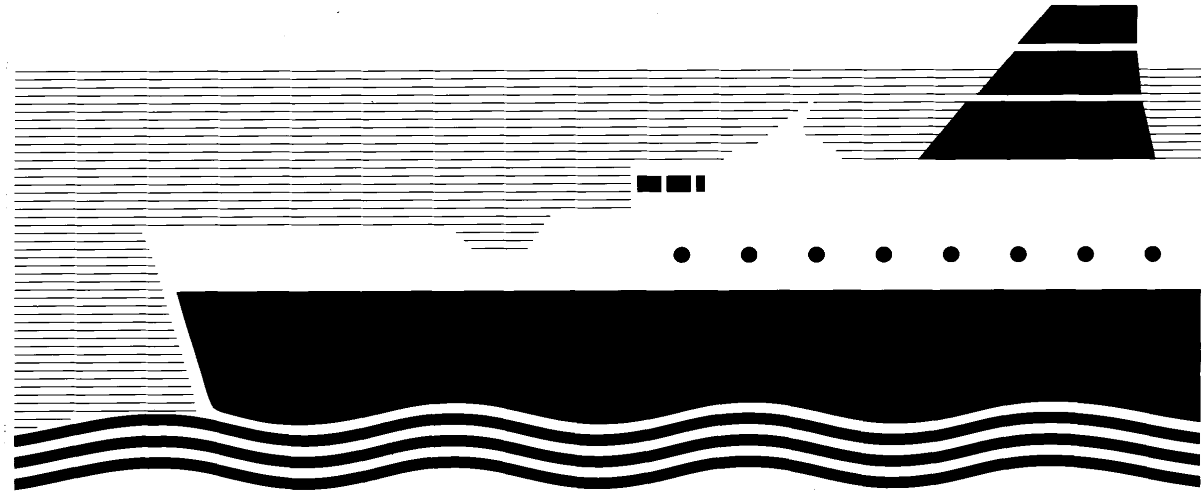

MARINE OCCURRENCE REPORT

04-214 **passenger freight ferry *Aratere*, loss of mode awareness leading to near grounding, Tory Channel** **29 September 2004**

TRANSPORT ACCIDENT INVESTIGATION COMMISSION
NEW ZEALAND

The Transport Accident Investigation Commission is an independent Crown entity established to determine the circumstances and causes of accidents and incidents with a view to avoiding similar occurrences in the future. Accordingly it is inappropriate that reports should be used to assign fault or blame or determine liability, since neither the investigation nor the reporting process has been undertaken for that purpose.

The Commission may make recommendations to improve transport safety. The cost of implementing any recommendation must always be balanced against its benefits. Such analysis is a matter for the regulator and the industry.

Report 04-214

passenger freight ferry *Aratere*

loss of mode awareness leading to near grounding

Tory Channel

29 September 2004

Abstract

On Wednesday 29 September 2004 at about 1720, the passenger freight ferry *Aratere* was entering Tory Channel from Cook Strait when it failed to make a programmed course alteration while in automatic steering. The navigational bridge team had to intervene and make a manual alteration of course to prevent the *Aratere* grounding at full speed on the north side of the channel.

Safety issues identified included:

- the adequacy of bridge resource management
- the adequacy of training in the use of all integrated bridge systems
- the adequacy of contingency planning for safety-critical situations on board
- the adequacy of procedures covering the dissemination of information from the International Maritime Organization.

Safety recommendations were made to the General Manager, Interislander and the Director of Maritime Safety to address these issues.

