)	60.0471	-1.3459
RNLI	09/04/2011	Person in distress	60.0462	-1.3419
MAIB	08/05/2011	Grounding/Stranding	60.1000	-1.3333
RNLI	08/05/2011	Grounding	60.1104	-1.3384
RNLI	27/06/2011	Man Overboard	60.8643	-0.7489
RNLI	05/07/2011	Equipment failure (vessel)	60.1823	-0.8101
RNLI	08/07/2011	Equipment failure (vessel)	60.1534	-0.7708
RNLI	20/07/2011	Leaks/Swamping	59.9994	-1.2001
RNLI	22/07/2011	Grounding	60.1585	-1.1488
RNLI	22/07/2011	Equipment failure (vessel)	60.3066	-1.6337
RNLI	04/08/2011	Equipment failure (vessel)	60.0953	-1.1112
RNLI	08/08/2011	Capsize/Sinking	60.2664	-0.4787
RNLI	21/08/2011	Equipment failure (vessel)	60.1790	-1.1493
MAIB	21/10/2011	Equipment Failure	60.0833	-1.3833
RNLI	21/10/2011	Equipment failure (vessel)	60.1410	-1.3806

Record Origin	Incident Date	Incident Type	Latitude	Longitude
RNLI	11/11/2011	Equipment failure (vessel)	60.1740	-1.1513
RNLI	24/01/2012	Equipment failure (vessel)	60.7533	-1.7850
RNLI	01/02/2012	Leaks/Swamping	60.0833	0.2500
RNLI	24/02/2012	Fire/Explosion	60.7355	-0.7302
RNLI	04/03/2012	Equipment failure (vessel)	60.1948	-1.1225
MAIB	27/03/2012	Flooding	59.9167	2.6167
RNLI	06/04/2012	Leaks/Swamping	60.7667	-0.9887
RNLI	17/04/2012	Equipment failure (vessel)	60.3397	-1.0983
MAIB	10/05/2012	Grounding/Stranding	60.1313	-1.3598
RNLI	11/05/2012	Leaks/Swamping	59.7775	-1.5537
MAIB	19/05/2012	Grounding/Stranding	60.2165	-1.5657
RNLI	20/05/2012	Equipment failure (vessel)	60.2045	-1.0807
RNLI	20/05/2012	Grounding	60.2165	-1.5657
RNLI	31/05/2012	Grounding	60.3728	-1.0200
RNLI	18/07/2012	Fire/Explosion	60.3852	-1.0050
RNLI	23/07/2012	Equipment failure (vessel)	60.0878	-0.7143
RNLI	17/08/2012	Man Overboard	60.1673	-1.1503
RNLI	22/10/2012	Aircraft crashed	59.5150	-2.0850
RNLI	22/10/2012	Aircraft crashed	59.4828	-2.0149
MAIB	08/12/2012	Equipment Failure	59.9478	-2.3357
RNLI	19/01/2013	Equipment failure (vessel)	60.3533	-0.6808
RNLI	02/04/2013	Person in distress	59.5567	-1.1467
RNLI	04/05/2013	Equipment failure (vessel)	60.1908	-1.6387
MAIB	05/05/2013	Contact Fixed object	60.4500	-1.2833
RNLI	27/05/2013	Equipment failure (vessel)	60.2863	-1.5436
RNLI	03/07/2013	Leaks/Swamping	61.4034	-1.1402
RNLI	05/07/2013	Grounding	60.1938	-1.0663
RNLI	27/07/2013	Equipment failure (vessel)	60.2768	-1.8475
RNLI	28/07/2013	Leaks/Swamping	59.9230	-1.2537
RNLI	05/08/2013	Grounding	60.1855	-1.3463
RNLI	23/08/2013	Aircraft crashed	59.8845	-1.3487
RNLI	24/08/2013	Aircraft crashed	59.8867	-1.3450
RNLI	24/08/2013	Aircraft crashed	59.8845	-1.3487
RNLI	25/08/2013	Person in distress	59.8867	-1.3450
MAIB	28/08/2013	Equipment Failure	60.1500	-1.5500
RNLI	07/09/2013	Person in distress	60.1593	-0.8187
RNLI	25/09/2013	Equipment failure (vessel)	60.2833	-1.0667
RNLI	01/10/2013	Equipment failure (vessel)	59.9418	-1.2293
MAIB	10/10/2013	Equipment Failure	60.4667	2.7500
RNLI	07/11/2013	Leaks/Swamping	59.3667	-1.0500
MAIB	10/11/2013	Person in distress	60.4833	-1.2833
MAIB	28/12/2013	Equipment Failure	59.8050	-1.3315
RNLI	28/12/2013	Equipment failure (vessel)	59.7900	-1.3733

