Report on the investigation of the contact made by

the UK registered ro-ro ferry

Daggri

with the breakwater at Ulsta, Shetland Islands

30 July 2004

Marine Accident Investigation Branch
Carlton House
Carlton Place
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Extract from

The Merchant Shipping

(Accident Reporting and Investigation)

Regulations 1999 – Regulation 4:

"The fundamental purpose of investigating an accident under the Merchant Shipping (Accident Reporting and Investigation) Regulations 1999 is to determine its circumstances and the causes with the aim of improving the safety of life at sea and the avoidance of accidents in the future. It is not the purpose to apportion liability, nor, except so far as is necessary to achieve the fundamental purpose, to apportion blame."

NOTE

This report is not written with liability in mind and is not intended to be used in court for the purpose of litigation. It endeavours to identify and analyse the relevant safety issues pertaining to the specific accident, and to make recommendations aimed at preventing similar accidents in the future.

CONTENTS

GLOSSARY OF ABBREVIATIONS AND ACRONYMS

AIS	-	Automatic identification system
ARPA	-	Automatic Radar Plotting Aids
CCTV	-	Closed-circuit television
EBL	-	Electronic bearing line
ECDIS	-	Electronic chart display and information system
ENC	-	Electronic navigation chart
GPS	-	Global positioning system
Gt	-	Gross tonnage
IBS	-	Integrated bridge system
ICS	-	International Chamber of Shipping
ISM	-	International safety management
mb	-	millibar
MCA	-	Maritime and Coastguard Agency
MES	-	Marine evacuation system
NAVTEX	-	Navigation telex
OOW	-	Officer of the watch
Ro-ro	-	Roll on/roll off
SIC	-	Shetland Islands Council
SMS	-	Safety management system
VDR	-	Voyage data recorder
VRM	-	Variable range marker

SYNOPSIS

(All times are UTC +1)

At about 1541 on 30 July 2004, the ro-ro passenger ferry *Daggri* made contact with Ulsta breakwater while entering the terminal in severely restricted visibility. The forward azimuth thruster blades of the propellers were distorted, the hull was indented but not breached and there were no injuries or pollution.

Daggri was a new, doubled-ended ferry built for the Shetland Islands Council, and had been in service for less than 3 weeks. She had a very sophisticated integrated bridge system and had two azimuth thrusters: one forward and one aft. She was built for the route between the terminal at Toft mainland and the terminal at Ulsta on Yell Island, a distance of about 2.6 nautical miles.

The vessel sailed from Toft and, once clear of the berth, the mate, who was sitting in the starboard pilot chair, took the con and manually steered the vessel across Yell Sound, while the master sat in the port chair. Both of the officers had radar displays in front of them, and between them was an ECDIS display. At the first point of the crossing, the visibility was variable, but it became poor near Yell shore. During the crossing, *Daggri*'s crew observed the ferry *Hendra* appear out of an area of restricted visibility off the Yell shore, passing about 2.5 cables abeam to port.

When *Daggri* was approaching Ulsta breakwater, speed was reduced to about 8 knots. The master went to the starboard enclosed bridge wing and took over the control of the vessel. A short time later, the mate informed the master that the breakwater was half a mile from the vessel. Several seconds later, the master saw the breakwater appear through the fog at short range, and he immediately performed an emergency crash stop manoeuvre. Notwithstanding this action, the vessel made contact with the Ulsta breakwater at a speed of about 3 knots. The forward thruster engine tripped and could not be re-started, however, the master was able to safely berth *Daggri* at the Ulsta terminal less than 10 minutes later, using only the after thruster unit for propulsion.

This MAIB investigation has identified key issues on the following:

- the challenges faced by ship's crews due to the introduction of new technology;
- effective bridge team management;
- type rating certificate training;
- general passage and blind pilotage plans for ferries; and
- the incorporation of passage plans into electronic navigational aids.

SIC has taken significant action to address all issues identified in the investigation.

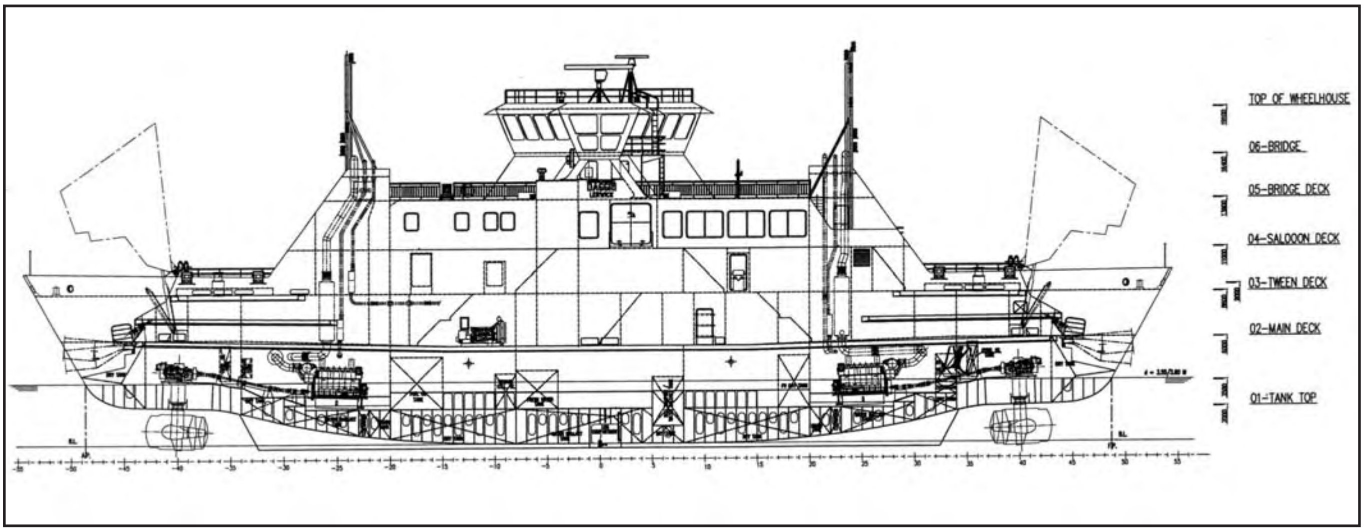
Recommendations have been made to the International Chamber of Shipping regarding encouraging shipping companies to introduce training schemes for sea staff whenever new technology is introduced on board their vessels. It should also encourage the necessary change to working practices this brings about.

The ICS is also recommended to encourage ferry operators to create generic passage plans for incorporation, where appropriate, into the electronic navigational systems fitted on board ships, to provide a template for use by ship's staff when planning individual voyages.

Photograph 1

Daggri berthed at Leith

Figure 1



Profile drawing of *Daggri*

SECTION 1 - FACTUAL INFORMATION

PARTICULARS OF *DAGGRI* AND ACCIDENT

Vessel details

Registered owner	:	Shetland Islands Council Ferry Services
Port of registry	:	Lerwick
Flag	:	United Kingdom
Type	:	Ro-ro cargo/ferry
Built	:	2004 at Gdansk
Construction	:	Steel
Length overall	:	65.36m
Loaded draught	:	3.7m
Gross tonnage	:	1,861
Engine power and type	:	Two MaK diesel engines (of 1,200kW each) geared to two fore and aft Rolls Royce Aquamaster azimuth thrusters with contra-rotating propellers
Service speed	:	12 knots

Accident details

Time and date	:	1541, 30 July 2004
Location of incident	:	Latitude 60° 29.72'N, longitude 001° 09.51W. Ulsta breakwater, on the island of Yell, Shetland Islands
Persons on board	:	39 passengers and 6 crew members
Injuries/fatalities	:	None
Damage	:	Forward azimuth thruster propellers severely distorted and some damage to the stem.

1.2 BACKGROUND TO THE SHETLAND ISLANDS COUNCIL'S FERRY SERVICES

The Shetland Islands Council owns and operates a fleet of 14 ferries providing services between mainland Shetland and the adjacent islands. The services run from 16 terminals serving 9 islands. The ferries make over 70,000 crossings each year and carry almost 700,000 passengers and over 300,000 vehicles.

Ro-ro services operate every day to the islands of Yell, Unst, Fetlar, Whalsay and Bressay. Freight and limited passenger services operate to Skerries, Fair Isle, Foula and Papa Stour.

The Yell Sound ferry service had previously been maintained by the *Bigga* and *Hendra,* vessels with a length of 33m and 274/248gt respectively. In 2000, it became apparent to the Shetland Islands Council that, due to increasing demand, larger ferries would have to be used on this service. *Daggri* was ordered and built in Poland, and was delivered to the Shetland Islands in June 2004. The sister vessel *Dagalien* was delivered several months later.

1.3 NARRATIVE

At 0630, on 30 July 2004, *Daggri*'s day shift crew took over from the night shift when the vessel was at the Ulsta ferry terminal.

From 0630, until the accident, the vessel made 17 trips across Yell Sound, which took between 10 and 15 minutes per passage.