The *Aratere* under way in the Marlborough Sounds

Contents

Figures

Abbreviations

AC	alternating current
ANTS	automatic navigation and track steering
ARPA	automatic radar plotting aid
BRM	Bridge Resource Management
Colregs	International Regulations for Preventing Collision at Sea 1972
DB2000	Databridge 2000
DC	direct current
DGPS	differential global positioning system
ECDIS	electronic chart display and information system
GANTS	global automatic navigation and track steering
IBS	integrated bridge system
IMO	International Maritime Organization
kW	kilowatt(s)
kt	knot(s)
m	metre(s)
MSA	Maritime Safety Authority of New Zealand
nm	nautical mile(s)
Norcontrol	Kongsberg Norcontrol
ro-ro	roll on – roll off
rx	receiver
SOLAS	International Convention for Safety of Life At Sea
STCW-95	International Convention on Standards of Training, Certification and Watchkeeping, 1978 as amended in 1995
UTC	co-ordinated universal time
VHF	very high frequency

Glossary

ARPA	automated system to plot and monitor targets on radar. Used by a watchkeeper to assist in collision prevention
autopilot	a device that automatically controls the steering of a ship on a selected course
bollard pull	a measure of the static pull a vessel can exert
bow thruster	a small athwartships propeller mounted in a tunnel at the forward part of a ship, used to manoeuvre a ship at slow speeds
chart datum	zero height referred to on a marine chart
con (conduct)	direct the course and speed of a ship
course	direction steered by a ship
digital selective calling	a tone signalling system, which operates on VHF Channel 70 and is similar to the tone dialling on a telephone
Doppler log	a device that uses the Doppler effect to measure a ship's speed
ECDIS	a type-tested navigation system that displays selected information from electronic charts along with positional information from navigation sensors
gross tonnage	a measure of the internal capacity of a ship; enclosed spaces are measured in cubic metres and the tonnage derived by formula
heading	direction in which a ship is pointing at any moment
helm	the amount of angle that the rudder is turned to port or starboard to steer the ship
knot	one nautical mile per hour
Loran C	a long-range radio navigational system in use in several areas around the world
neap tide	tidal undulation that has the highest low water, and lowest high water, in a series
parallel indexing	the use of a line drawn either manually or electronically on the screen of a radar through a fixed target parallel to the intended track of the vessel at a distance equal to the planned passing distance. Any displacement of the fixed target from the index line indicates that the ship is off track
port	left-hand side when facing forward
quartermaster	the person responsible for steering the ship when in hand steering
spring tide	tidal undulation that has the lowest low water, and highest high water, in a series
starboard	right-hand side when facing forward
tidal stream	the horizontal movement of the water due to tide

Data Summary

Vessel particulars:

Name:	*Aratere*
Type:	passenger freight ferry
Class:	✠ 1A1 car and train ferry A, general cargo carrier RO/RO DG-P
Classification:	Det Norske Veritas
Length:	150 m
Breadth:	20.25 m
Gross tonnage:	12 596
Built:	1998, Hijos de J. Barreras S.A. in Vigo, Spain
Propulsion:	four 3680 kW diesel generators driving four 2600 kW electric motors coupled in pairs through a reduction gearbox to two 4-bladed fixed-pitch propellers
Service speed:	19.5 kt
Owner:	Toll NZ Consolidated Limited
Operator:	Interislander
Port of registry:	Wellington
Minimum crewing requirement:	12
Date and time:	29 September 2004, 1720[1]
Location:	Tory Channel
Persons on board:	crew: 32 passengers: 260
Injuries:	crew: nil passengers: nil
Damage:	nil
Investigator-in-charge:	Captain I M Hill

[1] Times in this report are New Zealand Standard Time (UTC + 12 hours) and are expressed in the 24-hour mode.