Record Origin	Incident Date	Incident Type	Latitude	Longitude
RNLI	05/01/2014	Equipment failure (vessel)	59.3199	-1.1405
MAIB	08/01/2014	Flooding	60.4117	-1.4417
RNLI	08/01/2014	Leaks/Swamping	60.4020	-1.4377
RNLI	20/01/2014	Grounding	60.5333	0.2000
MAIB	24/02/2014	Collision	60.4500	-1.2833
MAIB	24/02/2014	Collision	60.4500	-1.2833
MAIB	25/03/2014	Flooding	60.2983	-1.5603
RNLI	25/03/2014	Grounding	60.2988	-1.5607
RNLI	22/04/2014	Person in distress	60.3553	-0.7595
RNLI	25/04/2014	Equipment failure (vessel)	60.1083	-1.1033
RNLI	17/05/2014	Equipment failure (vessel)	60.6523	-1.1498
RNLI	01/07/2014	Grounding	60.3342	-1.3728
RNLI	01/07/2014	Grounding	60.3342	-1.3728
RNLI	13/07/2014	Equipment failure (vessel)	60.1532	-0.7051
RNLI	13/07/2014	Person in distress	60.1099	-1.1907
MAIB	24/07/2014	Person in distress	60.6950	-1.7717
RNLI	27/07/2014	Person in distress	60.1880	-1.5947
RNLI	05/08/2014	Equipment failure (vessel)	59.8385	-1.3367
MAIB	17/08/2014	Collision	60.4500	-1.2833
MAIB	17/08/2014	Collision	60.4500	-1.2833
MAIB	17/08/2014	Collision	60.4500	-1.2833
RNLI	30/08/2014	Equipment failure (vessel)	60.1350	-1.1333
RNLI	31/08/2014	Equipment failure (vessel)	60.1378	-0.8852
RNLI	16/09/2014	Equipment failure (vessel)	59.3960	-1.3548
RNLI	24/09/2014	Leaks/Swamping	60.1467	-1.1250
RNLI	12/10/2014	Grounding	60.3330	-1.3738
MAIB	29/10/2014	Person in distress	60.4350	-1.7483
RNLI	21/12/2014	Leaks/Swamping	59.6767	-1.0600
MAIB	17/01/2015	Equipment Failure	59.9333	-1.4500
RNLI	17/01/2015	Equipment failure (vessel)	59.9480	-1.4182
MAIB	17/02/2015	Person in distress	60.0700	1.6200
RNLI	14/04/2015	Man Overboard	60.5368	-1.3250
RNLI	19/04/2015	Person in distress	60.1483	-1.1417
RNLI	12/05/2015	Equipment failure (vessel)	59.9670	-0.0353
RNLI	28/05/2015	Equipment failure (vessel)	60.3468	-1.3552
MAIB	15/06/2015	Grounding/Stranding	59.9017	-1.3863
RNLI	15/06/2015	Grounding	60.1533	-1.3625
RNLI	23/06/2015	Equipment failure (vessel)	60.2863	-1.3752
RNLI	06/07/2015	Equipment failure (vessel)	59.8733	-1.2800
RNLI	12/07/2015	Grounding	60.6980	-1.1339
RNLI	12/07/2015	Equipment failure (vessel)	60.2983	-0.6733
RNLI	16/07/2015	Equipment failure (vessel)	60.3488	-1.4747
RNLI	21/07/2015	Equipment failure (vessel)	60.1183	-1.1600

Record Origin	Incident Date	Incident Type	Latitude	Longitude
RNLI	01/08/2015	Person in distress	60.6645	-0.9112
RNLI	08/08/2015	Equipment failure (vessel)	60.0952	-1.3775
RNLI	09/08/2015	Equipment failure (vessel)	60.1532	-1.0065
RNLI	13/08/2015	Equipment failure (vessel)	60.1489	-1.1169
RNLI	15/08/2015	Equipment failure (vessel)	60.3338	-1.4505
MAIB	27/02/2016	Equipment Failure	60.1845	-1.3500
RNLI	07/03/2016	Equipment failure (vessel)	59.7530	-1.3752
RNLI	18/03/2016	Equipment failure (vessel)	60.1312	-1.1418
RNLI	27/05/2016	Fire/Explosion	60.2870	-1.3533
RNLI	02/06/2016	Fire/Explosion	60.0920	-3.4195
RNLI	13/06/2016	Person in distress	60.1450	-1.1379
MAIB	23/06/2016	Man Overboard	59.9833	-1.7333
RNLI	27/06/2016	Person in distress	60.1199	-1.1405
RNLI	27/06/2016	Equipment failure (vessel)	60.1532	-1.1187
MAIB	08/07/2016	Flooding	59.7092	-1.4170
RNLI	08/07/2016	Leaks/Swamping	59.7092	-1.4170
RNLI	08/07/2016	Man Overboard	59.7092	-1.4170
RNLI	23/07/2016	Leaks/Swamping	61.1667	0.0158
RNLI	06/08/2016	Person in distress	60.3067	-1.6553
RNLI	15/08/2016	Equipment failure (vessel)	60.1135	-1.1173
RNLI	23/08/2016	Equipment failure (vessel)	60.2835	-1.7115
MAIB	11/09/2016	Equipment Failure	60.0413	-1.4767
RNLI	11/09/2016	Equipment failure (vessel)	60.0670	-1.5352
RNLI	17/12/2016	Grounding	59.8865	-1.1405
RNLI	18/12/2016	Person in distress	60.1615	-1.1405
RNLI	03/03/2017	Other	60.4588	-0.2937
MAIB	14/03/2017	Equipment Failure	59.8858	-2.6292
RNLI	14/03/2017	Other	59.8858	-2.6292
RNLI	15/06/2017	Other	60.3325	-1.6817
RNLI	18/06/2017	Other	60.1000	-1.1152
RNLI	01/07/2017	Other	59.9845	-1.1000
RNLI	29/07/2017	Other	60.3268	-1.7025
RNLI	12/08/2017	Other	60.1393	-1.0031
RNLI	16/08/2017	Other	60.1333	-0.9833
RNLI	26/09/2017	Other	60.2955	-1.5403
RNLI	05/10/2017	Other	60.0380	-1.2027
RNLI	02/11/2017	Other	60.2017	-1.1000
RNLI	13/11/2017	Other	59.6840	-0.2702
RNLI	24/02/2018	Other	60.2140	-2.0008
RNLI	10/03/2018	Other	60.0840	-1.1500
RNLI	29/03/2018	Other	60.3823	-1.3992
RNLI	04/04/2018	Other	60.1001	-1.0834
RNLI	10/04/2018	Other	60.1573	-1.1427

