ACCIDENT REPORT

Report on the investigation of the near miss

between the ro-ro ferry

***Stena Superfast VII***

and a submerged

***Royal Navy submarine***

in the North Channel

on 6 November 2018

MAIB

MARINE ACCIDENT INVESTIGATION BRANCH

MARINE INCIDENT REPORT NO 13/2020 JULY 2020

**Extract from**

**The United Kingdom Merchant Shipping**

**(Accident Reporting and Investigation)**

**Regulations 2012 – Regulation 5:**

*"The sole objective of the investigation of an accident under the Merchant Shipping (Accident Reporting and Investigation) Regulations 2012 shall be the prevention of future accidents through the ascertainment of its causes and circumstances. It shall not be the purpose of an investigation to determine liability nor, except so far as is necessary to achieve its objective, to apportion blame."*

NOTE

This report is not written with litigation in mind and, pursuant to Regulation 14(14) of the Merchant Shipping (Accident Reporting and Investigation) Regulations 2012, shall be inadmissible in any judicial proceedings whose purpose, or one of whose purposes is to attribute or apportion liability or blame.



Front cover image courtesy of Stena Lines

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# CONTENTS

## FIGURES



## TABLES

# GLOSSARY OF ABBREVIATIONS AND ACRONYMS

| | | |
|---|---|---|
| AIS | - | Automatic Identification System |
| ALRS | - | Admiralty List of Radio Signals |
| COMFASFLOT | - | Commander Faslane Flotilla |
| COMOPS | - | Royal Navy's Commander of Operations |
| COQC | - | Commanding Officers' Qualifying Course (or 'Perisher') |
| CPA | - | Closest Point of Approach |
| DAIB | - | Defence Accident Investigation Branch |
| DSA | - | Defence Safety Authority |
| ECDIS | - | Electronic Chart Display and Information System |
| ETA | - | Estimated Time of Arrival |
| ETD | - | Estimated Time of Departure |
| FOST | - | Flag Officer Sea Training |
| HAZREP | - | Hazard Report |
| HMNB | - | Her Majesty's Naval Base |
| HQ | - | Headquarters |
| hrs | - | hours |
| IRPCS | - | International Regulations for Preventing Collisions at Sea, 1972, as amended |
| ISI | - | Immediate Ship's Investigation |
| kts | - | knot |
| Kyds | - | Kilo (thousands) of yards |
| LfE | - | Learning from Experience |
| m | - | metre |
| MCA | - | Maritime and Coastguard Agency |
| mins | - | minutes |
| MoD | - | Ministry of Defence |
| NAVTEX | - | Navigational and Meteorological Warning Broadcast Service |
| NCHQ | - | Navy Command Headquarters |
| nm | - | nautical mile |
| OOW | - | Officer of the Watch |
| PA | - | Preliminary Assessment |

| | | |
|---|---|---|
| RN | - | Royal Navy |
| secs | - | seconds |
| SMCS | - | Submarine Command System |
| SMS | - | Safety Management System |
| SOA | - | Speed of Advance |
| SOG | - | Speed over Ground |
| STCW | - | International Convention on the Standards of Training, Certification and Watchkeeping for Seafarers 1978, as amended |
| SUBFACTS | - | Submarine Information Broadcast |
| SUBOPAUTH | - | Submarine Operating Authority |
| TSS | - | Traffic Separation Scheme |
| UK | - | United Kingdom |
| UTC | - | Co-ordinated Universal Time |
| VDR | - | Voyage Data Recorder |
| VHF | - | Very High Frequency |
| WECDIS | - | Warship Electronic Chart Display and Information System |
| yds | - | yards |

## SUBMARINE TERMINOLOGY

| | | |
|---|---|---|
| Close quarters procedure | - | Rapid predetermined reactions taken by a submarine's command team to avoid collision |
| Deep | - | Submarine is submerged and below a depth where periscopes can be used |
| Go deep | - | Action taken by a submarine's command team to proceed from periscope depth to safe depth to avoid collision with a surface ship |
| Passive contact | - | A contact detected by a submarine's sonar listening equipment; this provides the compass bearing but not the range of the other vessel |
| Periscope depth | - | A submerged submarine at a shallow depth where periscopes and masts can be used, and a risk of collision exists with surface ships |
| Safe depth | - | A depth where a submarine can, if necessary, pass safely beneath the deepest draught merchant vessel that could be encountered |
| Surfaced | - | A submarine is fully buoyant with the fin and casing exposed and an officer of the watch / lookout on the bridge |

**TIMES:** all times used in this report are UTC unless otherwise stated

# SYNOPSIS

At 1256 on 6 November 2018, *Stena Superfast VII*'s officer of the watch took action to avoid collision with a submerged submarine that had been spotted at close range ahead of the ferry.

*Stena Superfast VII* was on a scheduled North Channel crossing from Belfast to Cairnryan; a Royal Navy submarine was at periscope depth conducting pre-deployment safety training in the same vicinity.

The submarine's command team detected and tracked the ferry using visual, sonar and automatic information system data. As the ferry's range reduced, the submarine's officer of the watch altered course to avoid it. However, this turn was towards the ferry and reduced the time available for the submarine to keep out of the ferry's way.

With the sonar contact on a steady bearing, the submarine's sonar team initiated a close quarters procedure; the commanding officer was also called to the control room. Based on the picture displayed by the submarine's electronic tactical command system, the commanding officer intervened to cancel the close quarters procedure and ordered that the submarine remain at periscope depth rather than go deep to its safe depth. At about the same time, *Stena Superfast VII*'s lookout spotted a submarine periscope close on the port bow, and alerted the officer of the watch, who took immediate action to avoid collision. After taking avoiding action, the ferry's closest point of approach with the submarine was about 250 yards, which was unsafe; however, the submarine's commanding officer believed the passing distance to be about 1000 yards, or four times the actual range.

This incident happened because the submarine's control room team overestimated the ferry's range and underestimated its speed. This combination meant that the submarine's commanding officer and its officer of the watch made safety-critical decisions that might have appeared rational to them at the time but were actually based on inaccurate information.

Two previous collisions between Royal Navy submarines and surface vessels show a similarity in that key decisions on board the submarines were made based on an insufficient appreciation of the location of surface ships in the vicinity. The Royal Navy has taken a series of actions in response to this incident, and previous similar accidents. As a result, this report makes a safety recommendation to the Royal Navy to undertake an independent review of its actions taken to ensure that such actions have been effective in reducing the risk of collision between dived submarines and surface vessels.

# SECTION 1 – FACTUAL INFORMATION

## 1.1 PARTICULARS OF *STENA SUPERFAST VII*, THE SUBMARINE AND THE INCIDENT

| **SHIP PARTICULARS** | | |
|---|---|---|
| Vessel's name | *Stena Superfast VII* | Not declared |
| Flag | United Kingdom | United Kingdom |
| Classification society | American Bureau of Shipping | Not applicable |
| Type | Ro-ro ferry | Nuclear-powered submarine |
| Registered owner | FPG Shipholding, Bermuda | UK Ministry of Defence |
| Manager(s) | Stena Line Ltd | Royal Navy |
| Construction | Steel | Steel |
| Year of build | 2001 | Not declared |
| Length overall | 203.3m | Not declared |
| Gross tonnage | 30285 | Not declared |
| Minimum safe manning | 18 | Not declared |
| Authorised cargo | Passengers, cars, freight | Not applicable |

| **VOYAGE PARTICULARS** | | |
|---|---|---|
| Port of departure | Belfast | HMNB Clyde, Faslane |
| Port of arrival | Cairnryan | HMNB Clyde, Faslane |
| Type of voyage | Commercial | Military operations |
| Cargo information | 215 passengers, 1144t of cars and freight | Not applicable |
| Manning | 67 | Not declared |

| **MARINE CASUALTY INFORMATION** | | |
|---|---|---|
| Date and time | 6 November 2018: 1256 | |
| Type of marine casualty or incident | Marine Incident | |
| Location of incident | 54° 54.4'N – 005° 20.1'W | |
| Place on board | Ship | Not declared |
| Injuries/fatalities | None | None |
| Damage/environmental impact | None | None |
| Ship operation | On passage | Military operations (training) |
| Voyage segment | Mid-water | Mid-water |
| External & internal environment | Wind: south-easterly, force 8. Visibility: good<br>Sea state: moderate. Depth of water: c.150m | |
| Persons on board | 282 | Not declared |

Image courtesy of Stena Lines


*Stena Superfast VII*

## 1.2 NARRATIVE

### 1.2.1 Pre-incident events

A Royal Navy (RN) submarine sailed from its base at Faslane, Scotland on 4 November 2018 and conducted a surface passage to the North Channel, where it submerged **(Figure 1)**. The submarine was conducing pre-deployment safety training. Members of staff from the Flag Officer Sea Training (FOST) organisation were on board to facilitate the training and assess the submarine crew's performance.

During the forenoon of 6 November 2018, the submarine was operating on the surface in order to resolve a defect. Prior to lunch, the submarine submerged having addressed the problem, and was then operating at periscope depth. The plan for the remainder of the day was to complete the lunchtime watch handover then continue with training procedures and drills, before heading north overnight. After diving, the commanding officer had instructed the officer of the watch (OOW) to patrol an area south of the ferry routes between Belfast and Cairnryan. The commanding officer also instructed the OOW to remain at periscope depth as the FOST programme for the afternoon needed the submarine to be shallow prior to training commencing.

*Stena Superfast VII* departed Belfast at 1130 for its scheduled passage to Cairnryan with 215 passengers and 67 crew on board; sea conditions were moderate and it was windy. On passing the Belfast fairway buoy, the master handed over to the chief officer as OOW; there was also an able-bodied seaman (AB) on the bridge as lookout. Once clear of Belfast Lough, *Stena Superfast VII*'s OOW altered to starboard to a heading of 060° **(Figure 2)** in order to pass astern of the northbound vessel, *Maersk Cancun*, and also to avoid fishing vessels; the ferry's speed was 21 knots (kts).