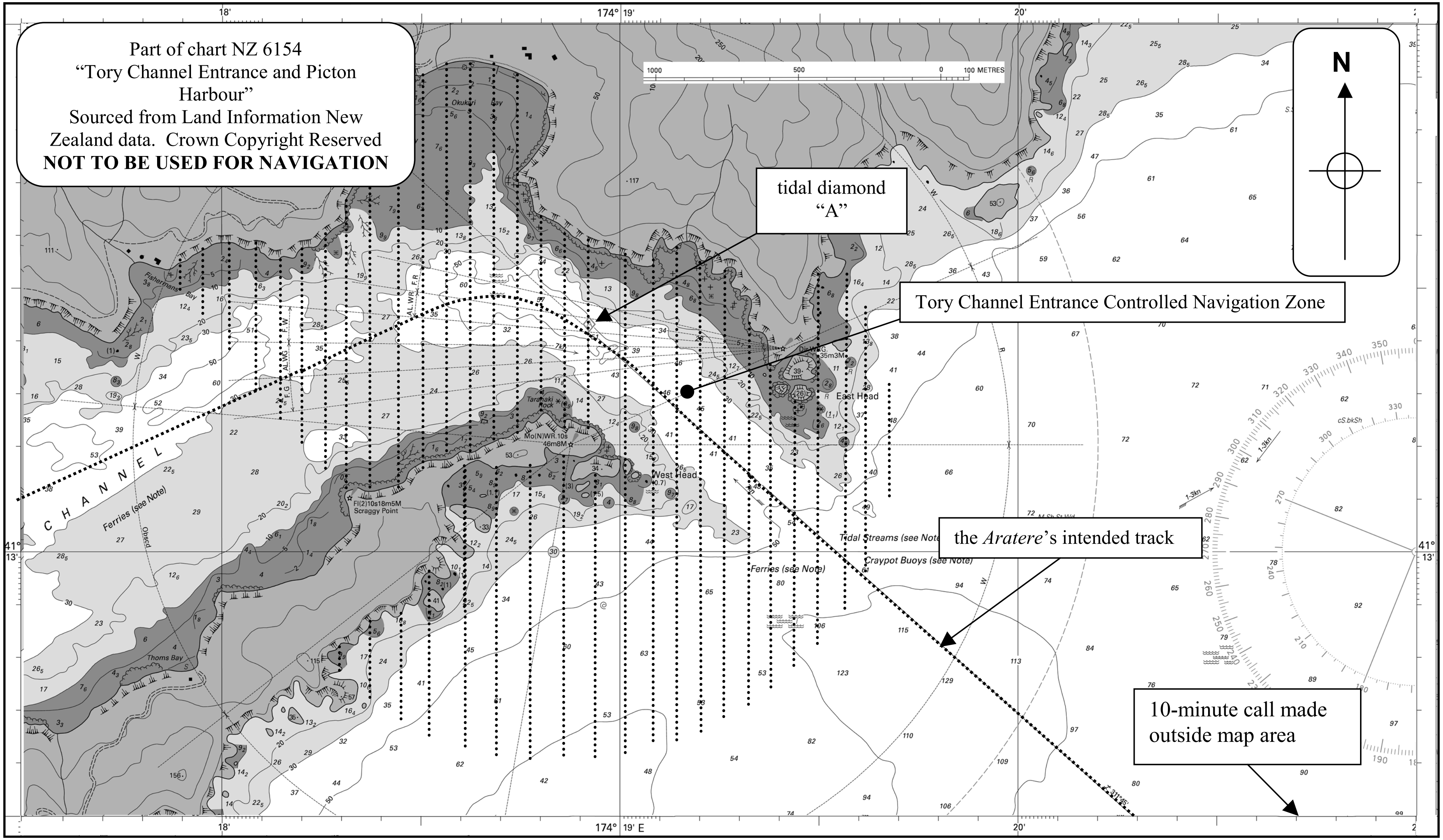

Figure 1
General area of occurrence

1 Factual Information

1.1 Narrative

1.1.1 On Wednesday 29 September 2004 at about 1525 the *Aratere* departed from the Wellington ferry terminal with 260 passengers and 32 crew on board. After the ship had cleared the terminal, the bridge team engaged the automatic navigation and track steering (ANTS) system that steered the ship automatically on a pre determined route to Picton.

1.1.2 At about 1600, after clearing Wellington Harbour entrance, the mate took over the navigational watch, conning the ship towards Tory Channel entrance. The crossing of Cook Strait was uneventful, with course alterations at 1614 off Sinclair Point and at 1622 off Karori Rock.