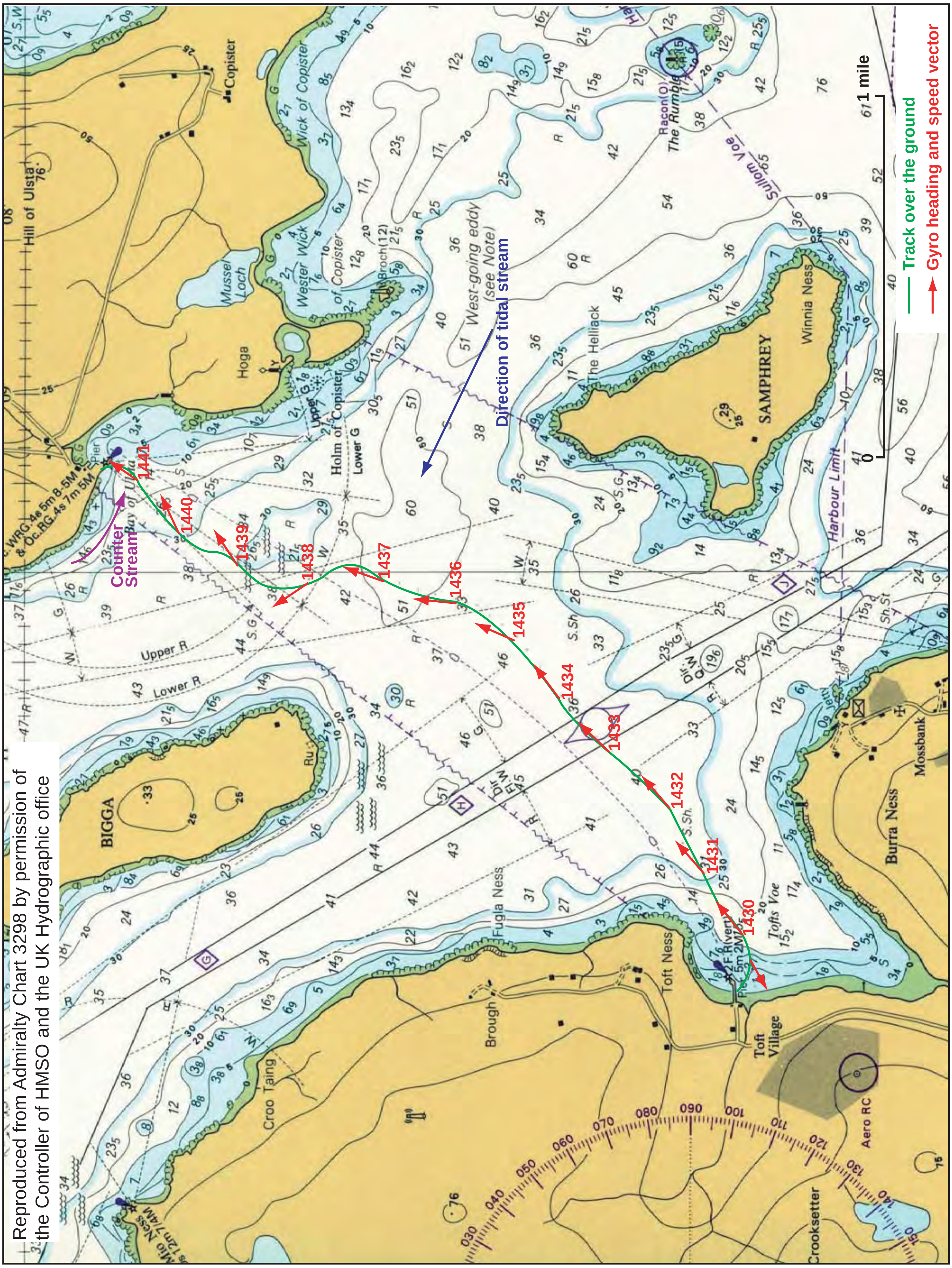
Daggri left Toft at 1530 with 39 passengers, 12 cars and 6 crew members on board. The crew consisted of the master, mate, an engineer and three deckhands.

The master manoeuvred the vessel off the berth. Once the vessel was clear of the terminal, the mate arrived on the bridge from the vehicle deck and took over the con. A lookout was on the bridge, but the engineer was down below in one of the engine spaces. The mate sat in the starboard chair and hand-steered the vessel across Yell Sound, by making adjustments to the aft thruster control as required **(see Section 1.5.1)**, while the master sat in the port chair. In front of each chair, were individual radar displays, whilst between them was an ECDIS. During the voyage, various courses were steered as the vessel proceeded across Yell Sound at between 11.8 and 15.5 knots over the ground **(see Figure 2)**.

At 1534, a mate, who was employed on another ferry route operated by the Shetland Islands Council, arrived on the bridge and began to talk to the master and mate of *Daggri* about the handling characteristics of that vessel. Up until this time, there had been little conversation between anyone on the bridge.

At about 1535, the Ulsta to Toft ferry *Hendra* passed *Daggri*'s port beam at 2.5 cables. *Daggri*'s bridge team saw the other ferry come out of an area of restricted visibility off Yell shore.

Figure 2


Reproduced from Admiralty Chart 3298 by permission of the Controller of HMSO and the UK Hydrographic office
Track over the ground
Gyro heading and speed vector
Direction of tidal stream
Counter Stream
West-going eddy (see Note)
1 mile
1430
1431
1432
1433
1434
1435
1436
1437
1438
1439
1440
1441
BIGGA
SAMPHREY
Toft Village
Toft Ness
Fugla Ness
Brough
Croo Taing
Burra Ness
Mossbank
Hoga
Copister
Hill of Ulsta
Mussel Loch
Wick of Copister
Wester Wick
Holm of Copister
Winnia Ness
The Helliack
The Rumble
Tofts Voe
Crooksetter
Harbour Limit
Sullom Voe
Upper R
Lower R
Aero RC
Racon(O)

At about 1537, the mate reduced radar display range from 1.5 miles (with fixed range rings of 0.25 mile) to 0.75 (also with fixed range rings of 0.25 mile).

The following times were derived from the VDR on board *Daggri.*

From 15:39:04 to 15:39:50, the mate reduced the speed of the engines in preparation for the approach to the Ulsta terminal.

At 15:40:02, control of the thrusters was transferred to the starboard bridge wing, from where the master acknowledged that he had control of the vessel. At about this time, the vessel entered the area of restricted visibility off the Yell shore. The master then increased the speed of the engines for a number of seconds before reducing them further. The visibility at this time was such that Ulsta breakwater could not be seen visually. He selected the electronic chart on the bridge wing monitor display.

At 15:40:23, the mate reduced the radar display range from 0.75 to 0.5 of a mile, and then, within several seconds, to 0.25 of a mile.

At 15:41:10, the visiting mate asked *Daggri*'s mate what fixed radar rings he had on the screen, to which he replied, “a quarter”. The visiting mate made the observation, by looking at the fixed range rings, that the vessel must have been between a half to three quarters of a mile away from the breakwater.

At 15:41:25, in response to the master’s request for a distance off Yell breakwater, the mate told the master, “we’re touching the half mile now”, by which he meant that the echo of the breakwater was observed to be on the half a mile range ring of the radar display.

At 15:41:30, alarmed at suddenly seeing the breakwater visually, the master rapidly reduced the speed of the two engines, rotated both thrusters to point astern and then increased the engine speed.

At 15:41:36, the mate told the master that they were close to the breakwater.

At 15:42:12, the vessel made contact with the breakwater at about 3 knots, and the forward thruster engine cut out immediately.

At 15:43.21, the vessel cleared the breakwater and, using the after thruster alone, the master managed to berth her alongside in about 10 minutes. During this time, there were no announcements made to the passengers, as the master believed that the contact with the breakwater was a minor one and the vessel was close to the berth.

After disembarkation of her passengers and cargo, *Daggri* proceeded to Leith under her own power to berth for repairs to her hull and replacement of the forward thruster unit.

1.4 ENVIRONMENTAL CONDITIONS

There were light south-east winds, it was overcast with poor visibility in fog patches and a barometric pressure of 1020mb. The tide was setting to the north-west at about 2 knots through Yell Sound.

1.5 *DAGGRI*

1.5.1 The vessel

Daggri was 65.36m in length, had a gross tonnage of 1,861 and a passenger capacity of 95 (with a crew of 5) and 144 (with a crew of 6). In addition, she could carry 31 cars, or 4 trucks and 7 cars. She was built to a Norwegian design at Gdansk in Poland, and after four days of sea trials, was delivered to the Shetland Islands Council, on 11 June 2004. Her Passenger Ship Safety Certificate was issued by the MCA on 12 July 2004 and she entered service 5 days later. Between delivery and entering service, there was an extensive training program for her six team crew.

Daggri was far larger than any of the ferries previously used on the Yell Sound route, and had four decks and a large passenger accommodation. She was double-ended, and had one azimuth thruster propulsion unit "forward" and another one "aft", as opposed to the usual twin screws and bow thrusters of the earlier ferries. Each thruster unit had two contra rotating sets of propellers, which were fixed pitch and thereby controlled directly by the engine speed. The azimuth thrusters and their bridge controls were manufactured by Rolls Royce.

1.5.2 The bridge team

The master was 57 years old and started his seagoing career on ferries travelling between a number of Scottish ports. He then served as an able seaman on deep sea ships for about 6 years. In 1973, he joined the Shetland Isle ferry company as deckhand. For the last 21 years he had served as master with the Shetland Islands Council ferries, the final 10 years of which he had worked exclusively on the Yell Sound route. He spent the previous 13 years manoeuvring vessels equipped with twin screws, Becker rudders and a bow thruster. He held a master's certificate of competency restricted to vessels of less than 3,000gt. Due to the roster system of the teams of crew, this was his first tour of duty on *Daggri* after his initial training. He had spent 5 days in operational service before the accident.