Record Origin	Incident Date	Incident Type	Latitude	Longitude
RNLI	12/04/2018	Other	60.3267	-1.0767
RNLI	09/05/2018	Person in distress	60.6324	-1.1966
RNLI	10/05/2018	Other	60.1556	-1.1228
RNLI	15/06/2018	Other	60.6083	-0.6033
RNLI	24/06/2018	Other	60.2488	-1.0916
RNLI	24/06/2018	Other	59.8218	-0.1935
RNLI	30/06/2018	Other	60.3489	-1.4520
RNLI	03/07/2018	Fire/Explosion	60.6175	-1.4218
RNLI	04/07/2018	Other	60.2045	-1.0740
RNLI	10/07/2018	Other	60.2005	-1.0040
RNLI	18/07/2018	Other	59.7031	-0.1171
RNLI	30/07/2018	Other	60.1880	-1.1032
RNLI	11/08/2018	Other	59.8320	-1.3336
RNLI	27/08/2018	Other	60.3287	-1.6475
RNLI	11/10/2018	Other	60.1915	-1.0958
RNLI	11/10/2018	Other	60.1922	-1.0848
RNLI	11/11/2018	Other	60.3549	-1.3853
RNLI	10/12/2018	Other	59.9992	-1.1886
RNLI	08/02/2019	Other	60.1477	-1.1593
RNLI	10/03/2019	Other	59.5343	-1.6333
RNLI	30/03/2019	Other	60.1941	-1.0875
RNLI	02/06/2019	Other	60.2842	-1.7934
RNLI	06/06/2019	Fire/Explosion	59.9663	-1.3684
RNLI	07/07/2019	Other	60.3483	-1.4407
RNLI	14/07/2019	Other	60.1481	-1.1585
RNLI	23/07/2019	Other	60.1472	-1.1428
RNLI	02/08/2019	Other	60.1102	-1.1222
RNLI	03/08/2019	Other	60.1483	-1.1444
RNLI	04/08/2019	Other	60.3689	-1.8284
RNLI	04/08/2019	Other	60.3698	-1.8270
RNLI	17/08/2019	Other	60.3682	-1.8263
RNLI	19/08/2019	Other	60.0822	-0.8288
RNLI	21/08/2019	Other	60.3408	-1.4425
RNLI	23/08/2019	Other	60.1533	-1.1203
RNLI	08/10/2019	Other	59.8541	-1.2430
RNLI	06/11/2019	Other	59.8938	-1.2762
RNLI	15/11/2019	Fire/Explosion	60.2113	-1.0839
RNLI	16/11/2019	Other	60.2109	-1.0836

B Consultation Responses

The following table documents the comments provided by consultees. The first column identifies the consultee group or organisation, the second column identifies the comments made. Each comment has been given a unique identifying code and number, (for example, SFF1 = Shetland Fisherman Federation Comment 1) with the final column providing the document reference in which the comment has been addressed.

Consultee	Comments	NRA Cross-reference
Shetland Fisherman Federations	It must be noted that there is fishing interests in most of the area, both inshore and offshore and would be concerned if our activities were hampered either by fishing restrictions or any debris which may be picked up in fishing gear. SFF1 From the information provided it looks like this will not be an issue and we will have adequate warning of any activity in the area by VHF and M notice. SFF2	SFF1 –3.3 SFF2 – 9.1
National Federation of Fishermen's Organisation NFFO	*Awaiting response*	
Shetland Shellfish Federation	SSF understand that there will not be restrictions on fishing activity, except that detailed around the launching and recovery of rockets/balloons. This is reassuring given that Shetland Shellfish Management Organisation has 103 licensed shellfish vessels operating around Shetland. SSF1	SSF1 – 3.3
RYA	Rather few recreational boats pass through the area. Those that do generally hug the coast before passing quite close to outside Muckle Flugga and the Out Stack. Vessels will generally avoid the Skaw Röst which extends about 2 nautical miles east of Lamba Ness and Holm of Ness. A few vessels may head for the Faroe Islands but would be on a course to the northwest. The AIS heat map for recreational boats on NMPi suggests that boats heading to the NW will go through Bluemull Sound rather than going to the north of Unst. RYA1 It would be useful to publicise dates and times well in advance. Knowing dates when launching will not take place would also be useful. However, Notices to Mariners posted at Lerwick and the other Shetland marinas would be adequate. The most important method of communication should be a Securité message as mentioned in your letter. Ideally this should be included in the 0710 Shetland MCA Safety Information Broadcast as well as being broadcast immediately before the launch. RYA2	RYA1 – 4.4 RYA2 – 9.1 RYA3 – 4.4

Consultee	Comments	NRA Cross-reference
	About 25% of recreational vessels in Shetland waters transmit AIS signal and recreational craft are often difficult to spot on radar. The support vessel can presumably act as a guard vessel and watch out for recreational craft. RYA3	
Lerwick sailing Club	*Response awaited*	
Shetland Islands Council	There is likely to be local and perhaps national interest in such launches – this may result in numbers of recreational craft being in the area to spectate – has this been considered? SIC1 No one else within SIC has come forward with any other comments other than supporting the ones I have already made. Have you consulted with ships agents at all – GAC & Denholms cover most of the tanker traffic, and the SFA & SSMO for fishermen. I can contact them on your behalf if you have a draft consultation statement to use.	SIC1 – 7.2
Sullom Voe Terminal	Can you let me know the approx. size, weight of the equipment beneath the balloon? Interested in the, albeit unlikely chance, risk it might have on a tanker should it impact on it during descent. SVT1 Also aware that winds can vary in strength and direction at different altitudes, just confirming that there are no credible scenarios for the balloon and package to land at Sullom Voe Terminal. SVT2 How many and when do you expect to see launches? Last point, I presume there will be some notice to mariners and aircraft about the launch and how it might impact fixed wing flight ad helicopter operations using Scatsta.	SVT1 – 5.3 SVT2 - 5.2, 9.1.1 Note: The consultees questions were answered and there were no further comments at this stage.
Lerwick Port Authority	Vessels are frequently transiting the area heading to our port which we do not want to hamper by adding additional distance to pass around , however if you are looking at a 45 mins deployment with radar and AIS monitoring to confirm an available slot with no passing vessels prior to going ahead with the launch then I see no issue. Provided the items are recovered from the water quickly, or vessels can be informed of the location, or can be seen by passing ships, I see no issue. Smaller inshore or pleasure vessels may be more difficult to maintain communication with, so some local notices in the marinas or local press may be useful to capture more of these. LHA1	LHA1 – 9.1