Reproduced from Admiralty Chart 2724 by permission of HMSO and the UK Hydrographic Office

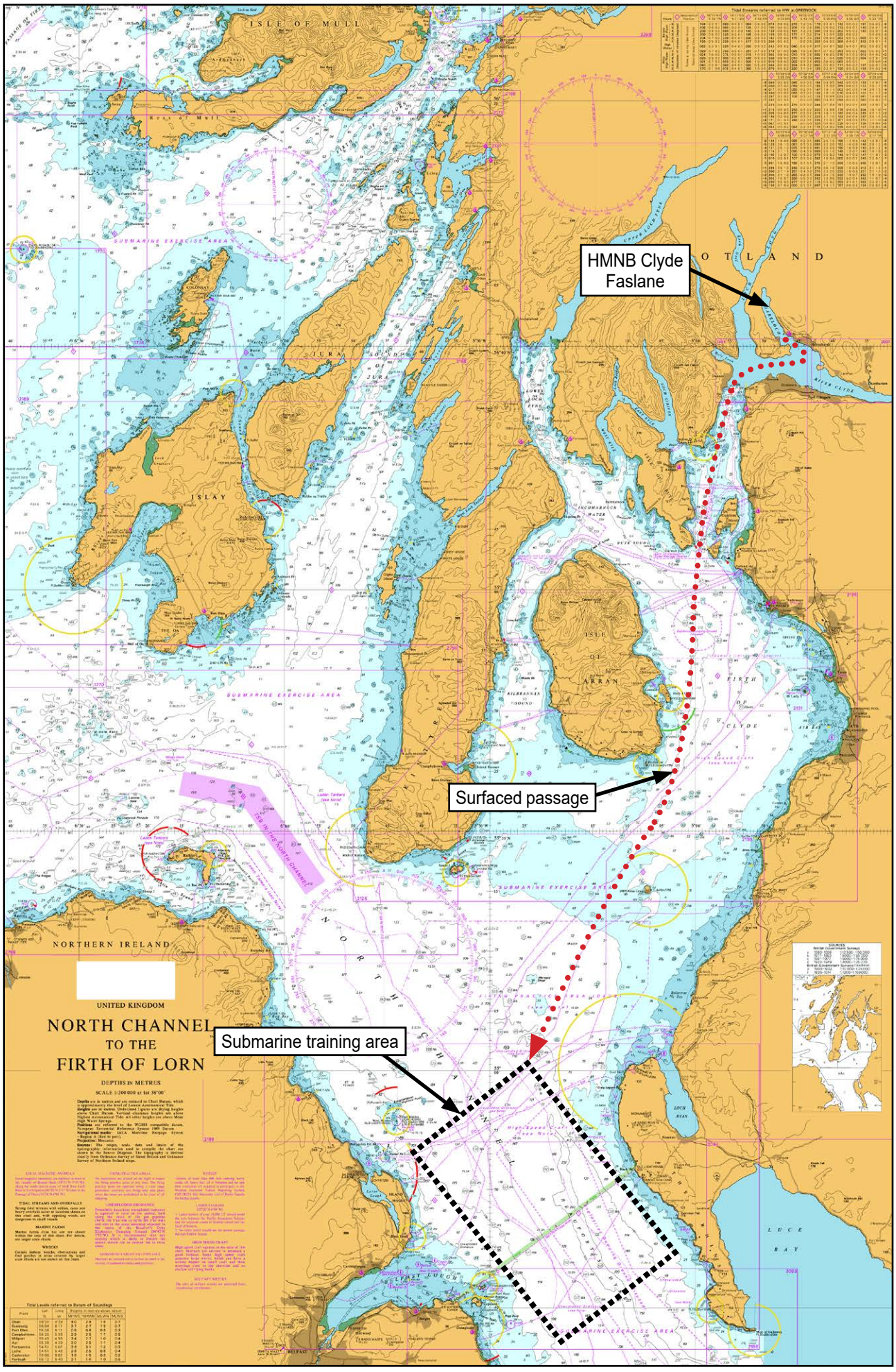


**Figure 1:** Overview of the submarine's operating base and allocated area for safety training

### 1.2.2 The incident

At 1243, the submarine's periscope watchkeeper (a trainee) reported sighting a new surface contact, the range of which was estimated to be between 9000 yards[1] (yds) and 10000yds. The new contact was reported to the submarine's OOW and was visually identified as a ferry; the compass bearing correlated with a passive sonar contact. The visual information on the new contact was entered into the submarine command system (SMCS). The submarine was on a westerly heading at a speed of about 6kts **(Figure 2)**.

At 1247, and having passed safely astern of the northbound *Maersk Cancun*, *Stena Superfast VII*'s OOW altered course to port to 046°; the ferry was 2 nautical miles (nm) to starboard of its planned track, steering towards its next waypoint north of Corsewall Point **(Figures 2** and **3)**.

At about 1247 the periscope watchkeeper advised the OOW that the ferry was estimated to be at a range of 6000yds and heading almost straight towards the submarine; the navigating officer (who was supervising) then took over the periscope watch from the trainee and the OOW asked the commanding officer to come to the control room. At about the same time, the OOW gave a conning order to turn the submarine to port. The aim of the course change was to put the submarine on a south-easterly heading in order to move away from the ferry's predicted path and remain to the south of the ferry lanes, as had been previously ordered **(Figure 2)**.

In the submarine's sound room, the sonar operators were tracking the ferry from its noisy acoustic output. The bearing was steady, so the sonar team initiated a close quarters procedure. A few moments later, when the commanding officer arrived in the control room, he was advised by the OOW of the developing situation and his intention to go deep should the ferry close within 2500yds.

The periscope watchkeeper reported frequent compass bearings and range estimations of the approaching ferry, which were input to the SMCS. A fleeting reception of *Stena Superfast VII*'s automatic information system (AIS) transmissions was displayed in the submarine's warship electronic chart display and information system (WECDIS) when the ferry appeared to be at about 3300yds. This information correlated with the SMCS track. *Stena Superfast VII*'s track, as displayed in the SMCS, showed the ferry on a north-easterly heading at a speed of 15kts with a small closest point of approach (CPA) developing.

At 1254:50, *Stena Superfast VII*'s AB lookout saw a submarine's periscope on the port bow at close range. The lookout immediately alerted the OOW, who also saw the periscope and observed, from its wake, that it was crossing the ferry's bow from port to starboard. Given this geometry and assessing that there was an imminent risk of collision, the OOW told the lookout to adopt hand-steering and, at 1255:20, 10° of port rudder was applied. Further port rudder angle was applied during the turn to increase the CPA from the periscope. The OOW also alerted the master, who came to the bridge immediately. At 1256:03, with the submarine's periscope passing close to starboard, *Stena Superfast VII* was steadied on a heading of 005° **(Figure 2)**.

[1] The unit of measurement used by submarines for the range of other vessels is yards, and this is applied in this report.