1.1.3 At about 1707, when the ship was about 10 minutes from passing East Head light, the mate made an "all ships" call on the very high frequency (VHF) radio, channels 16 and 19, advising that the *Aratere* would be transiting Tory Channel Entrance Controlled Navigation Zone (see Figure 1). After making the call, the mate called the master to the bridge.

1.1.4 At about 1709, the mate changed from sea mode to enclosed waters mode. Engaging enclosed waters mode ensured that at least 3 of the 4 diesel generators were engaged and certain other equipment in the engine room was ready for use.

1.1.5 Shortly after the mate had changed to enclosed waters mode, the master arrived on the bridge and positioned himself at the bridge console between the electronic chart display and information system (ECDIS) and the starboard radar (see Figure 3). The master did not take the con because, as he stated later, he was satisfied that the mate, who held a pilotage exemption for Picton, could continue to Picton.

1.1.6 After the master arrived on the bridge he had a short conversation with the shore-based company health and safety manager who was undertaking a passage on board the *Aratere* and was observing on the bridge. Also on the bridge at the time of the master's arrival were 2 other officers and the partner and children of one of these officers. After the master's arrival the other officers left the bridge, ushering the partner and children off the bridge with them.

1.1.7 As the *Aratere* approached Tory Channel entrance the mate noted that the ship was positioned on the track as plotted in the Databridge 2000 (DB2000) navigation system. However, as the ship got closer to the entrance he saw the ship start to move to the north of the plotted track, with the off-track distance steadily increasing.

1.1.8 The mate later stated that he told the master of the off-track distance when it reached 35 m , and started to call out the increasing distances. The master replied that he had seen an 85 m offset before. However, from data downloaded from the bridge voice recorder (BVR) component of the voyage data recorder, the first discernable mention, by the mate, of off-track distance was at 65 m.

1.1.9 After being told of the off-track distance, the master checked the rudder indicators and saw that the ANTS was applying no helm. By this time the mate was reading out an off-track distance of 90 m. The master and mate both reached for the steering controls. The master reached the controls first and switched the steering into manual mode with synchronised rudders and applied hard to port rudder as the mate called out an off-track distance of 100 m. The master later recalled that as he changed to manual control the text colour for the operating mode on the conning display changed to blue.

1.1.10 The *Aratere* reacted to the helm and swung rapidly to port. The master brought the ship around to a course of about 230° before steadying it up on the track as plotted on the DB2000. However, the ship came within about 100 m of a rock awash at chart datum and was close to grounding (see Figure 2).