The mate was 51 years old and started his seagoing career in 1970, working on board fishing vessels. He passed the Second Hand Special certificate in 1978 and the Class 1 (fishing) certificate in 1996. He had been a skipper and part owner of a fishing boat during which time he had used a Decca Bridge Master radar and an electronic chart system. Several years ago, he attended a course at Scalloway College, which resulted in the conversion of his fishing qualification into an OOW (unlimited) certificate of competency. About 2 years before the accident, he was appointed as mate on the Shetland Islands Council ferries. Prior to the accident, the mate had been on board for 3 days and, due to the roster system of the teams of crews, this was his first tour of duty after training on the vessel.

At the time of the accident, the chief engineer was occupied with work elsewhere in the vessel and was not at his usual station on the bridge. An able seaman was keeping lookout in addition to the master.

The shift system employed on *Daggri*, required the crew to work on board for 12 hours from about 0600 to 1800 daily for 6 days. The crew then had 24 hours off, followed by 3 night shifts. This period of 9 days on board was followed by 9 days of leave.

1.5.3 The integrated bridge system

The IMO defines an integrated bridge system as:

> *An integrated bridge system (IBS) is defined as a combination of systems which are interconnected in order to allow centralized access to sensor information or command/ control from workstations, with the aim of increasing safe and efficient ship's management by suitably qualified personnel.*

As *Daggri* was double-ended, and could travel in either direction without the need to swing the vessel, there were two identical integrated bridge system consoles on the bridge, one "forward" and one "aft" **(see Figure 3)**.

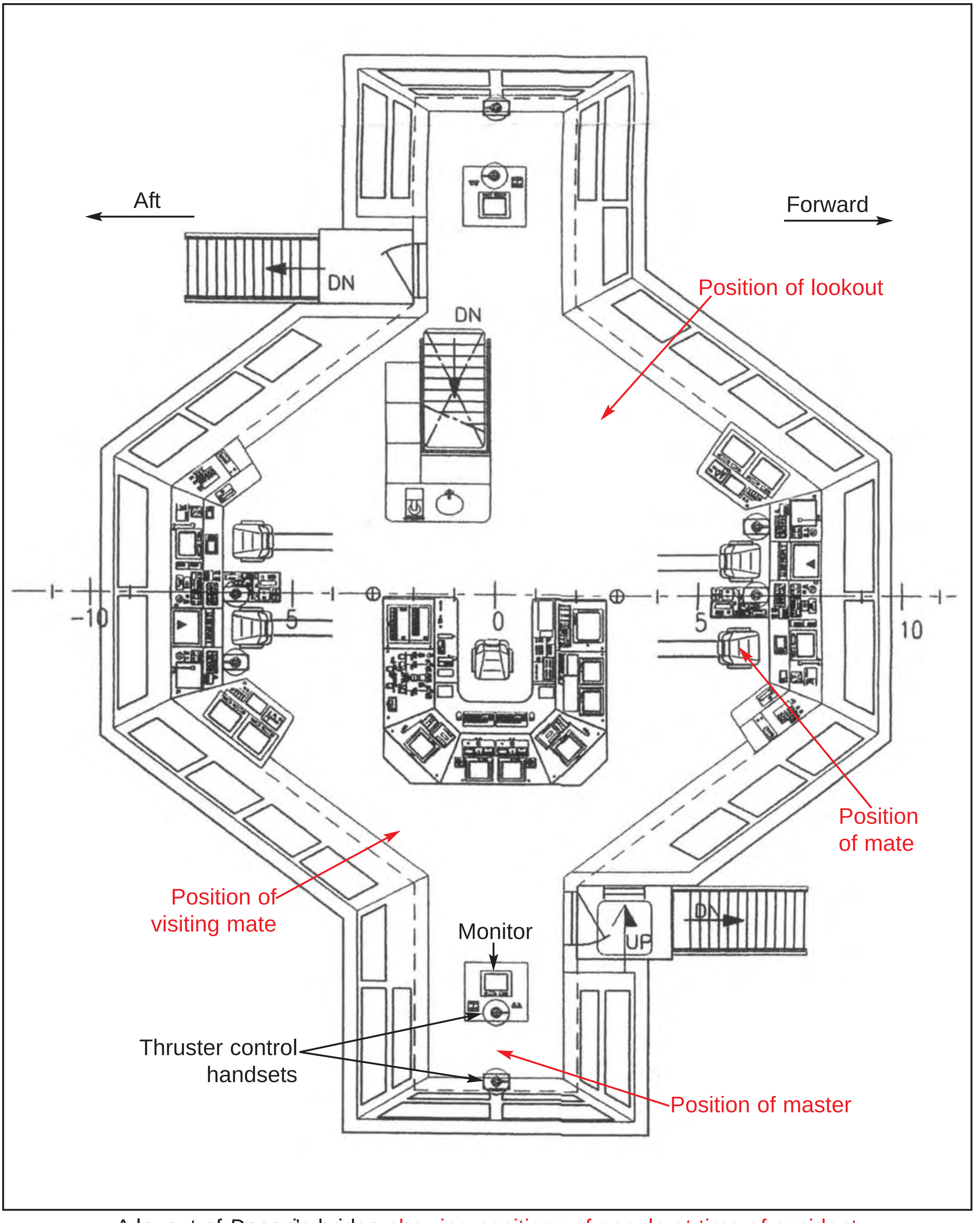
This design feature meant that the vessel did not have to be turned around after leaving the berth, as had been required when conventional ferries had been used on the Yell Sound route. When *Daggri* was leaving a berth, the master or mate selected the command button for the relevant "forward" console, and in doing so, the heading lines on the gyros, and the radar heading lines, swung through 180° and the navigation lights switched round from their previous settings.

Each integrated bridge console was fitted with three, Manta 2000-type, 22cm display units:

- the starboard display showed X (10cm) or S (3cm) band radar only;
- the centre display could show X or S band radar and/or ECDIS; and
- the port display could show X or S-band radar and/or ECDIS or CCTV, from a number of cameras around the ship.

Mounted on the consoles at the bridge wings was a display, which could show radar and/or ECDIS or CCTV.

Figure 3



A layout of *Daggri*'s bridge showing positions of people at time of accident

The ECDIS was supplied with the latest official ENCs and could display NAVTEX data. Both the ECDIS and the radar were integrated with an AIS system.

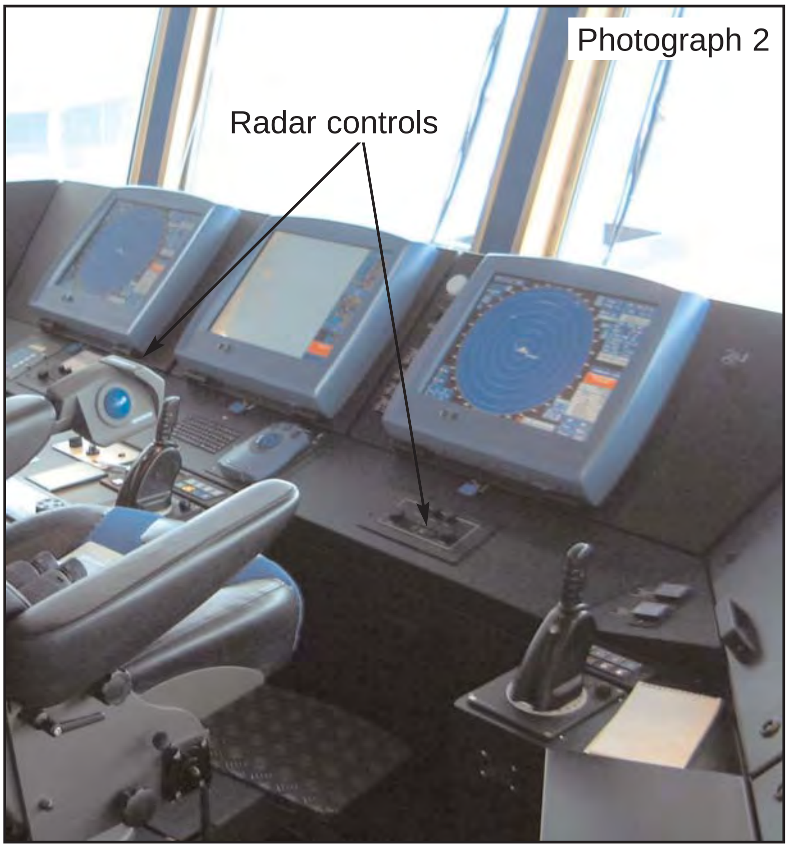
A VDR was fitted, from which data was downloaded after the accident.