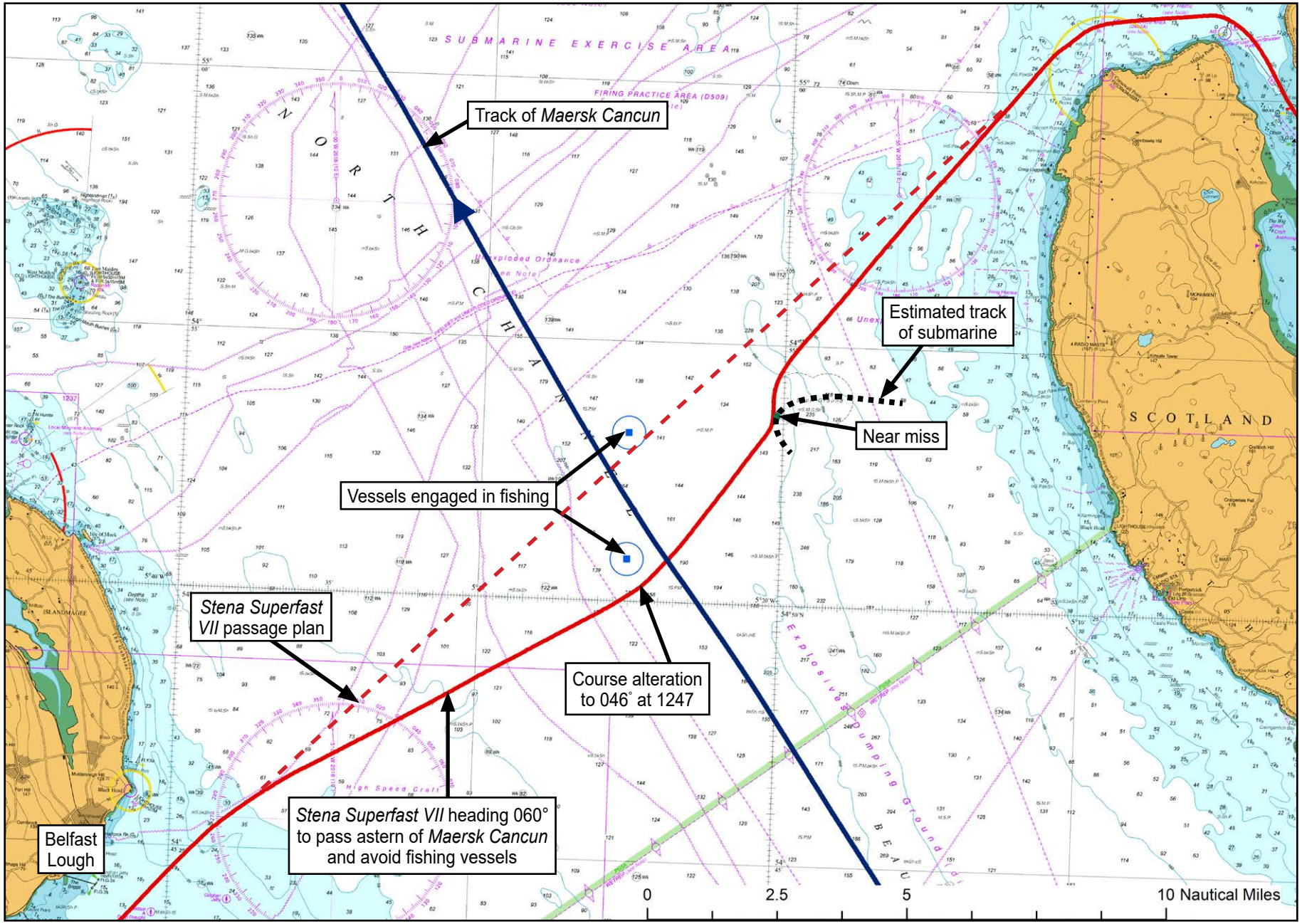


**Figure 2:** Overview of both vessels' tracks and the incident location

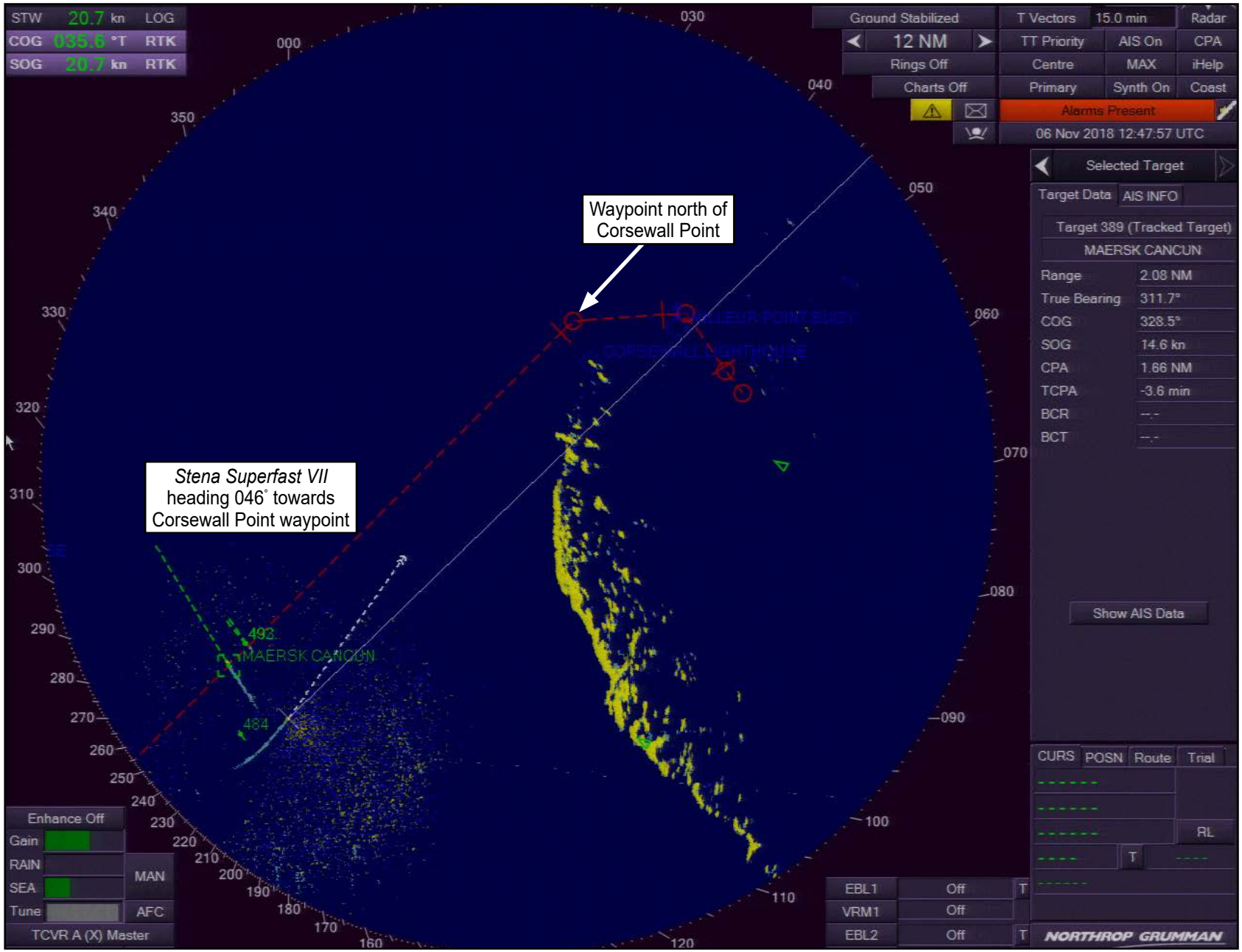


**Figure 3:** *Stena Superfast VII*'s radar picture at 1247 showing its relative position to the planned track, other vessels painting on radar and the ferry's heading towards its next waypoint

When the submarine's commanding officer became aware that the ferry was turning to port, he ordered the cancellation of the close quarters procedure and directed the OOW to remain at periscope depth. Based on the SMCS information, the commanding officer assessed that this decision was made when the ferry's range was about 2000yds and the CPA thereafter was about 1000yds. An assessment was made on board the submarine that the ferry's alteration of course to port was to regain its planned track (as it had been observed to be to starboard of its anticipated track) and not to avoid the submarine.

*Stena Superfast VII*'s OOW maintained visual contact with the submarine as it passed close down the ferry's starboard side **(Figure 4)**. The ferry's master also made a visual observation of the submarine's periscope close to starboard.

### 1.2.3 Post-incident reporting and events

After the ferry's range started to open, the submarine's command team settled back into their watchkeeping routines, prepared for the afternoon's training and the near miss was not reported ashore.

When *Stena Superfast VII* had passed clear of the submarine, the master contacted the ship's superintendent at the Stena shore offices and also notified Belfast Coastguard. The master's report to the coastguard stated that the submarine's periscope had passed down the starboard side of the ferry at a range of 50m-100m. The MAIB was notified of the incident at 1139 the following day, 7 November 2018, when Belfast Coastguard transmitted a Hazard Report (HAZREP) message. The MAIB then passed this information to the Navy Command Headquarters (NCHQ). An MAIB accident report form was also submitted by *Stena Superfast VII*'s master on 7 November.

NCHQ staff officers informed the Navy's Commander of Operations (COMOPS), who directed that the submarine surface and return to its base in Faslane in order that the incident could be investigated and that the crew could undertake further shore simulator-based safety training before returning to sea.

## 1.3 *STENA SUPERFAST VII*

### 1.3.1 Overview

Built in Germany in 2001, *Stena Superfast VII* was a 30285gt roll-on roll-off ferry that had been chartered and operated by Stena Line Limited (Stena Line) since 2011. *Stena Superfast VII* was one of 35 ferries operated on 21 routes across Northern Europe by Stena Line. Technical and safety management was provided by Stena Line, and the vessel operated under the company's safety management system (SMS).

*Stena Superfast VII* operated alongside its sister ship *Stena Superfast VIII* on the Belfast to Cairnryan service. The vessel was scheduled to complete three round trips every day departing Belfast at 0330, 1130 and 1930; each crossing lasted about 2 hours (hrs) 15 minutes (mins).

Image courtesy of Stena Lines

**Figure 4:** The submarine's periscope as seen from the bridge of *Stena Superfast VII* (looking to starboard)

*Stena Superfast VII* had three bridge control consoles: one on the centreline and one on each bridge wing. The centre console **(Figure 5)** was equipped with two radar displays, an electronic chart display and information system (ECDIS), very high frequency (VHF) radio and machinery controls. The primary steering position was integrated into the centreline console.

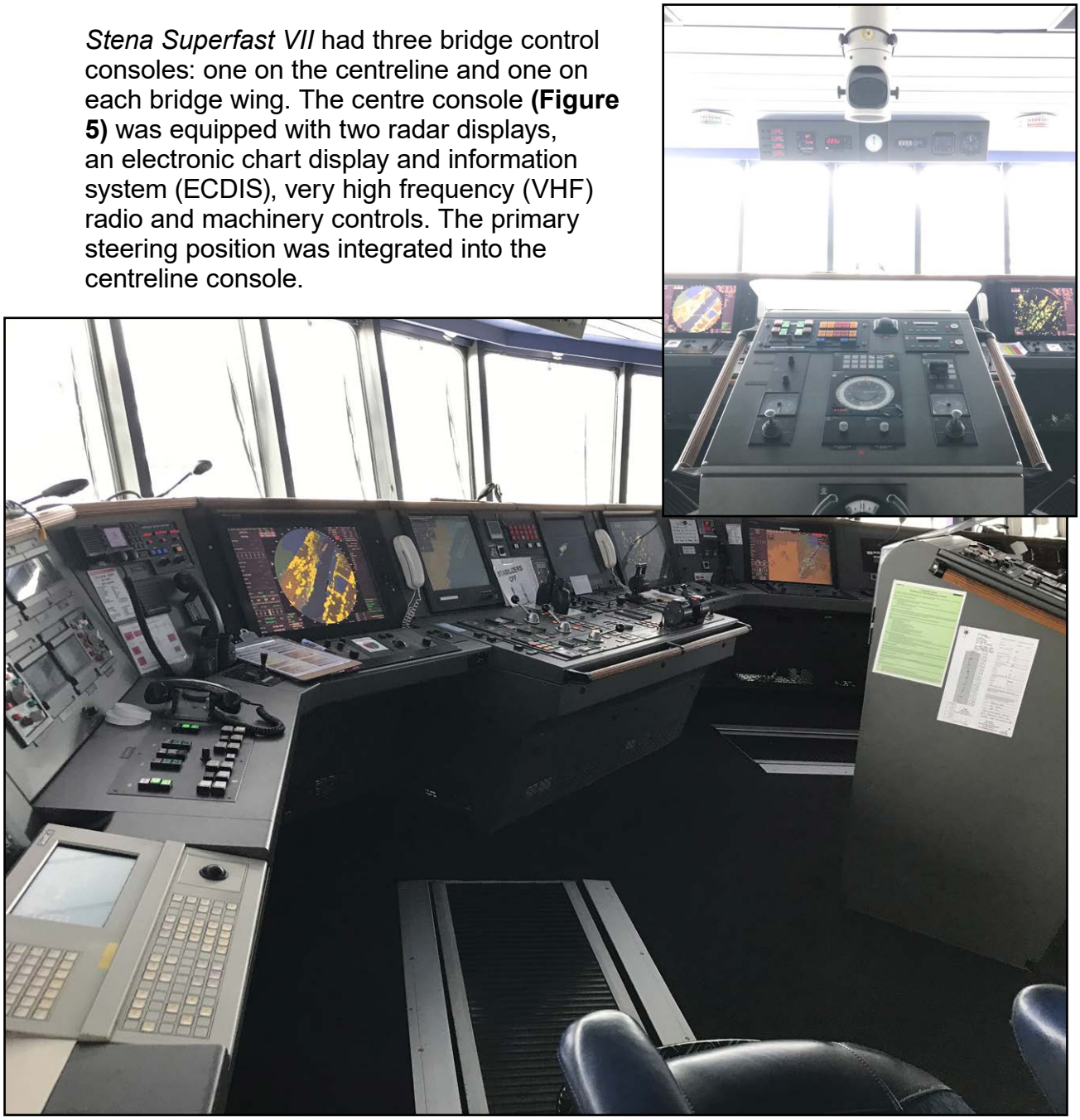

**Figure 5:** *Stena Superfast VII*'s bridge with centre console inset

### 1.3.2 Crew and lookout arrangements

*Stena Superfast VII* operated continuously with two crews on board working two 12-hour shifts. On 6 November 2018, the bridge team started their duty at 0500 having had 12 hours off watch. The masters changed over at 0630. All of the bridge team were UK nationals.