Consultee	Comments	NRA Cross-reference
Northern Lighthouse Board	The Northern Lighthouse Board has no objections to the Shetland Space Centre proposed weather balloon and rocket launches. SSC should ensure that all necessary aviation notifications are broadcast and copied to Northern Lighthouse Board as we have several assets in the immediate area that are accessed by air (helicopter) – Muckle Flugga, Holm of Skaw and Balta Sound Lighthouses. NLB1	NLB1 – 3.6
MCA	See Appendix C - MCA Meeting Minutes	
Cruising Association	Considering the Rockets and Weather Balloons separately. <u>Rocket:</u> 1) The safety area looks very much larger than the estimated impact area. 2) It is very unlikely that yachts would be anywhere close to the estimated impact area as the passage round the N end of Unst is within 1 NM of the coast. Longer distance cruisers will want to sail north of Out Stack (the northern most point of the British Isles) as part of a circumnavigation of the British Isles. There are overfalls ~1 cable north of Out Stack and so yachts are unlikely to stray further north. This route is not heavily used by cruising vessels; local fishing vessels are likely to be more prevalent. 3) It would take ~2.0 hours to transit the safety area if making passage between Muckle Flugga and Balta Sound (~10NM). 4) Once the rocket has cleared the launch area there would be no danger to vessels on passage as described in 2) above and restrictions within say 2 miles of the coast could be lifted, 5) The ideal time to make this passage is from a tidal planning perspective West – East HW(Lerwick) – HW+2 East to West LW (Lerwick -1) to LW +1 6) Poor time to make the passage would be HW -2.5 to HW -1 and HW+2.5 to HW +4.5 Launches during the poor transit times would cause last disruption to yachts on transit. With some flexibility over timing and an appropriate communications strategy it should be possible to launch in such a way as to avoid any undue hazard to cruising vessels. The existing Gunfacts system used for Royal Navy firing (Gunfacts) would be an acceptable way of dealing with launches.	

Consultee	Comments	NRA Cross-reference
Cont. Cruising Association	<u>Weather Balloons:</u> 1) The Operation window is huge and any exclusion covering the whole area would be unreasonable. 2) Vessels transiting the area would be as described in 2) above (comments on rocket launches) PLUS vessels travelling between Shetland and Norway. Out Skerries is a common starting point and landfall for a crossing of the North Sea and those bound for Lerwick would need to transit the area. 3) Detecting glass fibre yachts by radar can be difficult. 4) Vessels travelling from Norway pose a particular problem because yachts made of glass-fibre can be difficult to pick up on radar, even with radar reflectors and VHF reception, vessel to vessel, may be 20miles or less. The risk posed by the Balloons is of a low probability but the consequences of a crew member being hit by the falling balloon and its equipment could be moderately severe, but you will no doubt take expert advice on that. CA1 It would be very unreasonable to exclude vessels from this very large area during a balloon flight. Given the uncertainty of contact with vessels over such a large area all reasonable measures should be taken to inform vessels of the track of a balloon flight. Consideration could be given to installing an AIS transmitter on the balloon but the value of this would need to be weighed against the increased payload and hence potential for damage or injury. I note that it is intended to issue appropriate notice to mariners and that a recovery vessel will be in the vicinity of the expected landing zone and will be able to warn vessels in the vicinity of the impending landing. Vessels travelling from Norway will be unlikely to have seen Notice to Mariners and so an important part of the communications strategy should be to provide a general warning of the activity with contact details for up to date information on launches. This should include: *The Cruising Association Almanac* and *Reeds Nautical Almanac* (annual publications), and *The Clyde Cruising Club Sailing Directions for Orkney and Shetland* plus local websites for visiting yachtsmen. The existing Gunfacts system used for Royal Nay firing would be an acceptable way of dealing with launches but the above limitations would need to be considered in its implementation.	CA1 – 8.1.4

Consultee	Comments	NRA Cross-reference
UKHO	If the limits of the zone/s are likely to change, we would probably not include details (e.g. exclusion zone) on standard paper charts or ENCs prior to the initial launch. In this case, it would be easier to describe the area/s in a Nav Warning/Temporary Notice to Mariners if they were defined as a rectangular or circular area (although a Temporary Notice could include a diagram). If the site is to be used on a regular basis and the limits will not change, we can include details on standard charts/ENCs, and in Sailing Directions and The Mariners Handbook (and possibly on our Marine Data Portal), similar to the details we include for firing practice areas. We can then refer to the charted limits in any Temporary Notice to Mariners or Nav Warning. And finally, following the launch, UKHO would need to be informed of any debris which is not recovered, in order that we can include it on charts – exact position, nature/size of debris, depth of water over it (at LAT).	
Chamber of shipping	Providing that NtM and VHF signals are provided, and the activity does not interfere with Sullom Voe, Lerwick or other ports then the Chamber does not see considerable issue.	
RNLI Lerwick/Aith	*Response awaited*	
Oil and Gas Association	Our specialists have highlighted that from the perspective of the offshore oil and gas sector that it should be ensured that there is no disruption to flights to offshore facilities and that the launches went nowhere near Sullom Voe terminal or any other onshore or offshore oil and gas facilities in the area. OGA1 These are however mainly matters for the Health and Safety Executive and the Offshore Petroleum Regulator for Environment and Decommissioning (OPRED – who are part of the Department for Business, Energy and Industrial Strategy [BEIS]) and we would advise that you continue to keep them abreast of your plans. We would also advise, that if you have not already done so, that you contact the UK oil industry representative body, Oil & Gas UK. OGA2	OGA1 – 5.2 OGA2 – consultation with Oil and Gas UK is undergoing, see response within this table.
North Link Ferries	*Response awaited*	