The Shetland Islands Council fleet regulations on the use of navigational equipment stated:

> *The proper use of navigational aids including electronic aids is the responsibility of the Master who will delegate responsibility, as appropriate to the Mate.*
>
> *The Masters, or delegated officer, must use the navigational aids and electronic equipment to maximise and continually monitor the vessel's position and its relationship to danger and the movements of other vessels. There must be cross checking as far as possible to determine positions, using one system or another.*

1.5.4 Control of the propulsion system

Each of the two fore and aft azimuth thrusters was controlled by a handset, which could be rotated through 360°. The top of the handset was fitted with an integral lever which controlled the engine speed. A pair of controls was sited close to each of the starboard chairs **(see Photograph 2)** and at each of the bridge wing consoles **(see Photographs 3 and 4)**. The latter positions were used by the master to manoeuvre the vessel when approaching, entering and berthing at the terminals.



A view of one of the two consoles, showing the roller tracker ball and the two thruster control handsets

At each control position, the left-hand control operated the thruster sited to the rear of the operator and the right-hand control operated the thruster sited ahead of the operator.

Since the azimuth thrusters had fixed pitch propellers, when clutched in they always produced thrust. Therefore, for the vessel to remain on station, or operate at low speeds, it was necessary to point the thrusters in opposite directions.

Photograph 3

One of the two bridge wing consoles, showing the display and one of the two thruster control handsets

Photograph 4

The second bridge wing thruster control handset

Passage plan

The following extracts are taken from a generic passage plan for Yell Sound:

> *<u>Northbound</u>*
>
> *Base line course Toft Jetty 090° x 0.28’*
>
> *Alter course (Samphrey ahead 1.0’) to 034° x 2’*
>
> *Above base line course is a main guide to follow with prevailing tides and weather conditions requiring alterations normally given area of crossing pertaining to local knowledge of rapidly changing conditions.*
>
> *Observe weather perimeters in SMS code with consideration to prevailing tidal conditions.*
>
> *Under no circumstances must the vessel be allowed to get closer to any land or shoal than 0.15’. To assist use Visual* (sic) *Range Marker on the radar. Use the cursor on the radar parallel to the heading marker to parallel index.*
>
> *<u>Normal Operational Limits</u>*
>
> *Under normal operational conditions the vessel should remain within the area specified. You may leave the area only in cases of emergency or to avoid danger. Reason for leaving must be noted down in the deck log book.*
>
> *<u>Restricted Visibility</u>*
>
> *To remove any confusion, during restricted visibility, both vessels operating on Yell Sound must, when operating in close proximity leaving or approaching terminals, pass “Port to Port”. This will remove any doubt as to the intentions of the other vessel.*

The SIC Fleet regulations stated:

> ***Notwithstanding the shortness of the passage in time or distance and the frequency of these trips it is necessary to have a valid passage plan.*** *Masters and Mates are cautioned against allowing themselves to be lulled into a false sense of security in waters they are very familiar with. The planning must have the following components:*
>
> - *Appraisal*
> - *Planning*
> - *Execution*
> - *Monitoring*
>
> *Since Shetland Islands Council vessels operate frequently in pilotage waters the Master & Mate must check the following variables prevalent at the time:*
>
> - *Currents (wind and tide)*
> - *Draught of the vessel*

- *Local advice (Coastguard and Sella Ness)*
- *Status of navigational lights/buoys*
- *Weather forecast*
- *Vessel's handling characteristics*

In planning, the Master and Mate must provide for the unexpected, particularly a breakdown or malfunction of equipment. The approach must be to plan not to go where it is unsafe or be in a situation that is a threat.

In particular, great care must be taken to ensure that adequate clearance is given to shoal waters and navigational hazards at all times, and especially in areas which are poorly charted.

In execution, the Master and Mate must conduct all checks possible to ensure that the intended action is being achieved.

1.6 THE PILOT/CO-PILOT SYSTEM

Shetland Island Council Ferry Service's fleet regulations stipulated the use of a pilot/co-pilot system. The concept of the *pilot/co-pilot system* came from the high speed craft section of the marine industry, and was introduced into the fleet several years ago. The basic principle behind the system was that the pilot had control of the vessel and was in charge of the navigational watch, while the co-pilot monitored the actions of the pilot and kept a lookout. The system was based on positive reporting of actions and intended actions being stated and acknowledged, and the free flow of information between them. The co-pilot should question the actions or intents of the pilot. Either the master or the mate could perform the function of the pilot on *Daggri*.

The fleet regulations stated that its vessels were to be manually steered by a person other than the pilot, under the following conditions:

- restricted visibility
- congested waters
- during hours of darkness
- adverse weather conditions
- any condition which adversely affected the manoeuvrability of the vessel
- any other condition as deemed appropriate by the master.

As the master and mate could interchange responsibilities as pilot or co-pilot, the fleet regulations stated that it was essential that they were absolutely clear as to which role they were taking at any given time. This was to be done by making a verbal statement as to who had the con of the vessel and ensuring that it was acknowledged by the other officer.

1.7 TRAINING

1.7.1 Training during sea trials in Polish waters

Before delivery of *Daggri,* and during builders' sea trials, the Shetland Islands Council's marine superintendent and senior master received training in the manoeuvring of the vessel. One-to-one training was provided by a master employed by the thruster manufacturers, Rolls Royce, who had experience in the use of the Aquamaster propulsion system.

The marine superintendent and the senior master were also given instruction, by a Kelvin Hughes technician over several hours, on the use of the radars, ECDIS, the VDR and the integrated bridge system as a whole. The marine superintendent had also previously gained 5 years' experience operating similar Kelvin Hughes Nucleus radars.

1.7.2 Training in home waters

From 14 June to 11 July, the six teams of five crew were trained by the marine superintendent and the senior master on board *Daggri*. Each individual had to sit a written *Type Rating Certificate* examination for the vessel, which was set by the marine superintendent and marked by the senior master **(see Annex 1)**. Each of the teams was given 6 days of training lasting from 0800 - 1800 each day. The first two days involved training in safety equipment and procedures, lifesaving appliances, fire-fighting appliances, drills etc. The third day involved operation of ancillary equipment and manoeuvring training. The last three days involved manoeuvring training and practice, navigational aid training and practice.

The masters and mates were given instructions on ship handling for approximately half a day. Practical manoeuvring and steering training, plus instructions on the use of navigational aids, was provided over 2 days during the last 3 days of training.

(*A list of the manoeuvring training given is at **Annex 2**.)

The marine superintendent explained to the masters and mates the operation of the navigational aids on the fourth day of training **(see Annex 3)**.

The trainees were then given the operation manuals for the navigational aids, and were invited to practice using the equipment when they were not engaged in manoeuvring the vessel during the remainder of their training. The marine superintendent and a senior master were available to answer any questions the masters and mates had about the equipment.

1.7.3 Blind pilotage training

The SIC considered it unnecessary to retrain the bridge teams of *Daggri* on blind pilotage methodology, as they were already cognisant of the principles of navigation in restricted visibility, and had previously gained experience of this type of navigation in a simulator at college. The SIC Safety management system (SMS) requires masters of the vessels to ensure blind pilotage procedures are established and regularly practised.

Their fleet regulations state:

> *All masters and mates must practice the use of parallel index or equivalent techniques on a regular basis to enable blind pilotage to be carried out in the approaches to their scheduled service ports. The information should be prepared and kept on the bridge for the ports concerned and be exercised in clear weather conditions to establish confidence and ensure that masters and mates are familiar with the radar picture of the port and berth approaches.*

An internal company ISM audit, conducted on *Daggri* 3 days before the accident, revealed that there were no blind pilotage plans on board the vessel. This was noted as a minor non-conformity in the audit log.

1.7.4 Crash stop training

The master had been trained in the three methods of effecting an emergency crash stop:

1. The method which stopped the vessel in the shortest distance was to turn the thrusters through 90º in the opposite direction, which had the effect of slewing the vessel side on to the original course being steered. This method was estimated to stop the vessel from 13 knots in about 70m. However, it was considered the motion of the vessel would be too violent during this manoeuvre and could cause a shift of cargo and injuries to passengers.
2. The vessel could also be stopped by turning the thruster controls through 90° in the same direction. However, the engine speed of the aft thruster also had to be reduced to prevent the stern from swinging too fast towards the danger.
3. The preferred method was to turn the thruster controls through 180º in the same direction. Using this method, the stopping distance from 13 knots was estimated to be 120m.

1.8 BRIDGE TEAM MANAGEMENT

The following are relevant extracts from the Nautical Institute's *Bridge Team Management:*

The aim of the prudent mariner is to ensure that their ship reaches its destination safely and efficiently. To do this consistently demands a level of skill which is not easy to quantify but needs to become part of the maritime culture.

Like all knowledge based skills, bridge watchkeeping and navigation require practice, support and reaffirmation. Left unattended they can become casual. The actions taken on the bridge may be uncritical and the inter change of information between the master and the watchkeeping officers lapses into a working relationship where assumptions are made without being verified.

When bridge operations are loosely organised the impression can be given that all things will be all right. However, when the unexpected occurs, confusion arises. It becomes more difficult to make decisions and the possibility exists for an error of judgement which might lead to an accident.

An accident by its nature is unexpected, but most accidents occur because there is no system in operation to detect and consequently prevent one person making a mistake – a mistake of the type all human beings are liable to make.

Bridge team management .... is the implementation of a way of working which recognises that reliable and consistent standards can only be maintained if navigation is based upon sound principles and reinforced by effective organisation. In this context it is up to all ship's officers to make the best possible use of available resources, both human and material, to achieve the successful completion of the voyage.