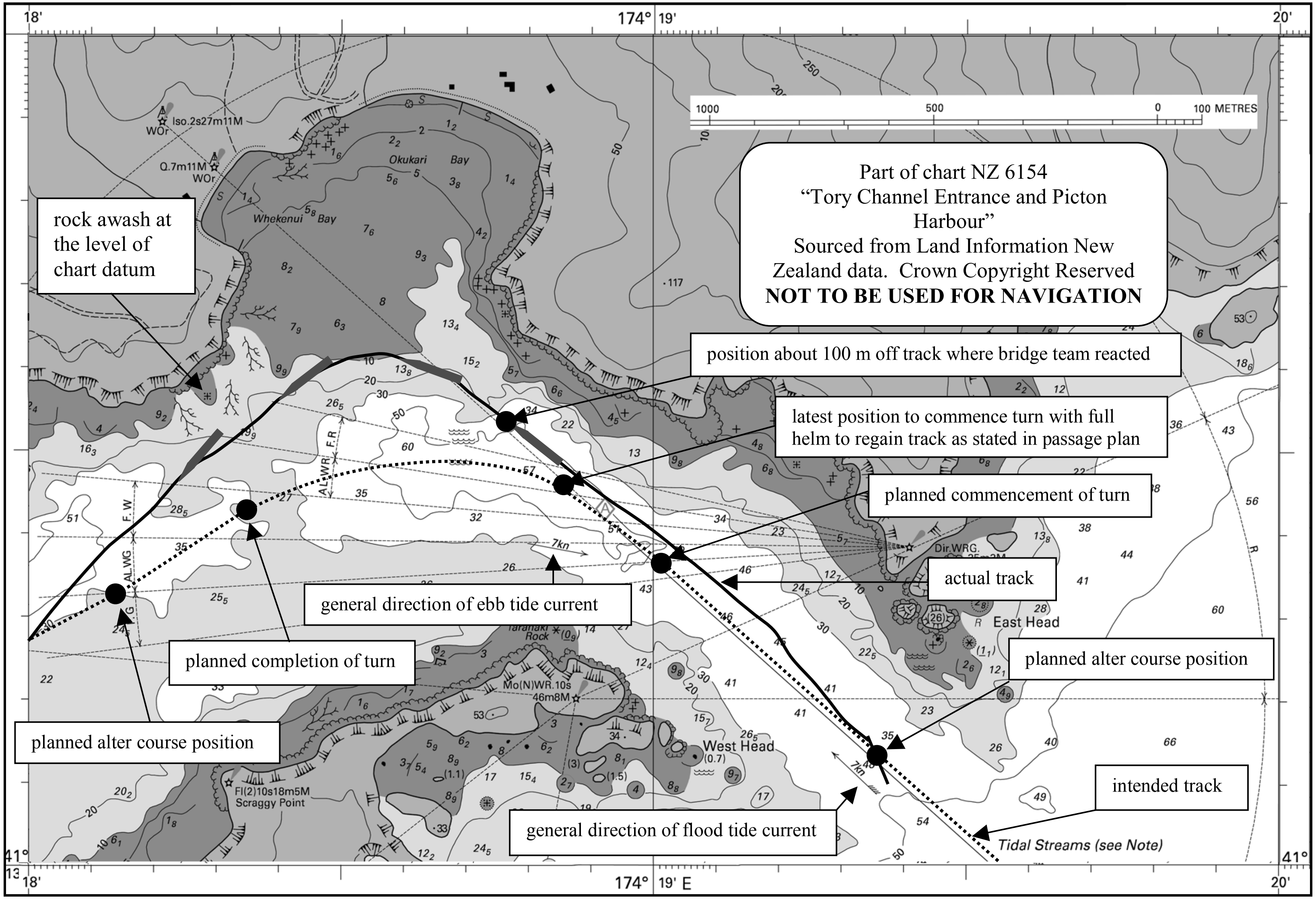

Figure 2
Plan showing the actual versus intended track of the *Aratere*

1.1.11 At about 1719, the *Aratere* passed Scraggy Point and at about 1722 the master re-engaged the ANTS system. For the remainder of the journey to Picton the ANTS system was used to navigate the ship without further incident.

1.1.12 On the return journey to Wellington the master used the autopilot to navigate the vessel out of the Marlborough Sounds before engaging the ANTS system for the passage across Cook Strait. The ANTS system worked correctly for this crossing.

1.1.13 On arrival in Wellington a shore-based technician boarded the ship to test the system and to download all relevant data from the system for analysis ashore both locally and by Kongsberg Norcontrol (Norcontrol). From the data downloaded no reason could be found for the apparent abnormal behaviour of the system.

1.2 Vessel information

1.2.1 The *Aratere* was a passenger and freight ferry operated by Interislander, a division of Toll NZ Consolidated Limited (the owner). The ship was certificated to carry a total of 399 persons and was capable of carrying both rail and vehicular cargo. The *Aratere* was in class with Det Norske Veritas and was built in Spain in 1998. The ship traded on a scheduled service between Wellington and Picton with a service speed of 19.5 kt.