The master who was in command at the time of the incident had extensive experience in the industry having predominantly worked on ferries for the previous 25 years. He had been one of *Stena Superfast VII*'s masters since February 2017. He held an STCW[2] II/2 master (unlimited) certificate of competency issued by the UK's Maritime and Coastguard Agency (MCA).

[2] International Convention on the Standards of Training, Certification and Watchkeeping for Seafarers 1978, as amended.

The chief officer, who was the OOW, had been at sea since 2013. He had worked for Stena Line since 2016 on the Belfast to Cairnryan route. He was a second officer but had been temporarily promoted to the rank of chief officer. He held an MCA STCW II/2 chief mate (unlimited) certificate of competency.

The AB lookout had worked on ferries for 18 years and joined *Stena Superfast VII* in 2014. The AB role rotated each week with the ABs being assigned to the bridge, cargo work or day work. When assigned to the bridge role, the ABs would keep a lookout at all times and operate the helm when the autopilot was not in use, primarily when entering or leaving harbour.

The Stena Line SMS stated that '*lookouts shall report every object that they are aware of to the OOW regardless of whether they consider it to be trivial or not to present a problem to their own ship. If they have any doubt over reporting a sighting to the OOW they shall not hesitate to report and discuss with the OOW*.'

## 1.4 THE SUBMARINE

### 1.4.1 Vessel and crew

The submarine was nuclear-powered and based at Her Majesty's Naval Base, Clyde in Faslane, Scotland (HMNB Clyde).

The commanding officer of the submarine was an experienced submariner who had been in command for over a year and had significant previous experience of operating in the North Channel. He had successfully completed the Commanding Officers' Qualifying Course (COQC or 'Perisher'). The Perisher Course prepared prospective submarine commanding officers to lead, manage and fight a submarine. Perisher students were trained and tested in every aspect of submarine operations. Early stages of the Perisher course, in simulators ashore and at sea, train future commanding officers in the necessarily intuitive skill of avoiding collision when in close proximity to surface vessels, including high speed ships, typically warships.

The submarine's OOW was a qualified submarine officer and this was his first period at sea in the OOW role. The periscope watchkeeper was the navigating officer who was a qualified and experienced submarine watchkeeper. Although initially supervising a trainee, the navigating officer took over the periscope watch when the ferry was reportedly at about 6000yds.

### 1.4.2 Passage planning

The Admiralty Manual of Navigation Volume 1, The Principles of Navigation, Book of Reference 45(1) was the RN's primary reference for the planning and conduct of navigation. The conduct of coastal navigation was covered by Chapter 12 and included:

> '***Appraisal.*** *After completing initial research, appraisal of the following items should be carried out as soon as possible thereafter…*
>
> - *ETD[3]s / ETA[4]s and refined speed of advance (SOA).*
> - *TSS[5], shipping lanes, traffic density, likely concentrations of fishing vessels.*

[3] Estimated time of departure.

[4] Estimated time of arrival.

[5] Traffic separation scheme.

- *Exercise areas.*
- *Any limitations of ship.*
- *Maritime Jurisdiction, Innocent Passage and Diplomatic Clearance.*
- *Intelligence requirements / planning.*
- *Cross check all available sources of navigation and other information.'*

The submarine's command team had identified the North Channel ferry routes as a potential hazard during the safety training at sea. As a result, the ferry routes had been marked as a hazard in the submarine's WECDIS.

## 1.5 ROYAL NAVY SUBMARINE OPERATIONS

### 1.5.1 Command and control

Command and control of RN submarines when at sea was delivered by the Submarine Operating Authority (SUBOPAUTH) from the Northwood HQ in Middlesex. The SUBOPAUTH was headed by COMOPS, an RN Admiral with submarine command experience. The SUBOPAUTH had responsibility for submarines' routing, waterspace management, communications, intelligence, logistics support and dealing with emergencies. The SUBOPAUTH was continuously manned and had access to a wide variety of information sources necessary to support submarine operations. Operational security was a critical factor in delivering submarine operations, restricting the information that can be disclosed.

### 1.5.2 Modes of operation

Submarines can operate in two modes: surfaced or dived. When surfaced, the submarine is fully buoyant with the fin and casing visual; the OOW and a lookout are on the bridge. When dived, a submarine will either operate at periscope depth or deep. At periscope depth, the submarine is fully submerged but at a shallow depth where periscopes or radar can be used, and there is a risk of collision with surface ships. When deep, submarines operate at a depth where there is no risk of collision with any surface vessel that could be encountered; this is known as 'safe depth' **(Figure 6)**.

When surfaced, submarines comply with the International Regulations for Preventing Collisions at Sea (IRPCS), including showing appropriate lights and shapes. There is no provision in the IRPCS for dived submarines; this means that responsibility for collision avoidance always rests entirely with its commanding officer once a submarine has dived.

### 1.5.3 Submarine exercise areas and information broadcasts

In the waters around the west coast of Scotland and Northern Ireland, there are permanently established exercise areas for submarine training, details of which are promulgated in the Admiralty List of Radio Signals (ALRS) Volume 3. Electronic and paper navigational charts in these areas are marked '*submarine exercise area*'.

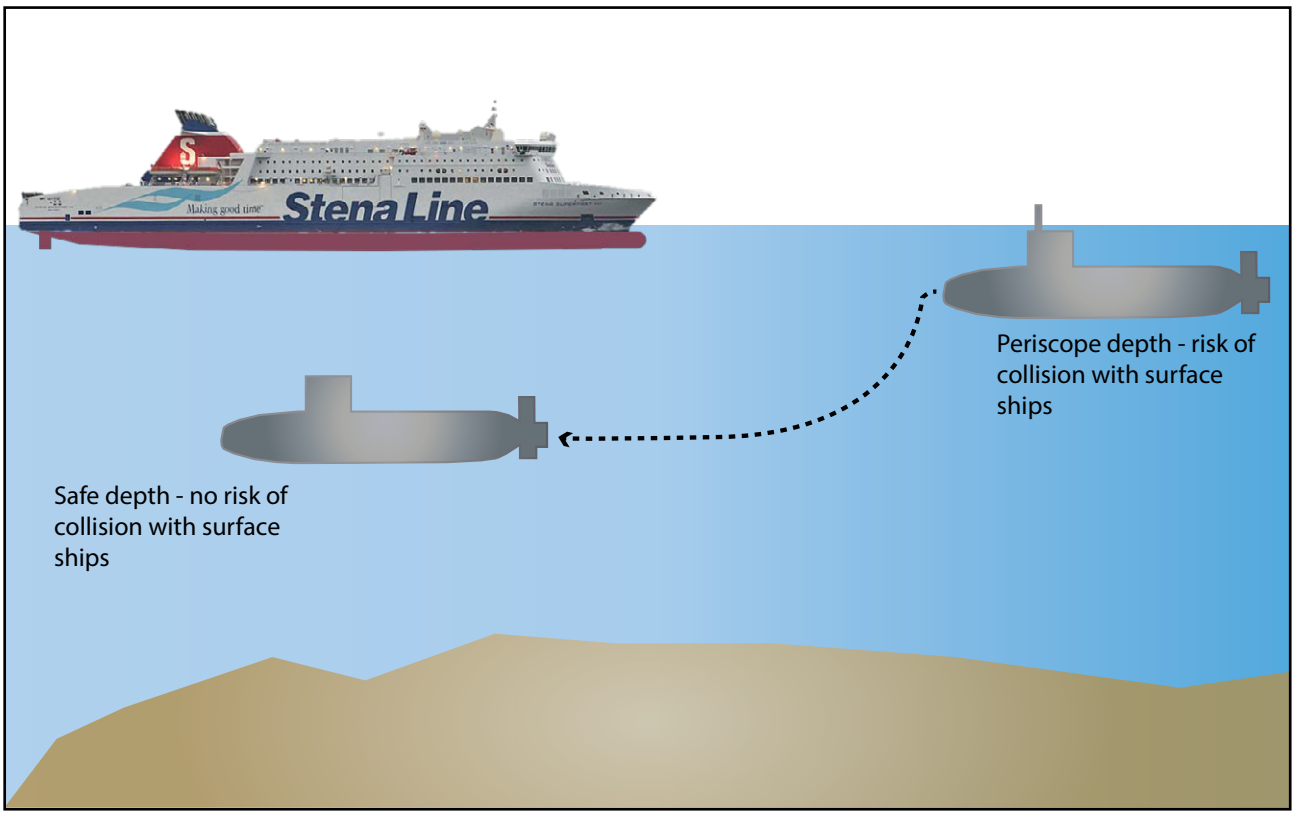


**Figure 6:** Illustration of periscope depth and safe depth used by Royal Navy submarines

The RN operated a warning system (SUBFACTS), intended to notify mariners of planned or known submarine activity. SUBFACTS information for the permanent exercise areas was compiled by the SUBOPAUTH and then sent to HM Coastguard daily at 0500. This information was then broadcast on VHF radio and the Navigational and Meteorological Warning Broadcast Service (NAVTEX).