1.9 DAMAGE

After the accident, all compartments were checked for ingress of water. None was found. However, the forward azimuth thruster unit was damaged and could not be used. One of the propeller blades for this unit was missing, and the remainder were all severely distorted **(see Photographs 5 and 6)**. There was also minor scoring to the bow, but this did not affect the seaworthiness of the vessel.

Photograph 5

The damaged “forward” thruster unit

Photograph 6

A closer view of the damaged propeller blades

SECTION 2 - ANALYSIS

2.1 AIM

The purpose of the analysis is to determine the contributory causes and circumstances of the accident as a basis for making recommendations to prevent similar accidents occurring in the future.

2.2 FATIGUE

Fatigue index software was used to evaluate the hours worked by *Daggri*'s master and mate prior to the accident. The result showed the risk of fatigue, as a contributory factor in the accident, was low for both men.

2.3 THE ACCIDENT

A number of causal factors led to *Daggri* making contact with Ulsta breakwater:

- No visual references because of the severely reduced range of visibility in fog.
- The master's and mate's lack of situational awareness.
- Erroneous interpretation of the radar range display rings.

The contributory factors were:

- The master and mate were not fully familiar with the operation of the navigational equipment on board.
- The master perceived the vessel to be further from the breakwater than she actually was, which meant that he did not slow her down sufficiently for the prevailing conditions.
- Passage and blind passage plans that were not specific to *Daggri.*
- The extended period of time between the master's and mate's training program and their actual operation of the vessel.

2.3.1 General

Daggri was radically different from the ferries previously used on the Yell Sound route. She was nearly twice the length; the propulsion system and manoeuvring characteristics were unconventional; and the bridge layout, propulsion controls and navigational aids were more sophisticated.

The masters and mates faced quite a challenge during their training period, especially in respect of the high degree of sophistication of navigational equipment fitted on the bridge, and the propulsion system, which gave the vessel significantly different manoeuvring characteristics to the vessels they had been used to. The bridge team was still in a period of learning and becoming familiar with the sophisticated navigation equipment onboard at the time of the accident.

2.3.2 The actions of the mate

During the passage from Toft to Ulsta, the mate sat in the starboard bridge chair and took on the role of pilot. The master took the role of co-pilot in the port chair. The VDR did not indicate that there had been any formal exchange between the mate and the master to signify that the former had taken the con of the vessel after leaving Toft. Formal handover of the con is good practice and leaves no doubt as to who has control of the vessel.

During the first minutes of the passage, there was little talk between the mate and the master. The engineer had gone below and the lookout was moving between the engineer's console and the port side of the bridge. About 5 minutes after departing Toft, one of the SIC's mates, from another route, arrived on the bridge and a conversation ensued with the bridge team about the new vessel.

During the voyage, the mate reduced the radar range twice, once when the vessel was 8 cables away from the Ulsta breakwater, and once when the vessel was 2.2 cables off. For each occasion, the new radar range, and the distance of the fixed rings, was numerically displayed at the top right of the screen **(see Photograph 7)**.

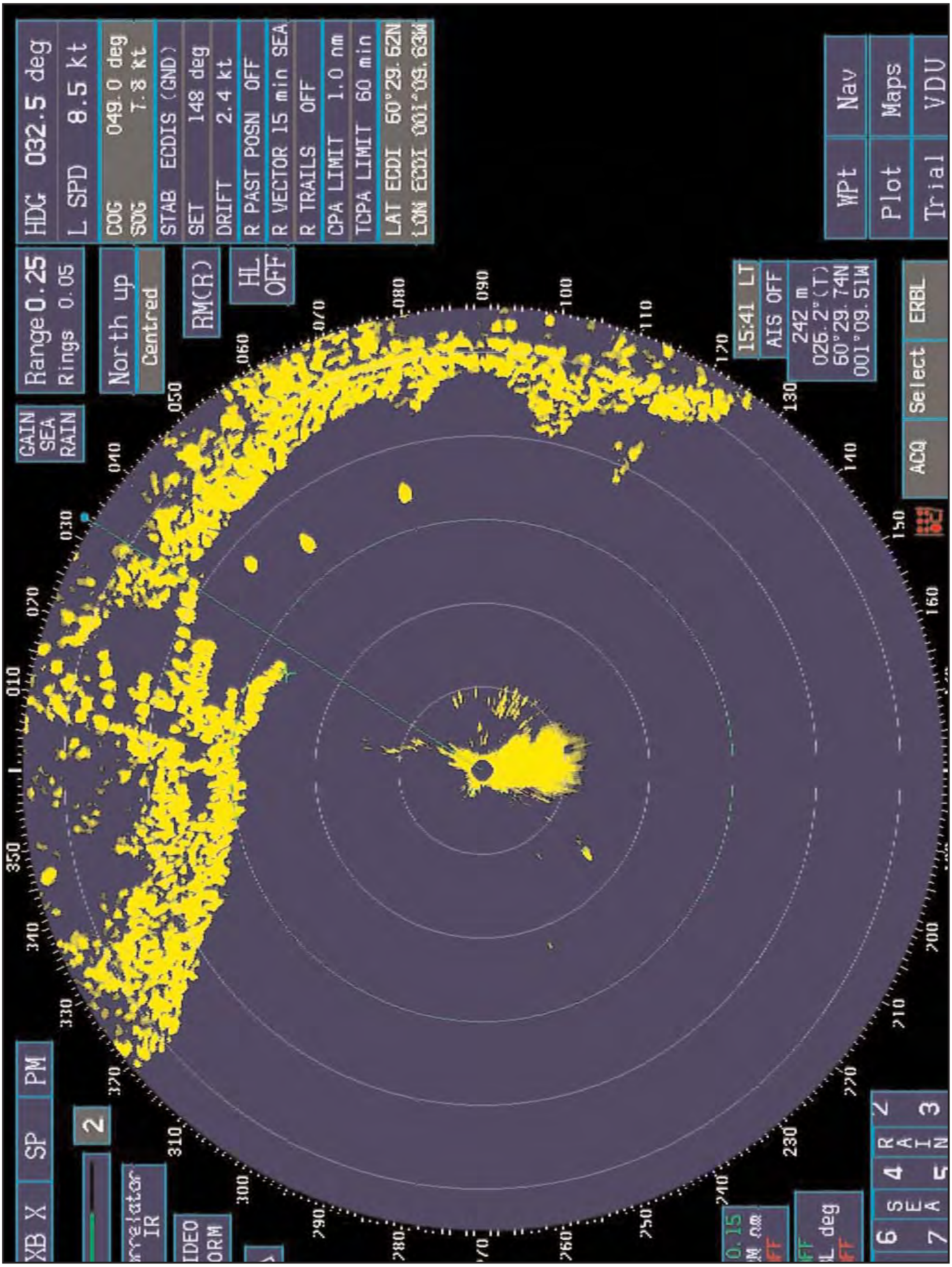
When asked by the visiting mate as to what fixed rings he had on the radar, the mate replied "a quarter" (or 0.25 of a mile). Yet the display readout showed that the radar range was 0.25 and, directly underneath, the fixed rings were spaced every 0.05 of a mile**.** Additionally, wherever the cursor was placed on the screen there was a readout to the lower left, which gave a bearing and distance. At this time, the mate had placed the cursor on the end of the breakwater and the display read 242m and 026.2°(T), but this readout was also not read **(see Photograph 7)**.

Neither the mate, nor the visiting mate noticed these readouts. The confused situation was compounded when the mate told the master that the breakwater was "touching the half-mile ring" (or the second ring out from the centre of the screen). Actually, the true range of the vessel was only 0.1 mile from the breakwater and rapidly closing, with *Daggri* still proceeding at about 8 knots **(see Photograph 8)**.

The mate had gained experience using modern radars when he operated his own fishing vessel. However, this did not prevent him from making an error when interpreting the radar range of *Daggri* from the breakwater just prior to the accident. The VRM and the EBL were switched off, and parallel index lines were not displayed on the screen. Because the radar was not being used to its full potential, when the mate was navigating *Daggri* across Yell Sound, in restricted visibility, he was unable to advise the master properly when the latter had taken the con.