1.2.2 The *Aratere* was powered by up to four 3680 kW diesel-driven DC generators that provided electrical power as required, via frequency converters, to four 2600 kW AC electric propulsion motors; coupled in pairs to each shaft. Each pair of electrical motors on each shaft drove a fixed-pitch propeller through a reduction gearbox. The maximum power rating of the propelling machinery was 10 400 kW.

1.2.3 Two rudders provided steering, one aft of each propeller. The rudders could be used either synchronised, where both rudders moved in the same direction to the same degree, or independently, where the operator controlled the direction and the degree of each rudder separately. On this occasion the master was using the rudders synchronised. The *Aratere* also had 2 bow thrusters each with a maximum power rating of 1000 kW, giving a combined 36 tonnes bollard pull.

1.2.4 The navigating bridge of the *Aratere* was designed on an integrated bridge principle with 3 manoeuvring consoles manufactured and fitted by Norcontrol. The main console was located forward on the centreline of the wheelhouse, and 2 smaller "docking" consoles were located at the port and starboard extremities of the wheelhouse. All the consoles had controls for:

- bow thrusters
- engine
- steering
- telephone communications
- whistles
- VHF radio communications
- searchlights
- screen wipers
- ECDIS
- readouts for
  - wind direction and velocity
  - ship's rate of turn.

1.2.5 The main console (see Figure 3) was also fitted with:

- 2 DB2000 automatic radar plotting aid (ARPA) radars that could be linked into the ECDIS
- 2 differential global positioning system (DGPS) receivers
- gyro compass controls
- medium-frequency radio communication equipment
- high-frequency radio communication equipment
- digital selective calling
- one AP2000 autopilot
- steering motor controls
- stabiliser fin controls
- navigation light controls
- anchoring controls.

1.2.6 At the time of the incident the ECDIS was not compliant for use under SOLAS Chapter V regulation 19.2.1.4 due to a partial system hardware failure such that no corrections for the electronic charts had been undertaken since 19 November 2002. The ship was therefore required to, and did, carry a full set of corrected paper charts for the intended voyage.

1.3 Automatic navigation and track steering system

1.3.1 The International Maritime Organization (IMO) defined an integrated bridge system (IBS) 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.

1.3.2 The Norcontrol IBS installed on board the *Aratere* complied with international standards, classification society requirements and IMO guidelines.

1.3.3 On 6 January 2003, IMO issued MSC/Circ.1061, Guidance for the operational use of integrated bridge systems (IBS) (see Annex 1). This circular contained among other things guidance on procedures, training, passage planning, record keeping, and the need for the operating company to have personnel ashore capable of supervising, training and evaluating the company operational procedures.

1.3.4 IMO invited member Governments to bring this circular to the attention of all parties concerned. The Maritime Safety Authority of New Zealand (MSA) received this circular as the New Zealand Government's representative at IMO. The MSA originally stated that it was unsure to whom it sent the circular. However, from annotations on the front of the original circular, it believed it sent it to 7 recipients in the maritime field but had no records of doing so. The MSA was later able to show from enquiries to other recipients that the circular was emailed and that Interislander was amongst the email addressees. However, Interislander could find no record of, or had any recollection of, receiving the circular.

1.3.5 Norcontrol developed the GANTS [ANTS] system as an integrated navigation system. In document number CN-0081-A/18-Nov-94 it stated:

> **Introduction**
>
> Based on a quality checked route plan, the system steers the ship automatically along the planned route, on straight courses and on radius turns from one course to another, at the accuracy of the positioning system. The system provides automatic positioning of own ship and traffic in a multi-function radar and electronic chart display featuring both grounding and collision avoidance functions.