The incident occurred in area 'Beaufort' **(Figure 7)**. The SUBFACTS message for 6 November 2018 warned of submarine activity in this area, and this was broadcast by Belfast Coastguard at 0818 that day.

### 1.5.4 Pre-deployment training and assurance

Responsibility for the safety of a submarine always rests with the commanding officer. During dedicated periods of training, sea-riding staff from the FOST organisation will embark in RN submarines. The role of the FOST staff was to deliver the training programme and to provide assurance to the SUBOPAUTH that the crew were capable of operating their submarine safely.

In this case, after a period of maintenance and a significant change of crew members, the submarine was undergoing a period of dedicated training in preparation for its next operational deployment. This initial sea phase of training was primarily for safety and scheduled to last 8 days. Prior to the training at sea, the crew had successfully completed a period of safety training in shore-based simulators. The embarked FOST team was led by an officer who was equally qualified to the commanding officer and who was in the control room at the time of the incident.

Reproduced courtesy of the UK Hydrographic Office

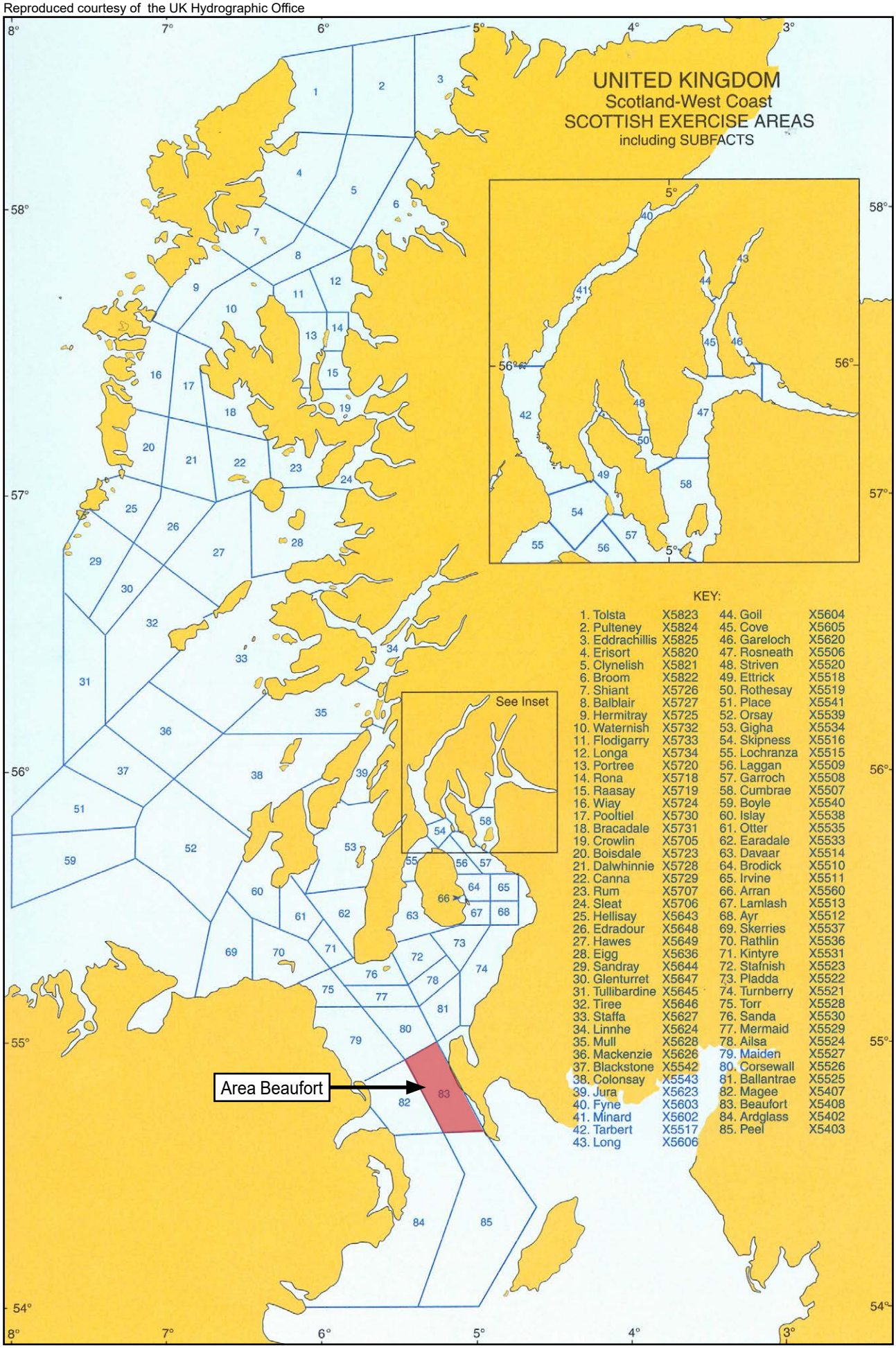


**Figure 7:** SUBFACTS chart highlighting area Beaufort that was allocated to the submarine at the time of the incident

## 1.6 MANAGEMENT OF SURFACE CONTACTS BY SUBMARINES

### 1.6.1 Periscope lookout and ranging

When operating at periscope depth, submarines use visual, sonar, radar and AIS information to compile a picture of surface contacts in the vicinity.

At the time of the incident, one of the submarine's periscopes was raised and was being used by a watchkeeper to maintain a 'continuous all-round look'. This meant that the watchkeeper was rotating the periscope through 360° and reporting all sightings, along with compass bearings and an estimation of the range of contacts. The periscope had two operational modes, high power and low power. The periscope was also fitted with a video camera supplying a live image to a display monitor in the control room.

Periscope range estimations are either an assessment based on the operator's experience or made using a split-image rangefinder. The split-image rangefinder measured the height of a vessel as an angular value that could then be triangulated into a horizontal distance. Split-image range finding was always conducted using the periscope's high power function. Attempting to range a contact when the periscope was in low power would not produce accurate results. Triangulation ranging tends to be more accurate with closer contacts.

### 1.6.2 Electronic navigational aids

RN submarines are fitted with a radar mounted on a mast that can be raised and operated when the submarine is on the surface or at periscope depth. Radar systems are maintained at immediate notice for operational use. Use of the radar system is at the discretion of the submarine's commanding officer. Guidance for commanding officers stated that radar should be used when in the vicinity of fishing vessels, but there was no specific direction on the use of radar when managing merchant vessel contacts.

The periscope in use at the time of the incident was the only raised mast and was fitted with a VHF aerial capable of transmitting and receiving both voice and AIS data. The low aerial height of a submarine periscope reduces the range at which surface vessels' AIS transmissions can be received, and the sea washing over the periscope can also interrupt AIS reception. During this incident, radar was not in use and there was only sporadic reception of *Stena Superfast VII*'s AIS transmissions.

### 1.6.3 Sonar information

Passive sonars are used by submarines to detect and analyse acoustic data from other vessels. Passive sonar equipment can only provide the compass bearing of a contact and not the range. Acoustic information received is also used to assist with the classification of the contact by determining characteristics such as the vessel's configuration of shafts and propeller blades. The audible intensity can offer a very approximate indication of a contact's proximity.

### 1.6.4 Submarine command system

The SMCS was a computerised tactical picture system. All source data was input to the system automatically or manually to present a tactical picture for command decision-making. For passive sonar information, where the only information available

was the compass bearing, SMCS used mathematical algorithms to estimate the contact's course, speed and range. The SMCS was programmed to prioritise visual contact information input from the periscope, ahead of sonar information.

### 1.6.5 Submarine safety at periscope depth

Safety when operating at periscope depth was achieved by manoeuvring the submarine to ensure that surface vessels do not approach within the calculated go-deep range. Should a surface ship approach the go-deep range, collision was avoided by the submarine going deep to a safe depth **(Figure 6)**. It takes about 1 minute for a submarine to go deep to a safe depth, so the go-deep range for any given vessel was the distance travelled at the combined speeds of both vessels in that time. This calculation was based on the worst case of both vessels heading directly towards each other.

Submarine watchkeepers make rapid mental arithmetic calculations to assess the relative movement of surface contacts when only estimated range information is available[6]. For this incident, the worst-case combined closing speed between *Stena Superfast VII* and the submarine was 27kts. This meant that the go-deep range for *Stena Superfast VII* was 900yds **(Figure 8)**.