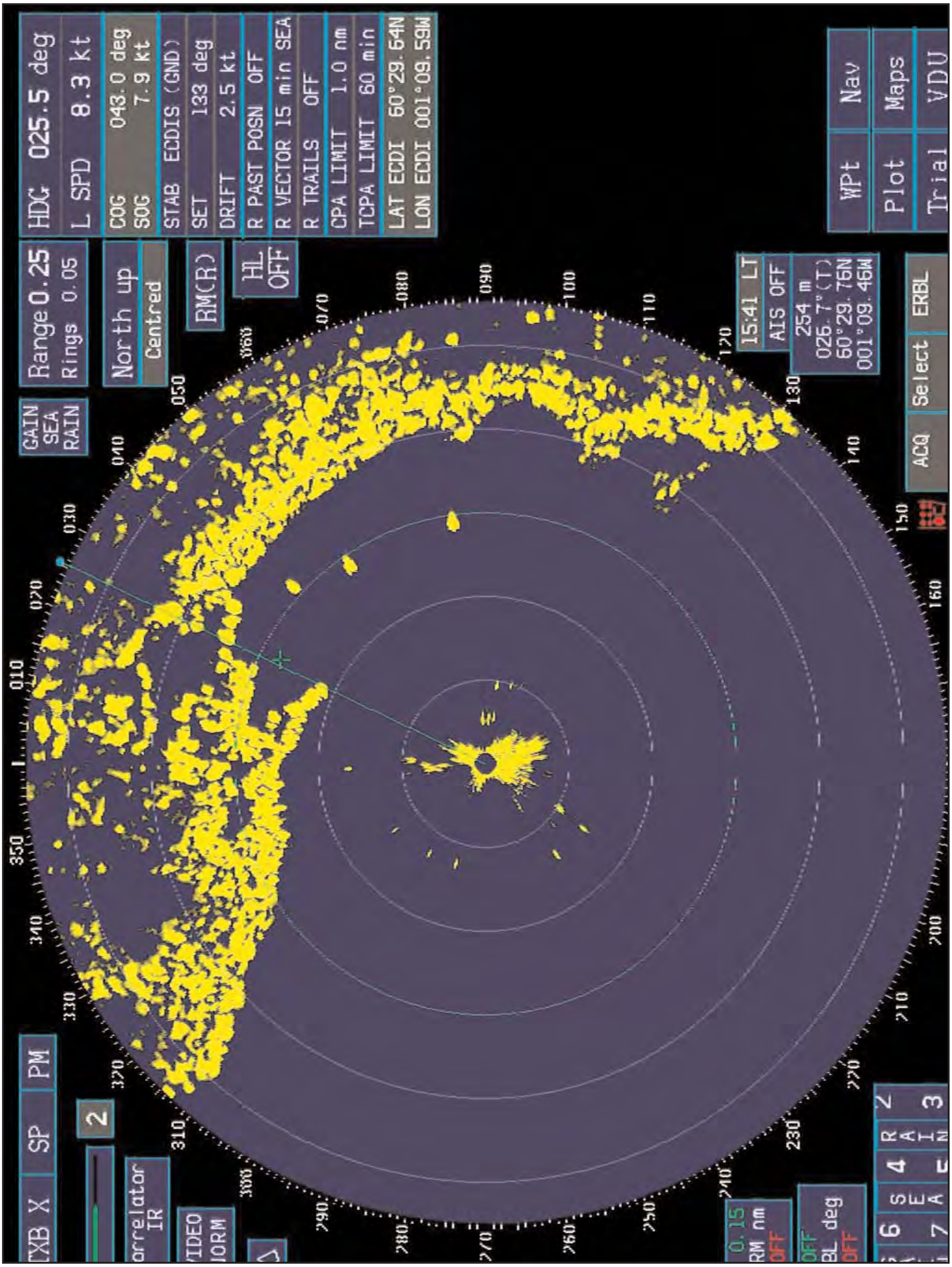
Had *Daggri*'s mate not become distracted, and his concentration not been impaired while talking to the visiting mate, he could have rectified the mistake he made when he read *Daggri*'s distance from the breakwater, and he could have alerted the master accordingly.

Photograph 7



An extract from the VDR

Photograph 8



An extract from the VDR

VRM and EBL off

2.3.3 The actions of the master

The master had been acting as co-pilot of the vessel since handing over the con to the mate shortly after leaving Toft. The master took back the con of the vessel at the starboard bridge wing control station at 15:40:02, when *Daggri* was proceeding at about 8 knots and was 2.7 cables away from the breakwater. Again, there was no formal handover of the con, even though a procedure for handover of the vessel's con had formed part of the earlier training programme. He switched through the wing displays from CCTV to radar, and then to ECDIS, and decided to use ECDIS on the approach.

The visiting mate had asked what was the fixed range scale rings on the radar, to which the mate replied "a quarter". The visiting mate then said that the vessel was a "half to three-quarters of a mile" away (from the breakwater). This was said sufficiently loud enough for the master to hear, leading him into a false sense of security. About 10 seconds later, the maDaggrite told him that the breakwater was "touching the half mile" range ring and, very shortly after this, the master saw the breakwater at close range, probably at about 150m.

The master relied on the information given to him, and did not question either the visiting mate's observation of the distance from the breakwater, or the mate's statement about being half a mile away from the breakwater. This implies that he did not know the exact position of the vessel, and that he might have been distracted by the conversation with the visiting mate before taking the con. The master perceived the vessel to be further from the breakwater than she actually was, and he also did not slow the vessel down sufficiently given the severely restricted visibility.

In accordance with the procedures set out in SIC's company regulations, when *Daggri* approached the area of restricted visibility, the mate should have passed the task of hand-steering the vessel to the master, so that the mate could be free to concentrate on using the radar and the ECDIS. If they had carried out these procedures, they might have been more aware of the vessel's speed and position in relation to the breakwater.

When the master saw the breakwater, he took immediate action by initially reducing the speed of the engines, turning the two thrusters in the opposite direction and then increasing the speed of the engines. However, the movement of the propulsion system had a delay of about 10 seconds.

When the vessel made contact with the breakwater, the speed of the vessel was about 3 knots. Therefore, the master had only been able, from 15:41:30 to 15:42:12 (42 seconds), to reduce the speed of the vessel by some 5 knots while travelling a distance of 150m.

The master used the third crash stop method, described in **Section 1.7.4**. However, the master could not remember, and the VDR does not show, whether he turned the thrusters in the same direction as advised in that method. It is probable that the master did not use exactly the correct method, which would have been practised during training, because he would not have been fully familiar with the handling characteristics of the vessel in the emergency mode.

It would have been wise for the master to have reduced *Daggri*'s speed **(see Figures 4 a, b and c)** further than he did on approaching Ulsta, given the prevailing restricted visibility. Had he done so, it would have given him a longer period in which to react to any unforeseen circumstances, and the accident might have been avoided.

In conclusion, the master and mate were not working together effectively in accordance with the principles of bridge team management, which was essential in restricted visibility. Had they done so, the mistakes that were made could have been detected and corrective action taken.

2.4 TRAINING OF THE MASTER AND MATE

Representatives of Kelvin Hughes and Rolls Royce gave the marine superintendent and the senior master training on the integrated bridge system and the handling characteristics of the vessel in Poland. Therefore, it was incumbent upon them to cascade their knowledge to the crew teams during the subsequent training period.

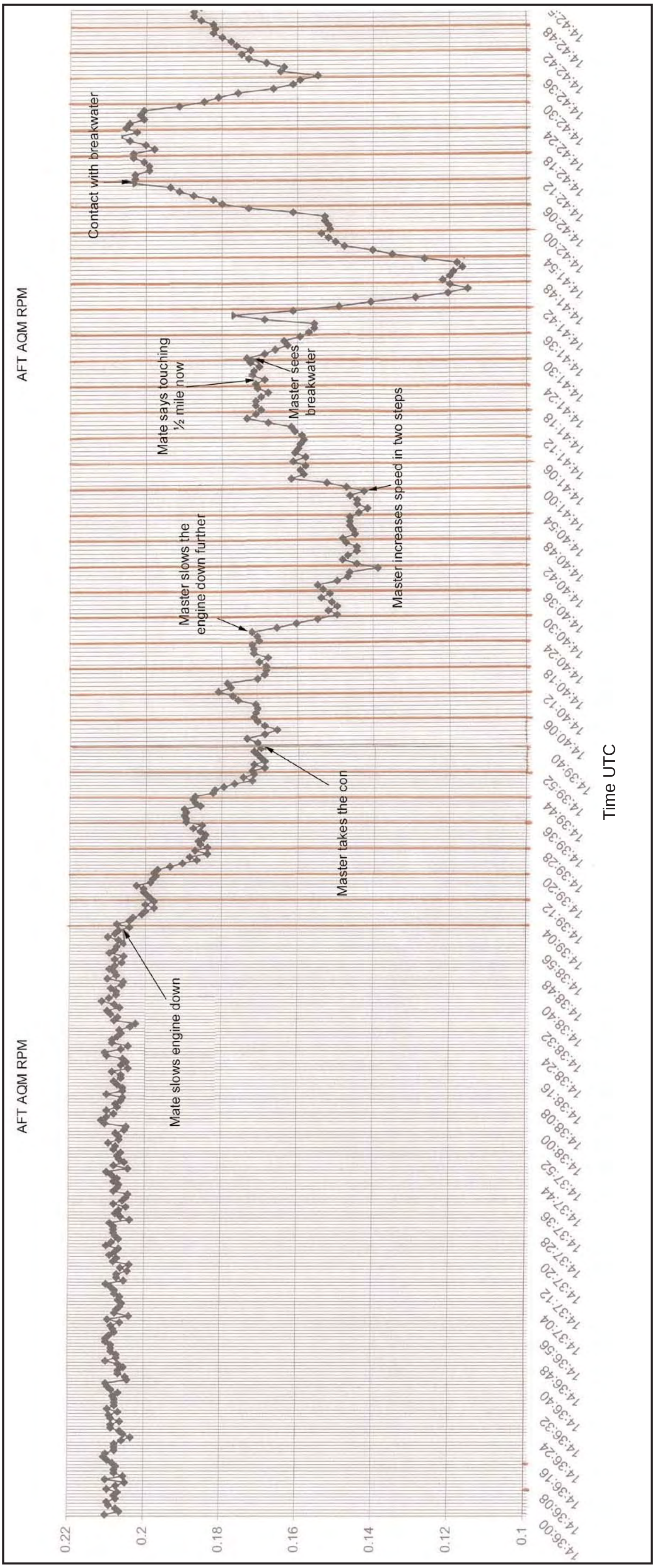
Consideration had been given to employing a Rolls Royce master to train the masters and mates directly. However, SIC decided that the costs that would have been incurred using this option were prohibitive.