C MCA Meeting Minutes

Subject	**MCA Meeting - Navigational Risk Assessment**		
Project	Shetland Space Centre (SSC)	**Project No:**	4858
Date/Time	24 March 2020		
Location	Microsoft Teams		
Participants	J. Meheut (JM)	SSC	
	H. Croxson (HC)	MCA	
	N. Salter (NS)	MCA	
	T. Bulpit (TB)	MCA	
	A. Fitzpatrick (AF)	ABPmer	
	H. Aitchison (HA)	ABPmer	

Notes	
1	**Introduction** HA began the meeting and talked through the agenda.
2	Project Overview JM spoke about the proposed launches, giving background and overview to MCA. SSC will be undertaking three types launch covered by the NRA namely balloon launches rockoon (rockets launched from balloons) and sounding rockets. The balloon launches will have an operating area centred on the launch site and will extend from the west clockwise to south-south-east to avoid interaction with ports and the oil and gas terminal at Sullom Voe. (See Figure 1) Prior to a balloon launch the predicted track will be calculated up to the day of the launch taking in consideration of change in weather. It is only possible to predict a balloon launch from 7 days prior to launch. The balloon will be tracked and monitored during the operation and a recovery vessel will be transiting to the drop zone to recover the payload and balloon. The rocket launch area is north from Unst with a maximum range of 60 km and an error of *circa* 5 degrees, this range can be reduced after a few launches using trajectory calculations. There will be a precautionary area established from the launch site and drop zone. The zone will be monitored from the patrol vessel and from the base station by using AIS and RADAR. Prior to launches Notice to Mariners will be published, NAVTEX warnings and Sécurité messages will be broadcast before and during the launch. A rocket launch will not exceed 45 minutes in length. (See Figure 2 for Rocket Operational Area) On descent the rocket will deploy a parachute 1 km above the sea surface to allow recovery of the fuselage and payload.

3	**Consultations** HA listed the consultees which have been contacted: • Shetland Islands Council • Lerwick Harbour • Scottish Fisherman Association • Shetland Fishermen Association • Shetland shellfish management organisation • Cruising Association • Oil and Gas Authority • RNLI • RYA • Mid Yell boating and social club • Delting Boating Club • Lerwick Boating Club • Chamber of Shipping HC identified other parties to consult with, they included: • NLB • Marine Scotland • Civil Aviation Association • Regular operators in the area • UKHO
4	**Headline Risks** HA outlined the 6 risks identified: 1. Balloon or rocket debris in water are not identified by transiting vessels. Get caught in prop of small vessel, disabling the propulsion. 2. Patrol/recovery vessel collides with transiting vessel (Head-on/Crossing) 3. Vessels entering rocket precautionary area during launch. 4. Parachute not deploying and rocket strikes vessel ballistically. 5. Balloon Payload lands on oil rig or within the 500 m exclusion zone. 6. Bad weather restricts vessel recovery/movement NS commented that consideration needs to be given to the potential for the payload/debris to land in the 500 m exclusion zone of an oil and gas platform. JM described the issues with communication in previous launches which were down to: • Crew inexperienced • Last minute crew/vessel changes In future operations, vessel and crew credentials will be checked and confirmed prior to operations. In addition, Local notice to mariners, Sécurité broadcasts and launch times are published to notify the operators and the public.

	NS queried how the payload will be tracked and backups in case of failure as they have been lost in previous launches. JM confirmed that the payload has GPS tracking as is primary device and the recovery vessel will have a frequency tracker which will be able to detect the payload when it is inverted and not broadcasting GPS.
5	**Additional Topics** JM described the mitigation to be used during the operations: • Prediction run • LNtM published in the local paper • VHF Sécurité notice • Operation zones • Precautionary area • Guard/recovery vessel • AIS Monitoring • Binoculars rocket trajectory analysis • Lights on payload. HC highlighted the list of items that MCA would expect to be considered for any application for launches going forward. List to be included with minutes. **Marine Traffic Analysis** AIS satellite data from a period in Summer 2019 and one in winter 2020. This data is for a 400 km^2 area centred on the launch site to show vessel transit patterns. Other means to identify vessel activity in the area are from RYA coastal atlas, VMS density grid and consultation with local operators. HC said that the approach taken to the traffic analysis would need to provide an accurate picture of the traffic in the area in the absence of any radar surveys, noting that AIS will not be carried by all vessels. HC stated that space launch activities were a new area for the MCA, where we would need to apply our safety policy and search and rescue requirements. There was a need therefore to keep us posted on progress and maintain dialogue to ensure the requirements were being adequately addressed.