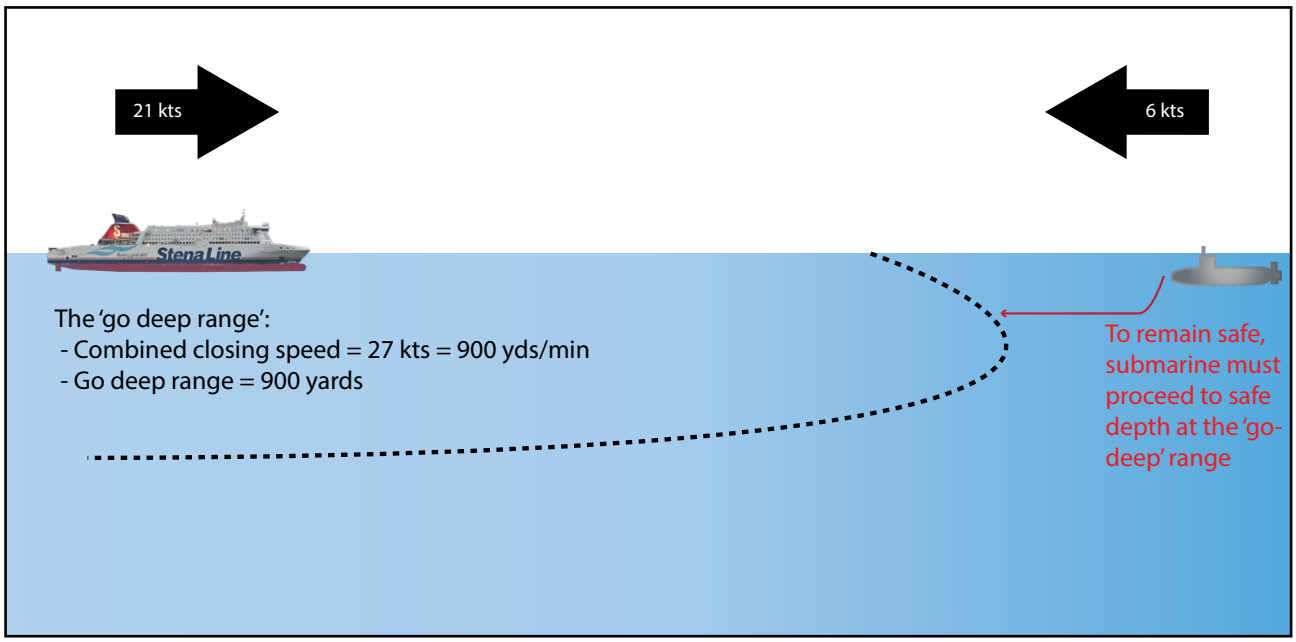


**Figure 8:** Illustration of the go-deep range of *Stena Superfast VII* proceeding at 21kts and the submarine at 6kts

In the event of any member of a submarine's command team, including the sonar team, detecting a potential collision situation, the close quarters procedure was commenced. This process was a rapid, predetermined set of reactions intended to focus all sensors and the control room team's effort to determine the most accurate tactical picture for command decision-making. In the case of a close surface contact with risk of collision, the procedure would require the OOW or the commanding officer to take the submarine to a safe depth.

[6] For example, a warship at 30kts heading directly towards a submarine at 6kts creates a worst-case scenario of a 36kts combined closing speed. This equates to 72000yds per hour or 1200 yards per minute (yds/min). Therefore, the go-deep range for a warship at 30kts would be 1200yds; the range at which the submarine must go deep to remain safe.

## 1.7 NORTH CHANNEL FERRY ROUTES

Northern Ireland is linked to Great Britain by scheduled passenger and freight ferry services. The level of service at the time of the accident is shown at **Table 1**.

| Route | Operating company | Number of vessels | Total crossings per day |
|---|---|---|---|
| Belfast – Cairnryan | Stena Line | 2 | 12 |
| Belfast – Liverpool | Stena Line | 2 | 4 |
| Belfast – Heysham | Stena Line | 2 | 4 |
| Larne – Cairnryan | P&O | 2 | 14 |
| Warrenpoint-Heysham | Seatruck | 2 | 4 |

**Table 1:** Summary of North Channel ferry routes

## 1.8 THE SAFETY INVESTIGATION

Once the RN was aware of the incident, two senior officers from HMNB Clyde visited the submarine to conduct an Immediate Ship's Investigation (ISI). On receipt of HM Coastguard's HAZREP message on 7 November 2018, the MAIB commenced a preliminary assessment[7] (PA). This process involved contacting Stena Lines and the RN, then gathering evidence including *Stena Superfast VII*'s voyage data recorder (VDR). Stena Lines also provided the VDR data to the RN to aid its investigation.

On 27 November 2018, the Chief Inspector of Marine Accidents wrote to COMOPS to: explain the purpose of the MAIB's PA, request RN evidence including the submarine's positional data, and to set up a meeting to discuss the case. COMOPS and the Chief Inspector of Marine Accidents then met on 10 January 2019 to review the case. This meeting included a detailed brief on the RN's analysis of the incident based on the accurate electronic positional data from both the submarine and the ferry. This brief demonstrated that, had the ferry not altered course, there was a genuine risk of collision. Given the potential seriousness of the consequences of a laden ferry colliding with a submerged nuclear-powered submarine, the Chief Inspector of Marine Accidents took a decision that the matter would be the subject of a formal MAIB safety investigation with the RN's co-operation.

The Defence Safety Authority's (DSA), Defence Accident Investigation Branch (DAIB) also conducted an initial triage assessment of the incident. The DAIB's initial report determined that, given the information available, a full DSA safety investigation was not required.

In response to further MAIB requests for evidence, COMOPS responded on 27 March 2019 with a written summary of the RN's assessment. This letter stated that '*the root causes of the incident are twofold: the submarine's crew did not appreciate the rate at which the ferry was closing; and the submarine's course alteration while in front of the ferry significantly reduced the rate at which she opened away from the ferry's path*'.

[7] See Article 6 of The Merchant Shipping (Accident Reporting and Investigation) Regulations, 2012 as amended.

An annex to COMOPS's letter summarised the RN's analytical findings, stating that:

- *CPA occurred at 1256 at a range of 250 – 500yds.*
- *Stena Superfast VII detected the submarine's periscope at range 800 – 1000yds – ordering a course alteration 20 seconds later.*
- *The submarine classified (visually) the Stena Superfast VII as Ferry at range 9 – 10kyds*

The annex also included diagrams showing the relative tracks of both vessels.

In a second annex to COMOPS's letter, the Commander of the Faslane Flotilla (COMFASFLOT) remarked that '*it is already clear from post-event analysis that the submarine over-ranged the STENA Ferry, resulting in flawed decision making by the Submarine Command Team*'. This annex also explained the actions taken by the RN as a result of the incident [Section 4].

On 9 April 2019, the Chief Inspector of Marine Accidents made a written request for a meeting between RN and MAIB staff to further review the case. This resulted in a meeting between MAIB inspectors and senior RN staff in Faslane on 1 July 2019, where further details of the event were disclosed and analysed in co-operation.

## 1.9 PREVIOUS SIMILAR ACCIDENTS

### 1.9.1 MAIB Report 20/2016[8]: Collision between *Karen* and a dived Royal Navy submarine

On 15 April 2015, an RN submarine was on passage and deep in the Irish Sea when it snagged the fishing vessel *Karen*'s trawl wires. *Karen* was dragged astern at about 7kts and partially submerged before the trawl wires parted under tension and it was released.

The MAIB's investigation established that the collision occurred because the submarine's command team assessed that *Karen* was a merchant vessel, resulting in significant overestimations of the fishing vessel's range and speed. The submarine was at a safe depth, therefore the command team did not perceive any risk of collision or need for avoiding action. The submarine's command team had assessed that the majority of shipping contacts in the area were merchant vessels, when they were, in fact, mostly trawlers. This presented a significant hazard to the fishing vessels and the submarine and it was not safe for the submarine to try and proceed through the Irish Sea below periscope depth.

There were sufficient clues on board the submarine to have identified the possibility of collision. Also, about 3 hours later, when the commanding officer became aware of the collision, the matter went unreported.

[8] https://www.gov.uk/maib-reports/collision-between-the-stern-trawler-karen-and-a-dived-royal-navy-submarine

### 1.9.2 Collision between HMS *Ambush* and *Andreas*

On 20 July 2016 the RN submarine, HMS *Ambush*, collided with the merchant vessel *Andreas* near Gibraltar. HMS *Ambush* was at periscope depth and was conducting tactical training exercises with the Perisher command course students on board.

The submarine was not maintaining a continuous all-round look, instead the periscope was only being raised intermittently. This was to reduce the risk of detection in a simulated threat environment. The submarine's tactical picture was being maintained using sonar and occasional periscope looks with AIS information whenever the periscope was raised. The control room team had detected *Andreas* and was monitoring its movement. However, they became distracted by a nearby yacht and lost focus on the approaching *Andreas*. A second periscope and the radar were available for the training staff to use for safety, but neither was raised. Assumptions had also been made about *Andreas*'s relative position based on out-of-date AIS data.

# SECTION 2 – ANALYSIS

## 2.1 AIM

The aim of the analysis is to determine the causes and circumstances of the near miss as a basis for making recommendations to prevent similar events occurring in the future.

## 2.2 SUMMARY

During safety training in the North Channel, the command team of a submerged submarine did not take sufficient action to prevent the ferry, *Stena Superfast VII*, passing inside its go-deep range. This was an unsafe event and placed the ferry's passengers and crew, as well as the submarine and its crew, in immediate danger. Rapid and effective action by *Stena Superfast VII*'s bridge team reduced the risk of collision. This section of the report will assess the causes and circumstances of the incident including safety-critical decision-making on board the submarine. The RN co-operated with the MAIB's investigation to the maximum extent possible within the boundary of operational security. The submarine's actual speed is unknown, but 6kts has been used as a basis for the calculations in this section.

## 2.3 THE NEAR MISS

### 2.3.1 The submarine's turn towards the ferry

When the submarine's control room team initially detected *Stena Superfast VII* visually, they estimated it to be at a range of 9000yds-10000yds. Appreciating that the ferry was heading almost straight towards the submarine, the OOW decided to alter course to open away from its projected track; this decision was taken when the range was estimated to be 6000yds.

At a speed of 21kts, *Stena Superfast VII* would cover 6000yds in 8mins 34secs. This is an estimate of the time available for the submarine's OOW to take avoiding action. However, the submarine's OOW had estimated the ferry's speed as 15kts, so would have incorrectly calculated that it would take the ferry 12mins to travel 6000yds. Therefore, the OOW almost certainly assessed that there was significantly more time to take avoiding action than was actually the case.

Having made the decision to turn to port towards the ferry, the vessels were then converging, and the calculation can be refined using the combined speeds of 27kts, or just 6mins 40secs for the submarine and the ferry to close the 6000yds. This is a significantly lower estimate of the time available to take action to avoid the approaching ferry. Had the submarine been turned to starboard and away from the ferry, the resultant closing speed would be just 15kts, or an estimate of 12mins for the vessels to converge.

These calculations are only estimates; however, they demonstrate that by using 15kts for the ferry's speed, the OOW's assessment when the ferry was at about 6000yds distant, was probably misleading and resulted in the unsafe decision to turn the submarine towards the approaching ferry, instead of immediately opening the range by turning to starboard and away.

### 2.3.2 Overestimation of the ferry's range

Accurate compass bearing information of the ferry was available to the submarine's command team from passive sonar and the periscope. However, without radar operating and only sketchy AIS reception, the command team was heavily reliant on the periscope watchkeeper to assess the approaching ferry's range. The range was only ever an estimation, either through the watchkeeper's experienced assessment or using the periscope's split image rangefinder.