The training schedule proposed by SIC's marine superintendent and senior master was well laid out, and included the operation of the vessel, emergency procedures and familiarisation with the new equipment. The crew members were continually assessed by the marine superintendent and the senior master, who discussed each person's performance. The crew were not issued with a type rating certificate until the marine superintendent and senior master were satisfied with each individual's ability.

The marine superintendent used his past experience of high speed craft to introduce a type rating written examination for the trainees. Both the master and mate passed this examination **(see Annex 1)**. This type of examination was not compulsory for the operation of the new Shetland Islands ferries, but it is compulsory for operators of high speed craft.

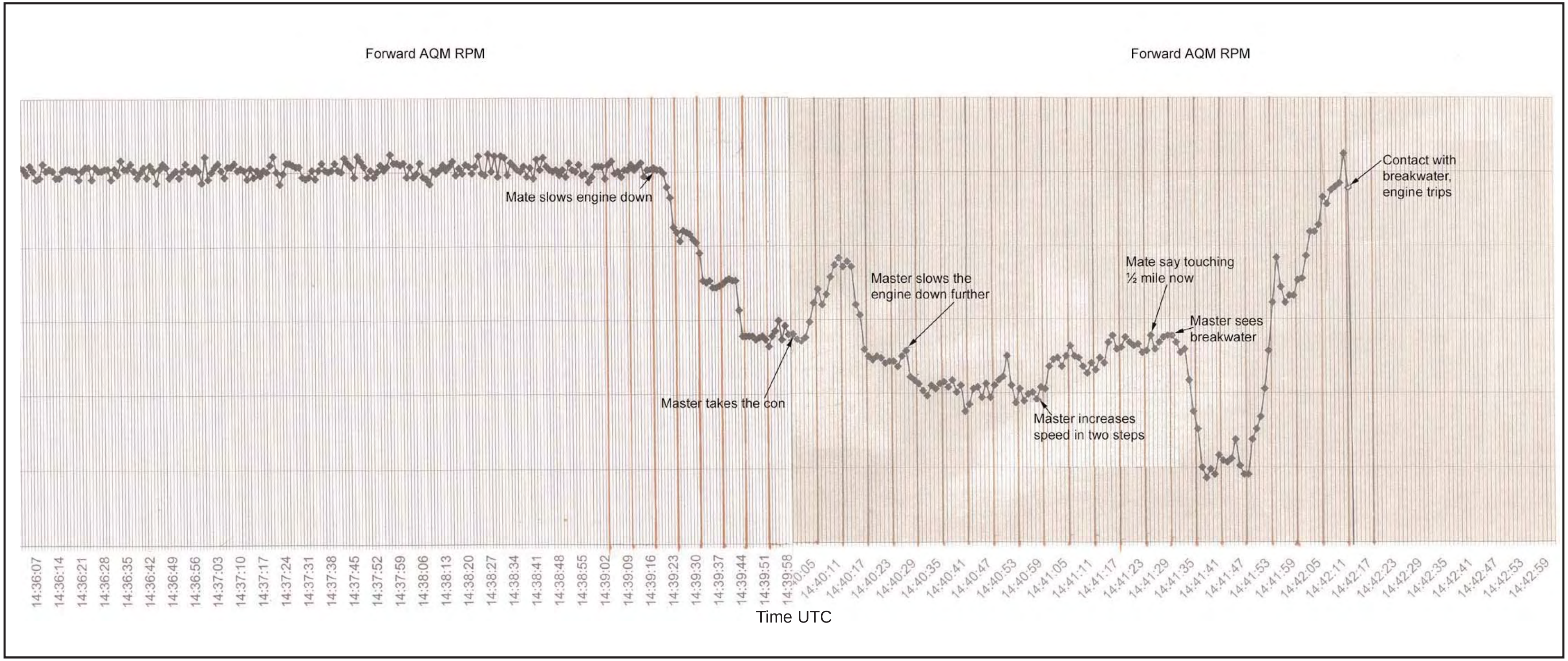
Approved type rating training, as used on high speed craft, incorporates knowledge of the craft's propulsion and control systems, handling characteristics, communication and navigation procedures, intact stability and survivability of the craft.

Figure 4a



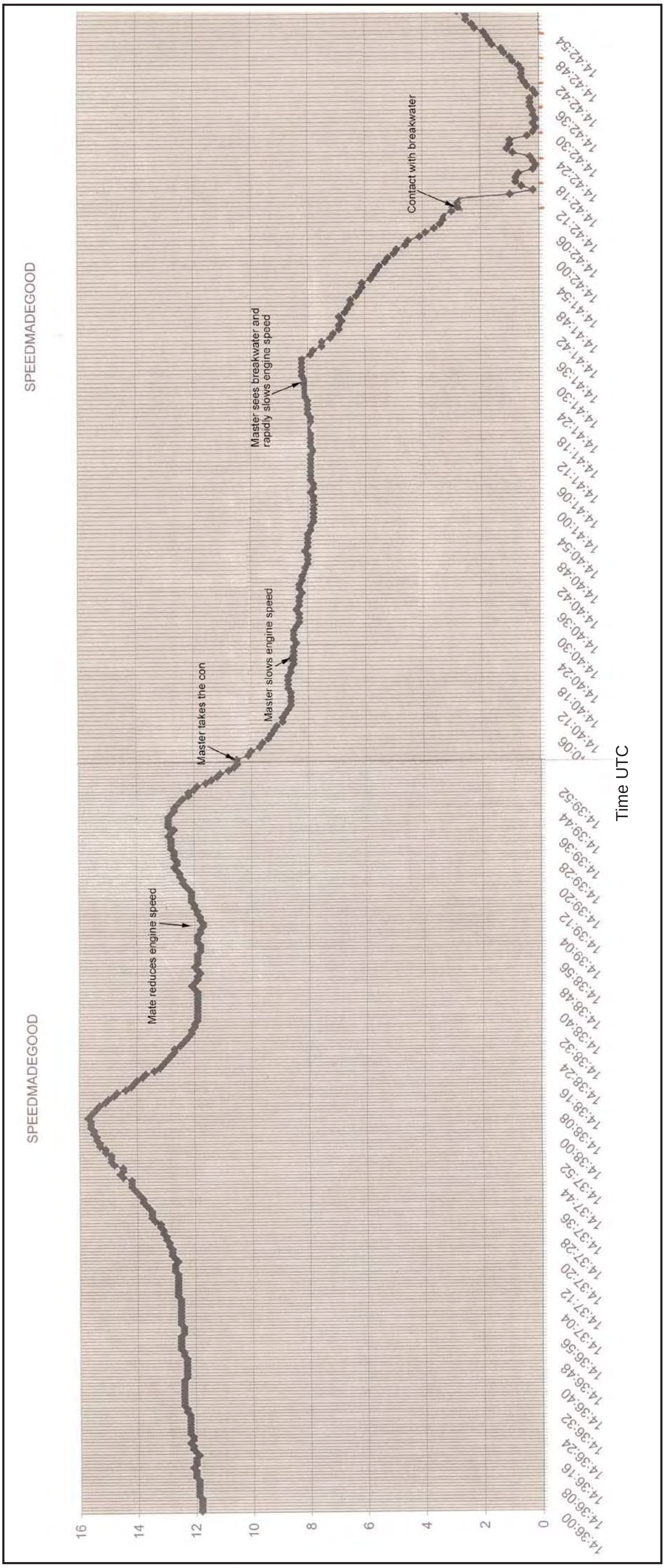
An extract from the VDR

Figure 4b



An extract from the VDR

Figure 4c



An extract from the VDR

The tenets of the high speed craft type rating certification were not strictly adhered to by the Shetland Islands Council's ferry management, nor was there a requirement to do so. However, the principle of introducing the type rating scheme for *Daggri's* crews was a good one. It complemented the training schedule, and attempted to establish a basic understanding of *Daggri's* functions before the crews were asked to actually operate her. This was a significant undertaking, when considering the great differences between the smaller, older ferries that were previously used on the Yell Sound route and *Daggri*.

The roster system worked by the crews meant that the master had an interval of approximately 25 days, and the mate had 19 days between the end of training and the beginning of their first tours of duty on board the vessel. These intervals would have diminished the familiarity with the operation of *Daggri* they had gained during training.

It would have been beneficial for the Shetland Islands Council's management to have allowed and encouraged the master and the mate to maintain the level of knowledge and understanding of the new systems and manoeuvring characteristics of *Daggri.* This could have been achieved by the master and mate spending additional periods of familiarisation on board the vessel between the period when she entered service and their first official tour of duty some 3 weeks later.

(Note: Five days of extra training was available to the masters and mate after the training period. Only a couple of the masters took this training; the master of *Daggri* was not one of them. The senior master or the marine superintendent offered to sail with each master during their operational shift until they felt they were confident on their own.)

Several masters, out of a total of 12, spent time on board *Daggri* during the final 2 weeks of build and sea trials in Poland. The master on board on 30 July, was one of those who went there, however he was unable to benefit fully from the familiarisation as he had to return home for serious family reasons.