D Navigational Risk Assessments

Assessment Number	Hazard Category	Hazard Scenario Title	Worst Credible Scenario	Years between worst occurrence	Consequence				Most Likely Scenario	Years between likely occurrence	Consequence				Inherent Risk	Current Risk	Cause ID	Causes
					People	Property	Planet	Business			People	Property	Planet	Business				
1	Machinery related accidents	Balloon or parachute from the sounding rocket lands in water and becomes entangled in small craft's propeller(s) or steering gear (rudder)	Balloon lands in water and goes unidentified by-passing small vessel or recreational craft. The parachute cord and balloon gets entangled in the propeller causing the vessel to lose control and propulsion. Vessel starts to roll uncontrollably in large swell and capsizes. multiple fatalities and loss of vessel.	50	4	3	3	2	Small vessel collides with pay load damaging the instrument and camera and continuing on voyage, no damage to vessel	5	0	1	0	0	4.55	Mod	1	Human error/fatigue - commercial vessel
																	4	Human error/fatigue - recreational vessel
																	6	Inadequate bridge resource management
																	16	Unplanned interaction with recreational/fishing craft
																	21	Equipment failure - steering/propulsion
																	28	Restricted visibility
																	36	Failure of payload Navigation light (Unlit)
																	87	Notice to Mariners failure to observe
																	101	Unexpected change in schedule

Control ID	Embedded Controls				Aggregate Risk	Current Risk	Control ID	Further Applicable Controls				Residual Risk	Final Risk
	Control	Comment	Likelihood Reduction	Consequence Reduction				Control	Comment	Likelihood Reduction	Consequence Reduction		
53	SOLAS	International regulation providing regulations for commercial vessels dependent on size	0%	5%	4.48	Mod	2	Predicted balloon/rocket runs	Prediction software to determine flight paths	5%	0%	4.35	Low
54	Emergency services equipment - third party	Coastguard, local SAR and ambulance services	0%	5%	4.55		6	Local Notice to Mariners		5%	0%	4.30	
							16	AIS/Radar coverage	Marine space monitored for vessel activity	5%	5%	4.04	
							17	Patrol/ Recovery vessel	Recovery of payload and warning of other sea users of SSC's activities	15%	10%	3.49	
							21	Notices to mariners		5%	0%	3.45	
							41	Precautionary area	Rocket firing range to ensure vessels are aware of potential risks	5%	0%	3.41	
							46	Operation zones	Zones for SSC clearly defined	5%	0%	3.37	
							52	Nav Warnings		5%	0%	3.33	
							25	Lights and reflective tape on payload	Navigation aid to warn seafarers	5%	0%	3.30	

Assessment Number	Hazard Category	Hazard Scenario Title	Worst Credible Scenario	Years between worst occurrence	Consequence				Most Likely Scenario	Years between likely occurrence	Consequence				Inherent Risk	Current Risk	Cause ID	Causes
					People	Property	Planet	Business			People	Property	Planet	Business				
2	Machinery related accidents	Balloon, or parachute from the sounding rocket and Payload land on marine infrastructure, such as an oil rig Oil rig	Balloon lands on an oil rig and gets caught in machinery and causing it to stop, effecting the production of the oil rig. Loss of revenue for the rig and damaged equipment.	50	1	1	0	0	Balloon lands within the oil rigs exclusion zone and is not recoverable by the patrol vessel and the equipment is lost.	10	0	1	0	0	2.00	Low	2	Human error/fatigue - shore staff
																	26	Adverse weather conditions
																	79	Weather & hydro failure - equipment

Control ID	Embedded Controls				Aggregate Risk	Current Risk	Control ID	Further Applicable Controls				Residual Risk	Final Risk
	Control	Comment	Likelihood Reduction	Consequence Reduction				Control	Comment	Likelihood Reduction	Consequence Reduction		
17	Patrol/ Recovery vessel	Oil rig standby/Patrol vessels			2.00	Low	2	Predicted balloon/rocket runs	Prediction software to determine flight paths	25%	0%	1.68	Low
							32	Weather forecasting	Constant weather monitoring prior to operations	10%	0%	1.59	
							46	Operation zones	Rocket firing range to ensure vessels are aware of potential risks	5%	0%	1.54	

Assessment Number	Hazard Category	Hazard Scenario Title	Worst Credible Scenario	Years between worst occurrence	Consequence				Most Likely Scenario	Years between likely occurrence	Consequence				Inherent Risk	Current Risk	Cause ID	Causes
					People	Property	Planet	Business			People	Property	Planet	Business				
3	Other	Balloon, or parachute from the sounding rocket and payload land on a vessel berthed at in Sullom Voe oil terminal	Balloon lands within the oil terminal disrupting operations and distracting personnel causing minor injuries to people and a loss of revenue from disruption to operations.	25	1	0	0	1	Balloon lands within Sullom Voe oil terminal causing little disruption to activities and is recovered by SSC under supervision of the terminal. Negative local publicity.	5	0	0	0	1	2.41	Low	2	Human error/fatigue - shore staff
																	26	Adverse weather conditions
																	79	Weather & hydro failure - equipment

Control ID	Embedded Controls				Aggregate Risk	Current Risk	Control ID	Further Applicable Controls				Residual Risk	Final Risk
	Control	Comment	Likelihood Reduction	Consequence Reduction				Control	Comment	Likelihood Reduction	Consequence Reduction		
					2.41	Low	2	Predicted balloon/rocket runs	Prediction software to determine flight paths	25%	0%	2.20	Low
							32	Weather forecasting	Constant weather monitoring prior to operations	10%	0%	2.14	
							46	Operation zones	Rocket firing range to ensure vessels are aware of potential risks	5%	0%	2.12	

Assessment Number	Hazard Category	Hazard Scenario Title	Worst Credible Scenario	Years between worst occurrence	Consequence				Most Likely Scenario	Years between likely occurrence	Consequence				Inherent Risk	Current Risk	Cause ID	Causes
					People	Property	Planet	Business			People	Property	Planet	Business				
4	Accidents to personnel	Man Overboard when collecting balloon, sounding rocket or payload from the sea surface	Whilst collecting the payload after a launch a member of the crew gets pulled overboard and hits is head while retrieving the item. Possible fatality and adverse national publicity.	25	4	0	0	2	Crew member of the patrol boat get pulled overboard whilst retrieving payload and suffers minor injuries and is recovered from the water quickly.	5	1	0	0	0	4.28	Mod	1	Human error/fatigue - commercial vessel
																	5	Human error/fatigue - marine personnel
																	23	Communication failure - operational/procedural
																	26	Adverse weather conditions
																	76	Inadequate training/competence - Others
																	114	Competence