The RN's post-event analysis [Section 1.8] established that the periscope watchkeeper had overestimated the ferry's range. This is underpinned by the difference between the CPA value in SMCS of 1000yds (derived from the periscope), and the post-event CPA calculated by the RN, of about 250yds.

As the ferry was approaching, the range information in the SMCS system was based on the estimation of the periscope watchkeeper. This information was not checked by any of the three more experienced officers[9] in the control room, none of whom went to the periscope to supervise the navigating officer.

There would also have been other clues in the control room to the very close proximity of the ferry, especially the sonar characteristics and camera image, both of which would have been presenting contradictory evidence of the ferry's range. Nevertheless, command decisions were being made using the SMCS track of the ferry's range, based exclusively on the inaccurate periscope range data.

The persistent overestimation of the ferry's range happened primarily because of a lack of supervision of the periscope watchkeeper; additionally, clues to the closer proximity of the ferry were also ignored.

### 2.3.3 The decision to remain at periscope depth

With a worst-case scenario of a combined closing speed of 27kts, the range at which the submarine needed to go-deep to safely avoid the ferry was 900yds, and it was unsafe to remain at periscope depth with the ferry inside this range.

Early in the encounter, the submarine's OOW recognised that a potentially hazardous situation was developing, called the commanding officer to the control room and stated an intention to go deep should the ferry approach within 2500yds. Sonar operators had also detected a potentially dangerous situation and announced a close quarters procedure. The ferry's close proximity could also be observed in the control room via the periscope camera display.

When faced with information that does not conform to an operator's assessment of a situation, there is a choice to make: reassess the situation based on the new data or ignore it. Ignoring new information in a dynamic, decision-making environment requires a bias towards an operator's existing belief in a particular understanding of the situation.

As the ferry headed towards the submarine, command decisions were being made using the SMCS picture that was based on inaccurate range estimations from the periscope watchkeeper. Given that the range was being overestimated, the ferry's

[9] The commanding officer, the OOW and the FOST command-qualified officer.

track in the SMCS would have been suggesting a safer situation than was the reality. The SMCS was also prioritising the visual information on range, ahead of the algorithm calculation based on sonar bearings.

Equally, when *Stena Superfast VII* was observed to alter course to port, this was used as a reinforcing bias to underpin the assessment that the ferry was to starboard of its planned track and would make such a turn. This was not correct as the ferry had, in fact, since the alteration of course at 1247, been on a heading to regain its navigational plan by intersecting the waypoint north of Corsewall Point **(Figure 3)**. Expecting that a merchant ship will alter course in this way, to regain its planned track, was a very risky strategy, and a safer course of action for the control room team would have been to deal with the situation 'as seen' rather than as anticipated.

Had the ferry's CPA of 1000yds as shown in the SMCS been accurate, it would have been safe for the submarine to remain at periscope depth. This means that the submarine commanding officer's decisions to cancel the close quarters procedure and remain at periscope depth would have appeared rational at the time given that decisions were based on the SMCS picture.

An additional factor influencing the commanding officer's decision not to go deep, was the FOST request for the submarine to commence the afternoon's training at periscope depth. A perceived pressure to remain shallow was created because it would have wasted training time had the submarine been taken deep only to have to return to periscope depth to start training procedures.

### 2.3.4 Actions on board *Stena Superfast VII*

There is no expectation that the bridge team of a merchant ship should be able to detect or avoid a submerged submarine, and there is no provision for this in the IRPCS. It is, therefore, extremely fortunate that *Stena Superfast VII*'s lookout spotted the submarine's periscope.

Having been alerted to the presence of the periscope, the ferry's OOW was very quick to assimilate that it was crossing from the port bow to the starboard side, and that urgent avoiding action was required. Therefore, the ferry's OOW showed great presence of mind and strong conviction in altering course to port to avoid collision. Post-incident analysis indicated that, without this alteration, there was a serious risk of collision **(Figure 9)**. Further, had there been a collision, given the relative speed and movement of the two vessels, there was every chance that the ferry would have suffered significant underwater damage.

## 2.4 CONDUCT OF SUBMARINE OPERATIONS

### 2.4.1 Passage planning

Identifying shipping lanes as a potential hazard to submarine operations was a requirement of the appraisal phase of creating a passage plan. Planning for this safety training had identified that the operating area included the ferry routes between Cairnryan and Belfast. This route had been plotted in the submarine's WECDIS system to remind the OOW of the potential hazard.

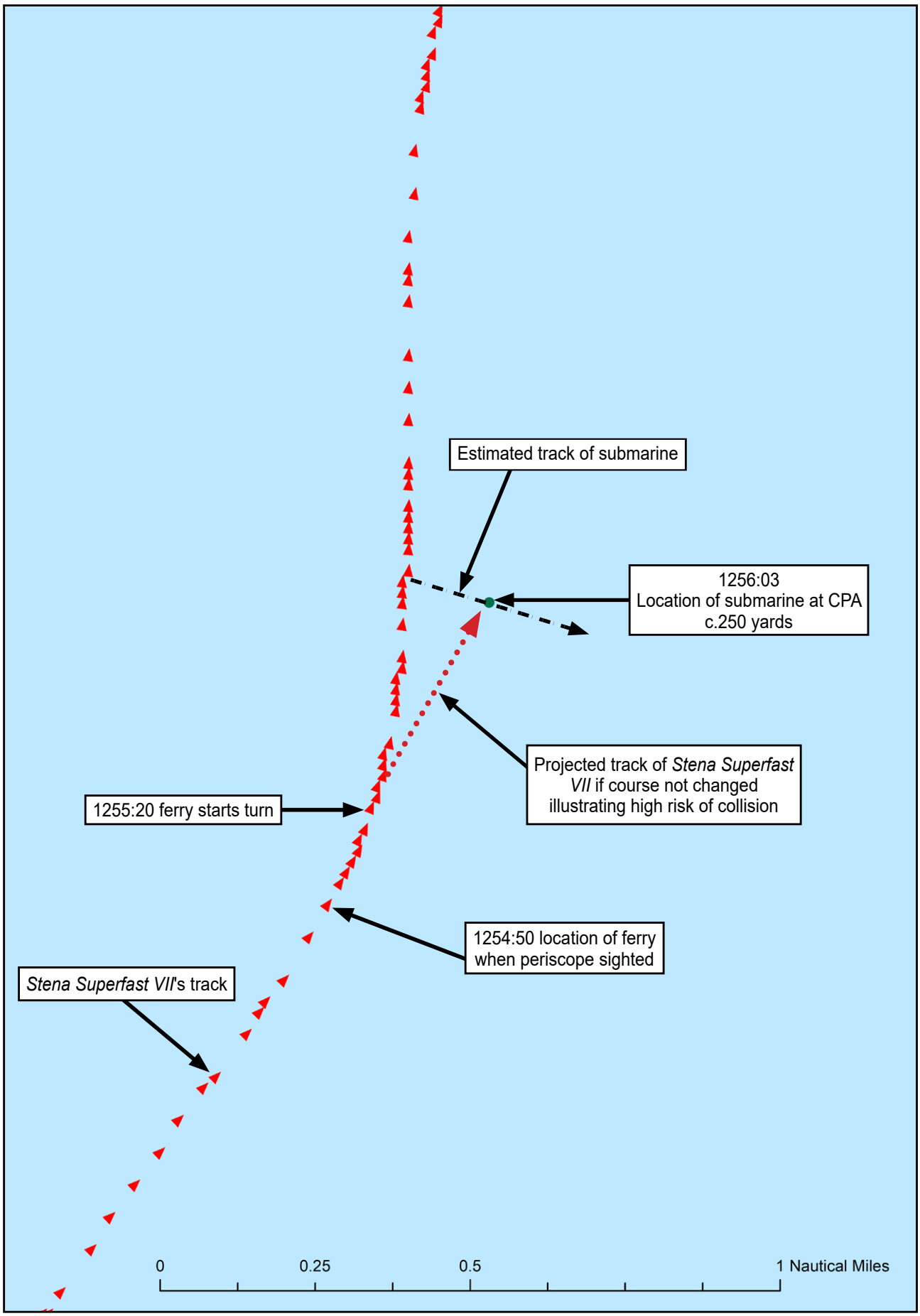


**Figure 9:** Detail of *Stena Superfast VII*'s track and the estimated CPA position of the submarine highlighting the risk of collision had the ferry not altered course

Having submerged again after the defect rectification, the commanding officer gave a verbal instruction to the OOW to remain at periscope depth and to the south of the ferry lanes in preparation for the afternoon's training programme. However, the plan was to head north overnight, so there was also pressure on the OOW not to proceed too far south.

In the build-up to the incident, the submarine's command team correctly assessed that *Stena Superfast VII* was to starboard of its planned track **(Figure 3)**. However, this track was a line between Belfast Lough and Corsewall Point, whereas the ferry route was in reality a corridor. **Figure 10** shows historical AIS data for the 7 days following the incident and its location. This illustrates that, although the OOW might have considered that the submarine was clear of the ferry lanes, it was actually operating within the hazardous zone.

### 2.4.2 Training and assurance

The submarine was in the early stages of pre-deployment preparation, with a team from the FOST organisation on board. In preparation for this sea phase of safety training, the submarine's command team had undergone a phase of simulator training ashore, that they had successfully passed. The aim of the safety training was to ensure that the submarine was operated safely.

The presence of the FOST sea-riding team was to facilitate training, but also to provide assurance to the SUBOPAUTH that the submarine was operated safely. However, as this hazardous situation developed, the FOST command sea rider did not advise or intervene to ensure the safety of the submarine, because he had agreed with the commanding officer's assessment of the situation at the time. Moreover, the absence of an intervention by the FOST team probably reassured the submarine's command team that they had acted appropriately when dealing with a close surface contact. This assessment is reinforced by the SUBOPAUTH's decision to order the submarine back to its base in Faslane to repeat the shore-based simulator training before returning to sea.