A recommendation has been made to the International Chamber of Shipping to encourage its member shipping companies to introduce appropriate training schemes for sea staff wherever there is a significant change in the technology used on board ships, and to encourage the necessary change in working practices this brings about.

2.5 INTEGRATED BRIDGE SYSTEM

An integrated bridge system is made up of various navigational aids, which are interconnected, with the primary aim of increasing the safety of navigation. This is done by integrating the navigation systems and their sensors to provide information to the operator, including warnings of hazards. However, the information should be presented in a clear and easily understood format, which does not overload the operator, so as to complement and enhance the effectiveness of the bridge team.

Daggri was furnished to a much higher standard than would otherwise be expected for the size of vessel and type of trade. The bridge was especially sophisticated, being equipped with two identical fore and aft integrated bridge systems, each containing X and S band radars and ECDIS.

However, the master and mate did not make full use of the available navigational aids. Basic radar tools such as the parallel index lines, VRM and the EBL, were not used by them. It was possible to overlay the radar onto the ECDIS to provide a display that verified the vessel's position from two sources of information. Passage plans could have been incorporated onto the ECDIS chart giving, for instance, warnings of certain depths and no-go areas. These facilities had not been fully mastered by the master and mate during their training period, a problem which was compounded by them not having attended a generic ECDIS course.

The SIC bridge teams had been given instruction on the use of the radars by someone who was very familiar with the equipment during the first 3 days of their training course. It was left to the masters and mates to read the operating manuals and experiment with the equipment, during the remaining 3 days of training. The manuals were extensive, and it was an onerous task for anyone to read and understand them.

Had they been able to use the full capacity of the navigational aids features, the master and mate might have been more alert to the close proximity of the breakwater on *Daggri*'s approach to Ulsta terminal, especially in the circumstances of severely reduced visibility.

In conclusion, the master and mate did not make full use of the integrated bridge system, because they were unfamiliar with the system's features and capabilities. The radar and ECDIS could have been used to greater advantage, and a passage plan could have been incorporated into the ECDIS.

2.6 PASSAGE AND BLIND PILOTAGE PLANS

In preparation for any voyage, an appraisal of the hazards and risks should be undertaken and all relevant information gathered. In the case of Yell Sound, for example, information such as tidal flows, weather, local navigational warnings and traffic movements should be obtained when preparing the plan. The plan should be from berth to berth and should include all eventualities and contingencies.

The masters and mates had been taught the principles of passage planning and blind pilotage when they attended college for their certificates of competency, and there should have been no need for Shetland Islands Council to give them training on this subject.

Under SIC guidance, serving masters had produced a generic passage plan for the Yell Sound route in 2001. Additionally, the master and mate of *Daggri* had produced their own passage plan in accordance with the company fleet orders.

The masters of ferries operating in the Yell Sound route were also required to produce their own blind pilotage plan for the route/vessel and present it to management for approval.

Generally passage plans were used for navigation in good visibility and supplemented by the blind pilotage plan for navigation in restricted visibility. It is important that the people who carry out the actual operation of the vessel are involved in drawing up the passage plan and blind pilotage plans. Therefore, given that *Daggri* was to ply the same route, a new general passage plan and a general blind pilotage plan could have been drawn up by the company, consulting with the masters and mates on their experiences gained from operating the vessel. This would have provided consistency and best practice for all crews. The same method could also have been adopted to produce procedures for the drilling of blind pilotage plans.

The ICS is recommended to encourage shipping companies who operate ferries, to create generic passage plans for incorporation, where appropriate, into the electronic navigational systems fitted on board ships, to provide a template for use by ship’s staff when planning individual voyages.

SECTION 3 - CONCLUSIONS

The following are the safety issues which were identified as a result of the investigation. They are not listed in any order of priority.

1. *Daggri* was radically different from the ferries previously used on the Yell Sound route. [2.3.1]

2. The bridge team were not sufficiently familiar with the operation of the navigational equipment onboard. [2.3.1]

3. The distraction of the conversation with the visiting mate adversely affected the mate's situational awareness. [2.3.2]

4. The master and mate were not working together effectively in accordance with the principles of bridge team management, which was essential in restricted visibility. If they had done so, the mistakes that were made could have been detected and corrective action taken. [2.3.3]

5. The introduction of a type rating certification training scheme for the masters and mates was sensible given the radically different type of technology in use on *Daggri* in comparison to that found on the previous ferries employed on the Yell Sound route. [2.4]

6. The period of time between the master's and mate's training and actual operation of the vessel, would have diminished their familiarity with the operation of *Daggri* which they gained during training. [2.4]

7. The master and mate did not make full use of the integrated bridge system, because they were unfamiliar with the system's features and therefore capabilities and user options available to them. [2.5]

8. The radar and ECDIS could have been used to greater advantage and a passage plan could have been incorporated into the ECDIS. [2.5]

9. The master and mate had generic training on passage planning and blind pilotage but there were no specific plans for *Daggri*. [2.6]

10. A general passage plan and blind pilotage plan for the Yell Sound route would have been advantageous. [2.6]

SECTION 4 - ACTION TAKEN

Shetland Islands Council Ferry Services have taken the following actions since the accident:

1. Management is working with masters to ensure that all vessels have adequate blind pilotage plans, and blind pilotage drills are carried out at regular intervals as required by the SMS.

2. The Crew Assessment system, recently introduced into the SMS, has been initiated with a view to identifying areas where lack of compliance is caused by a lack of knowledge or training.

3. The attention of all masters and mates has been drawn (via fleet circulars) to blind pilotage procedures, navigation in restricted visibility, bridge visitors and bridge team management.

Intended actions to be taken:

1. All masters and mates are to be sent on a Bridge Resource Management course.

2. Area managers will be introduced at local level, allowing superintendents to concentrate on core issues of safety and standards.

3. Agreements will be formed with major ferry operators so that the Shetland Islands Council's master and engineers sail on their vessels and gain exposure to modern technology, procedures and industry best practice.

4. A number of high calibre agency masters and engineers with good ferry experience will be employed to sail with, mentor and coach, existing staff of all ranks, enforce procedures and report to management on operational training issues.

5. In-house training courses will be developed, including provision of correspondence courses and a lending library of training materials.

6. Senior sea staff will be seconded into the office on a rotational basis to coach, instruct and improve communications.

7. Funding will be provided to adapt the ship simulator at the nautical college at Scalloway to simulate a range of inter-island ferries (including the Aquamaster propulsion system). The simulator will then be used for training, to augment crew assessment, to better identify training needs and to put key staff through periodic competence checks.

SECTION 5 - RECOMMENDATIONS

The **International Chamber of Shipping** is recommended to:

2005/134 Encourage shipping companies to introduce training schemes for sea staff whenever new technology is introduced on board their vessels. It should also encourage the necessary change to working practices this brings about.

2005/135 Encourage ferry operators to create passage plans for each ferry route to provide basic templates for ships' staff to build upon. Ferry operators should ensure, where applicable, that the passage plans are loaded into the electronic navigational systems on board.

Marine Accident Investigation Branch
April 2005

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

Annex 1

Relevant questions for the type rating written examination

The masters and mates also had to pass a written Type Rating Certificate examination; the answers to 38 questions had to be handed in at the end of the 6 day training period.

Some of the questions included:

- Descriptions of the vessel's propulsion steering system.
- The main tasks of persons in the starboard hand bridge seat and the port hand seat.
- Procedures for transfer of control from one console to another.
- Back-up means of steering.
- Description of the actions to be taken in the case of complete loss of an azimuthing thruster unit.
- Description of three methods of making a crash stop and the effect on the vessel of each method.
- What is the vessel's minimum stopping distance?
- List the main navigational equipment on board, giving brief description of each.

Manoeuvring training

The master and mate were given the following manoeuvring training:

1. Steering the vessel at various speeds, both thrusters ahead
   - Steering with the forward thruster only
   - Steering with the aft thruster only
   - Steering with both thrusters.
2. Use of autopilot
   - Forward thruster only
   - Aft thruster only
   - Both thrusters
   - Automatic disconnection when Aquapilots are moved
   - Autopilot in “hove to” mode.
3. Crash stops
   - Shortest distance – thrusters turned 90° in opposite directions, vessel swings broadside on.
   - Maintaining heading – thrusters turned 180° from ahead to astern, power reduced on aft thruster during turning.
   - Sideslip – thrusters turned 90° in the same direction, minimum power aft, increase power forward to maintain heading.
4. Neutral position – transition to and from neutral position.
5. Crabbing sideways – from neutral position.
6. Practice departures/arrivals Toft lay by and linkspan berths.
7. Practice departures/arrivals Ulsta lay by and linkspan berths.

Annex 3

Training on navigational aids

The master and mate were given instruction on:

- The use of tracker ball controls and general principle of the menu-driven screen.
- Layout of information on the screen.
- Set-up, including pulse, tune, heading alignment, gain, clutter, orientation and stabilisation.
- Changing range, use of rings, VRMs and EBLs.
- Setting parallel index lines.
- Use of ARPA.

They were also given instructions on ECDIS:

- Principle of vector charts, including displaying layers of information.
- Layout of information on the screen.
- Chart scale and stabilisation, including DR mode if inputs fail.
- Use of “predictor” vector.
- Route planning.