Control ID	Embedded Controls				Aggregate Risk	Current Risk	Control ID	Further Applicable Controls				Residual Risk	Final Risk
	Control	Comment	Likelihood Reduction	Consequence Reduction				Control	Comment	Likelihood Reduction	Consequence Reduction		
39	Standards of Training, Certification and Watchkeeping for Seafarers (STCW)		5%	5%	4.15	Mod	Low	Emergency Response Plan	SSC's Emergency Response Plan	0%	5%	3.93	Low
40	Vessel safety management system (ISM code)		5%	0%	4.17		55	Standard Operating Procedure –	Procedures for recovery of items	5%	5%	3.53	
47	Safe Access		5%	0%	4.19								
48	Emergency equipment available	Coastguard, local SAR and ambulance services	0%	5%	4.23								
53	SOLAS	Vessel carrying correct SOLAS equipment	0%	5%	4.28								

Assessment Number	Hazard Category	Hazard Scenario Title	Worst Credible Scenario	Years between worst occurrence	Consequence				Most Likely Scenario	Years between likely occurrence	Consequence				Inherent Risk	Current Risk	Cause ID	Causes
					People	Property	Planet	Business			People	Property	Planet	Business				
5	Loss of hull integrity /Flooding	Adverse weather disrupting patrol vessel operations.	Adverse weather causes large swells and high winds which begin to flood the patrol vessel which capsizes and sinks. Loss of life and vessel. Negative national publicity and tier 2 pollution.	50	4	2	3	2	Payload recovery operations have to be abandoned and patrol vessel returns to port for safety. Payload lost at sea, adverse local publicity.	5	0	1	0	1	4.82	Mod	1	Human error/fatigue - commercial vessel
																	26	Adverse weather conditions
																	37	Failure to comply with safe systems of work
																	48	Risk Assessment, Incomplete/not reviewed
																	79	Weather & hydro failure - equipment

Control ID	Embedded Controls				Aggregate Risk	Current Risk	Control ID	Further Applicable Controls				Residual Risk	Final Risk
	Control	Comment	Likelihood Reduction	Consequence Reduction				Control	Comment	Likelihood Reduction	Consequence Reduction		
39	Standards of Training, Certification and Watchkeeping for Seafarers (STCW)		5%	5%	4.67	Mod	1	Operational planning	Launches planned in advance with weather restrictions	5%	0%	4.57	Mod
54	Emergency services equipment - third party	Coastguard, local SAR and ambulance services		10%	4.82		32	Weather forecasting		5%	0%	4.51	
							43	Contractor risk assessment method statement (RAMS)	Risk assessments to assess the limits of operation	5%	0%	4.45	
							51	Emergency Response Plan	SSC's Emergency Response Plan	0%	5%	4.23	

Assessment Number	Hazard Category	Hazard Scenario Title	Worst Credible Scenario	Years between worst occurrence	Consequence				Most Likely Scenario	Years between likely occurrence	Consequence				Inherent Risk	Current Risk	Cause ID	Causes
					People	Property	Planet	Business			People	Property	Planet	Business				
6	Other nautical safety	Parachute does not deploy and sounding rocket or balloon strikes vessel	The parachute of the rocket doesn't deploy and rocket strikes vessel ballistically. Possibility of loss of life and seriously injured crew members.	50	4	1	0	2	Rockets parachute fails to deploy and rocket hits water ballistically causing the rocket to be damaged and loss and some damage to the payload. Loss of equipment and negligible pollution from damaged payload.	5	0	0	1	1	4.21	Mod	1	Human error/fatigue - commercial vessel
																	4	Human error/fatigue - recreational vessel
																	7	Inadequate procedures in place onboard vessel
																	24	Communication failure - equipment
																	44	Radar coverage inadequate
																	59	Inadequate procedures shoreside
																	75	Inadequate maintenance/inspection
																	87	Notice to Mariners failure to observe

Control ID	Embedded Controls				Aggregate Risk	Current Risk	Control ID	Further Applicable Controls				Residual Risk	Final Risk
	Control	Comment	Likelihood Reduction	Consequence Reduction				Control	Comment	Likelihood Reduction	Consequence Reduction		
54	Emergency services equipment - third party	Coastguard, local SAR and ambulance services	0%	10%	4.21	Mod	1	Operational planning	Launches planned in advance with weather restrictions	5%	0%	4.05	Low
							2	Predicted balloon/rocket runs	Prediction software to determine flight paths	10%	0%	3.96	
							6	Local Notice to Mariners		5%	0%	3.91	
							17	Patrol/ Recovery vessel	Recovery of payload and warning of other sea users of SSC's activities	5%	0%	3.87	
							21	Notices to mariners		5%	0%	3.83	
							29	Visual confirmation (clear line of sight)	Watching the launch with binoculars	5%	0%	3.79	
							41	Precautionary area	Rocket firing range to ensure vessels are aware of potential risks	5%	0%	3.76	
							44	VHF Sécurité Messages		5%	0%	3.72	
							46	Operation zones	Zones for SSC clearly defined	5%	0%	3.69	
							52	Nav Warnings		5%	0%	3.66	