### 2.4.3 Submarines' surface picture management

An accurate awareness of surface shipping in the vicinity of a dived submarine is an essential building block for safe operations. However, decisions in this incident were not based on sufficiently accurate information.

It was unfortunate that the submarine was not receiving good quality and consistent AIS data as this, when plotted in real time, can significantly improve awareness of the shipping situation. However, the low aerial height of a submarine periscope reduces the range at which transmissions can be detected, and sea washing over the periscope can interrupt AIS signals altogether.

Radar was available but not used. In these early stages of safety training, it would be entirely reasonable to use the radar system to improve the quality of the surface picture. In particular, radar could be used to build the confidence of periscope watchkeepers by comparing estimated and actual ranges of observed vessels.

The key common factor with this and two previous collisions involving submerged RN submarines [Section 1.9] was the absence of a sufficiently accurate plot of surface shipping, critical to inform command decision-making. In the case of the

Reproduced from Admiralty Chart 2724 and 1411 by permission of HMSO and the UK Hydrographic Office

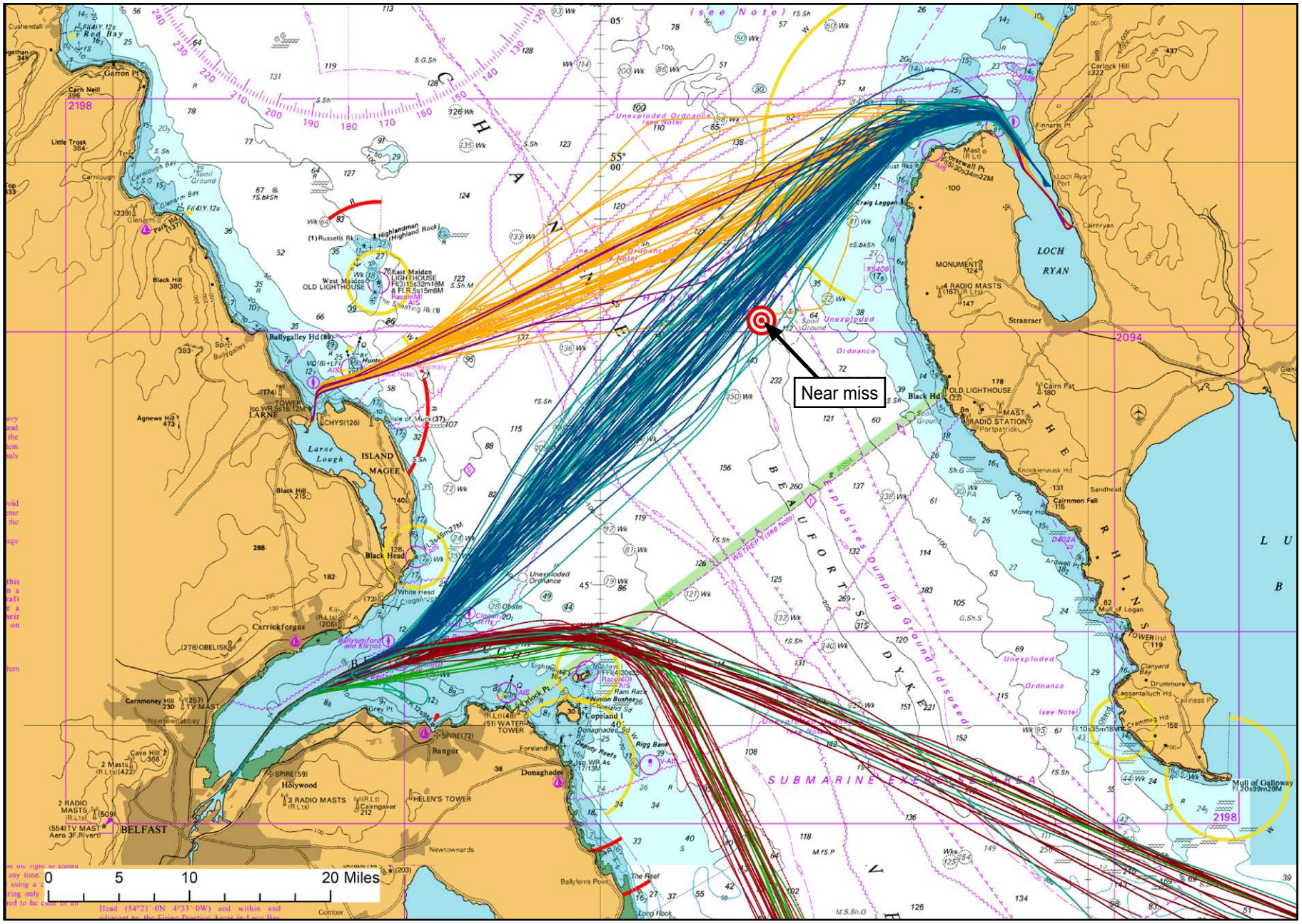


**Figure 10:** Seven days of AIS data for the North Channel showing ferry corridors and the incident location

collision involving HMS *Ambush*, periscope use was limited to infrequent ‘looks’ to avoid detection, and the command team became distracted, resulting in them lacking an appreciation of the risk of collision. In the case of the collision involving the fishing vessel *Karen*, the submarine’s command team mistook a trawler for a merchant ship. This resulted in a significant overestimation of *Karen*’s range and speed, reflecting similar errors to this case.

Although the circumstances of the accidents were different, the fact that there have been two collisions and one very near miss between surface ships and submarines in a period of 4 years is cause for concern. The latest event, though ultimately a near miss, had the potential to be the most serious of all, and it was avoided only by the actions of the bridge team of the ferry involved. In all three cases, not only did the submarines’ command teams have an inaccurate appreciation of the position, course and speed of the surface vessels in their vicinity, but they also did not detect that their assessments were in error in sufficient time to take action to remain safe.

# SECTION 3 – CONCLUSIONS

## 3.1 SAFETY ISSUES DIRECTLY CONTRIBUTING TO THE INCIDENT THAT HAVE BEEN ADDRESSED OR RESULTED IN RECOMMENDATIONS

1. Until avoiding action was taken by *Stena Superfast VII*'s OOW, there was a serious risk of collision between a laden ferry and a submerged Royal Navy submarine. [2.3.4]

2. *Stena Superfast VII* passed inside the submarine's go-deep range, therefore, it was unsafe for the submarine to remain at periscope depth. [2.3.3]

3. It was extremely fortunate that *Stena Superfast VII*'s bridge AB spotted the submarine's periscope, though there was no reasonable expectation he would do so. [2.3.4]

4. Safety-critical decisions on board the submarine, specifically to turn towards the ferry and remaining at periscope depth, were taken based on inaccurate information. [2.3.1, 2.3.3]

5. Overestimation of the ferry's range and underestimation of its speed resulted in the submarine's command system presenting an inaccurate surface picture. However, this situation meant that the unsafe decisions might have seemed rational at the time. [2.3.3]

6. The submarine's command team and the command qualified FOST sea rider demonstrated a bias towards the safer SMCS track that was based upon visual overestimations of the ferry's range. This bias created a situation where other clues to the close proximity of the ferry could be ignored. [2.3.3] [2.4.2]

7. Perceived pressure to remain at periscope depth for training purposes might also have influenced the decision not to go deep. [2.3.3]

8. Although the submarine's passage plan had identified the North Channel ferry hazard and the commanding officer had directed the OOW to remain south of the ferry lanes, the submarine was actually operating in the hazardous area. [2.4.1]

## 3.2 OTHER SAFETY ISSUES NOT DIRECTLY CONTRIBUTING TO THE INCIDENT THAT HAVE BEEN ADDRESSED OR RESULTED IN RECOMMENDATIONS

1. The key similarity between this incident and two previous collisions involving Royal Navy submarines was the absence of a sufficiently accurate picture of surface shipping to support safety-critical decision-making. [2.4.3]

2. Although intended to provide assurance of safe operations, the embarked FOST command sea rider did not advise or intervene to ensure the safety of the submarine. [2.4.2]

# SECTION 4 – ACTION TAKEN

## 4.1 ROYAL NAVY ACTIONS

### 4.1.1 Actions in response to this incident

Post this incident the RN reported that the following actions had been taken:

- FOST shore-based simulator training was updated to enhance the management of close quarters situations with merchant or fishing vessels.

- Submarine command teams were briefed on the critical importance of operating safely at periscope depth in coastal waters. This included a brief on the facts of this case to raise awareness of the potential risks posed to submarines and other vessels nearby.

- Comprehensive learning from experience (LfE) events were delivered to submarine command teams prior to proceeding to sea.

- Training and documentation for the operational use of AIS was reviewed.

- FOST training was amended to ensure that, if a close quarters procedure was commenced, this was run to conclusion and not interrupted.

- Incident reporting procedures have been reviewed and the amended policy reiterated to the submarine flotilla; commanding officers are also briefed on reporting requirements prior to taking command.

- The decision to conduct safety training in areas of known high density shipping was reviewed and found to be justified. However, direction was given that a formal risk assessment should be conducted by FOST prior to safety training commencing.

- All submarines operating near known shipping lanes and when operational circumstances permit, were recommended to use radar to provide increased accuracy of ranging.

### 4.1.2 Actions in response to the *Karen* collision

Although it related to the conduct of submarine operations in the vicinity of fishing vessels, the MAIB's report 20/2016 recommended that the RN conduct a review of procedures and training. Actions taken by the RN in response to this safety recommendation included:

- All submarine commanding officers were ordered to review their pre-deployment planning processes to ensure that all potential hazards were identified.

- Pre-deployment planning was also reviewed by the SUBOPAUTH.

- Direction was provided to all submarine commanding officers on when to report to their chain of command, as well as the requirement to take steps necessary to ensure the safety of other vessels.

- A review concluded that the oversight provided by the SUBOPAUTH was sufficient.

## SECTION 5 – RECOMMENDATIONS

The **Royal Navy** is recommended to:

**2020/124** Deliver an independent review of the actions taken following this and previous similar events, to provide assurance that such actions have been effective in reducing the risk of collision between dived RN submarines and surface vessels to as low as reasonably practicable.

Safety recommendations shall in no case create a presumption of blame or liability

Marine Accident Report