Assessment Number	Hazard Category	Hazard Scenario Title	Worst Credible Scenario	Years between worst occurrence	Consequence				Most Likely Scenario	Years between likely occurrence	Consequence				Inherent Risk	Current Risk	Cause ID	Causes
					People	Property	Planet	Business			People	Property	Planet	Business				
7	Collision	Patrol vessel collides with other traffic	The patrol/recovery vessel *enroute* to recover the payload does not see another vessel and strikes them head on or side on which leads to a hole in the hull which floods the vessel and sinks. Crew suffer serious injuries or fatalities. Negative national publicity and tier 2 pollution.	50	4	3	3	2	The patrol/recovery vessel has a glancing blow with other vessel transiting the area. Minor injuries onboard from impact with the vessel and local adverse publicity.	10	1	0	0	1	4.92	Sig	1	Human error/fatigue - commercial vessel
																	4	Human error/fatigue - recreational vessel
																	6	Inadequate bridge resource management
																	16	Unplanned interaction with recreational/fishing craft
																	21	Equipment failure - steering/propulsion
																	23	Communication failure - operational/procedural
																	28	Restricted visibility
																	56	COLREGS failure to comply
																	76	Inadequate training/competence - Others
																	114	Competence

Control ID	Embedded Controls				Aggregate Risk	Current Risk	Control ID	Further Applicable Controls				Residual Risk	Final Risk
	Control	Comment	Likelihood Reduction	Consequence Reduction				Control	Comment	Likelihood Reduction	Consequence Reduction		
16	AIS/Radar coverage	Commercial vessels able to monitor other vessels by Radar and, where equipped, AIS	10%	0%	4.68	Sig	19	Training of operations personnel	Personnel involved in the launch are appropriately trained	5%	5%	4.42	Mod
26	International COLREGS 1972 (as amended)	Provides rules to prevent vessel collision	5%	0%	4.71		51	Emergency Response Plan	SSC's Emergency Response Plan	0%	10%	3.99	
34	Vessel maintenance		5%	0%	4.74		35	Vessel inspection/survey	Check of vessels and crew's certification before contracted	5%	5%	4.33	
39	Standards of Training, Certification and Watchkeeping for Seafarers (STCW)		5%	0%	4.77		21	Notices to mariners		5%	0%	4.25	
54	Emergency services equipment - third party	Coastguard, local SAR and ambulance services	0%	10%	4.92		50	Promulgation of information		5%	0%	4.17	

Assessment Number	Hazard Category	Hazard Scenario Title	Worst Credible Scenario	Years between worst occurrence	Consequence				Most Likely Scenario	Years between likely occurrence	Consequence				Inherent Risk	Current Risk	Cause ID	Causes
					People	Property	Planet	Business			People	Property	Planet	Business				
8	Other nautical safety	Sounding rocket or balloon debris get caught in fisherman's nets	Rocket/balloon and payload get caught in fisherman's nets and damage gear. Adverse local publicity.	25	0	1	0	0	Rocket/balloon and payload get caught in fisherman's nets and are pulled up on deck causing little to no damage.	5	0	1	0	0	2.22	Low	26	Adverse weather conditions
																	59	Inadequate procedures shoreside

Control ID	Embedded Controls				Aggregate Risk	Current Risk	Control ID	Further Applicable Controls				Residual Risk	Final Risk
	Control	Comment	Likelihood Reduction	Consequence Reduction				Control	Comment	Likelihood Reduction	Consequence Reduction		
0					2.22	Low	6	Local Notice to Mariners		5%	0%	2.19	Low
							19	Training of operations personnel	Personnel involved in the launch are appropriately trained	5%	5%	2.03	
							21	Notices to mariners		5%	0%	2.00	
							25	Lights and reflective tape on payload	Navigation aid to warn seafarers	5%	0%	1.97	
							52	Nav Warnings		5%	0%	1.94	

Assessment Number	Hazard Category	Hazard Scenario Title	Worst Credible Scenario	Years between worst occurrence	Consequence				Most Likely Scenario	Years between likely occurrence	Consequence				Inherent Risk	Current Risk	Cause ID	Causes
					People	Property	Planet	Business			People	Property	Planet	Business				
9	Other nautical safety	Spectator vessels: sightseeing, day boats and other recreational craft	Spectators in recreational boats and day boats gather in groups to observe a launch. Increased chance of collision between vessels, moderate damage to vessel, major injuries to people and national adverse publicity.	25	3	1	0	2	Due to increased vessel traffic there is an increased chance that vessels will collide making contact with one another in glancing blow minor injuries to people and, local adverse publicity.	5	1	1	0	1	4.52	Mod	4	Human error/fatigue - recreational vessel
																	6	Inadequate bridge resource management
																	7	Inadequate procedures in place onboard vessel
																	11	Vessel breakdown or malfunction
																	16	Unplanned interaction with recreational/fishing craft
																	56	COLREGS failure to comply
																	76	Inadequate training/competence - Others

Control ID	Embedded Controls				Aggregate Risk	Current Risk	Control ID	Further Applicable Controls				Residual Risk	Final Risk
	Control	Comment	Likelihood Reduction	Consequence Reduction				Control	Comment	Likelihood Reduction	Consequence Reduction		
26	International COLREGS 1972 (as amended)	Provides rules to prevent vessel collision	5%	0%	4.35		6	Local Notice to Mariners		5%	0%	4.33	
7	Passage planning	Planning of vessels passage from berth to berth	5%	0%	4.37		21	Notices to mariners		5%	0%	4.28	
34	Vessel maintenance	Maintenance of vessels steering and propulsion components	5%	0%	4.39	Mod	46	Operation zones	Zones for SSC clearly defined	5%	0%	4.23	Mod
54	Emergency services equipment - third party	Coastguard, local SAR and ambulance services	0%	5%	4.52		44	VHF Sécurité Messages		5%	0%	4.19	

Contact Us

ABPmer

Quayside Suite,
Medina Chambers
Town Quay, Southampton
SO14 2AQ

T +44 (0) 23 8071 1840
F +44 (0) 23 8071 1841
E enquiries@abpmer.co.uk

www.abpmer.co.uk