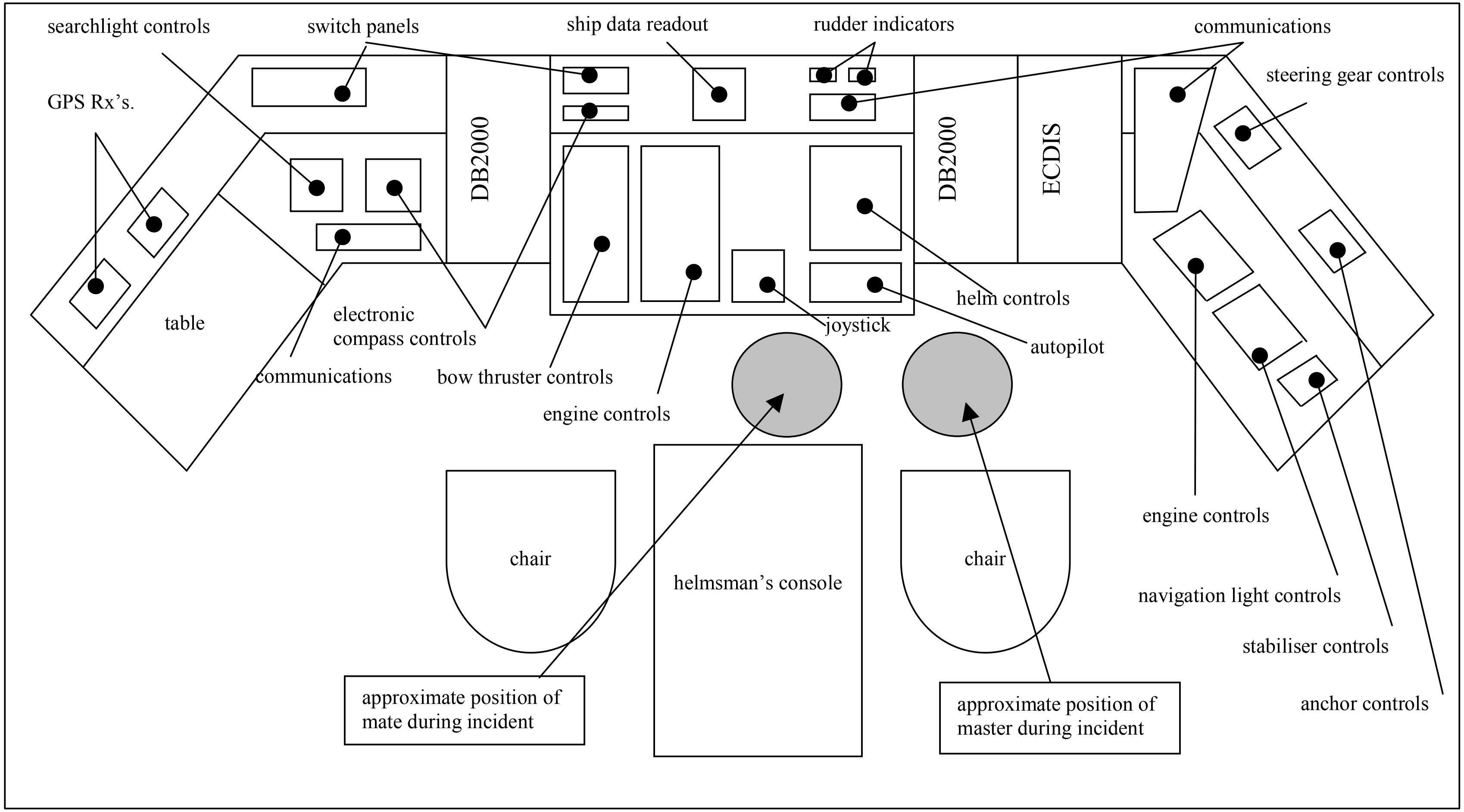

Figure 3
Diagram of the layout of the central console on board the *Aratere*

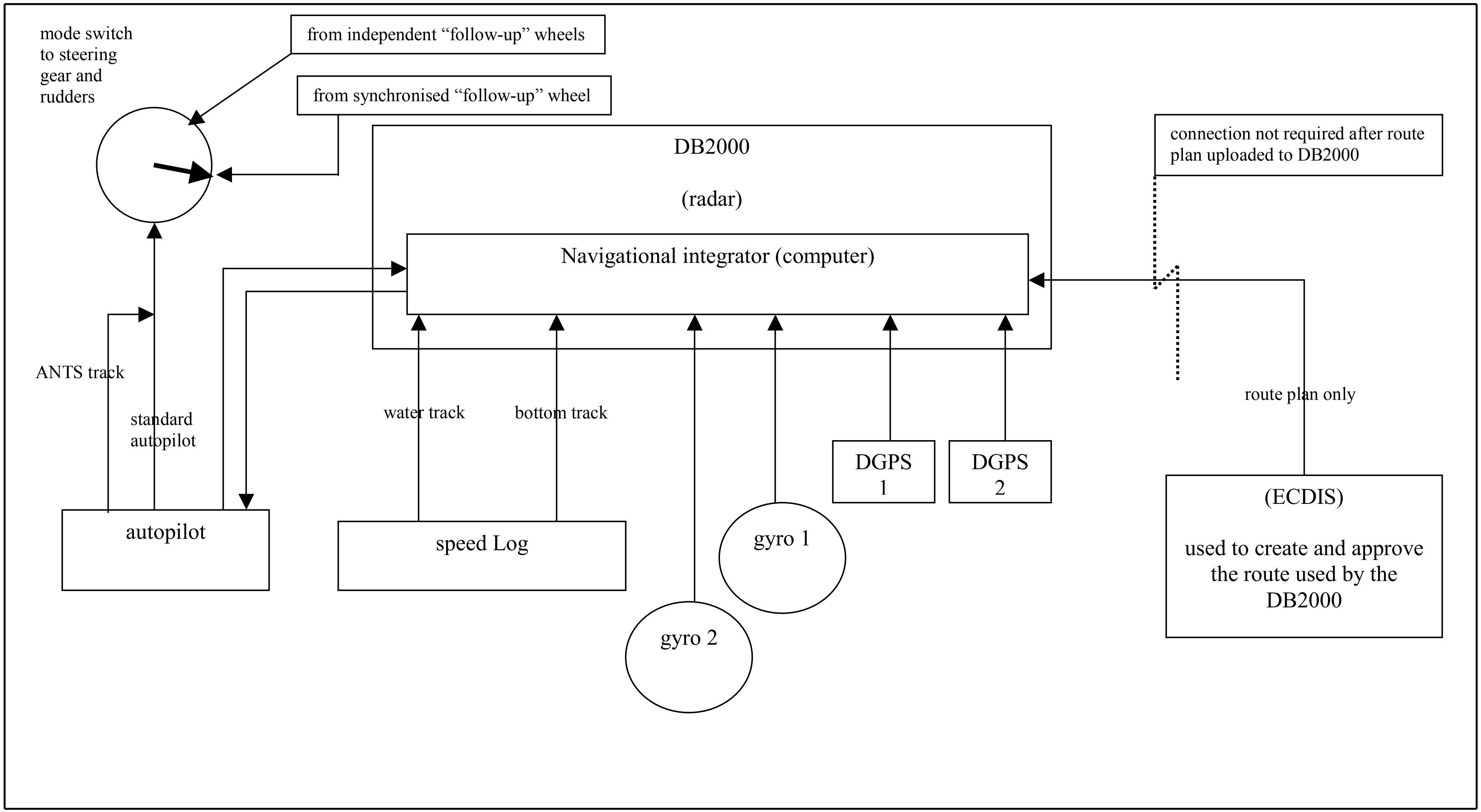

Figure 4
Schematic diagram of the DB2000 and autopilot interfaces

6. System Safety

6.1. Fail-to-safe and alternative modes of operation

If a malfunction occurs in any other system than the steering system during GANTS operation, the autopilot automatically continues the steering according to the course order if the ship is on a straight course. If the ship is in a turn, the steering will continue in accordance with the set radius and the planned course order. The system incorporates a steering tiller overriding all other systems to enable an instant take-over of steering functions if the autopilot fails.

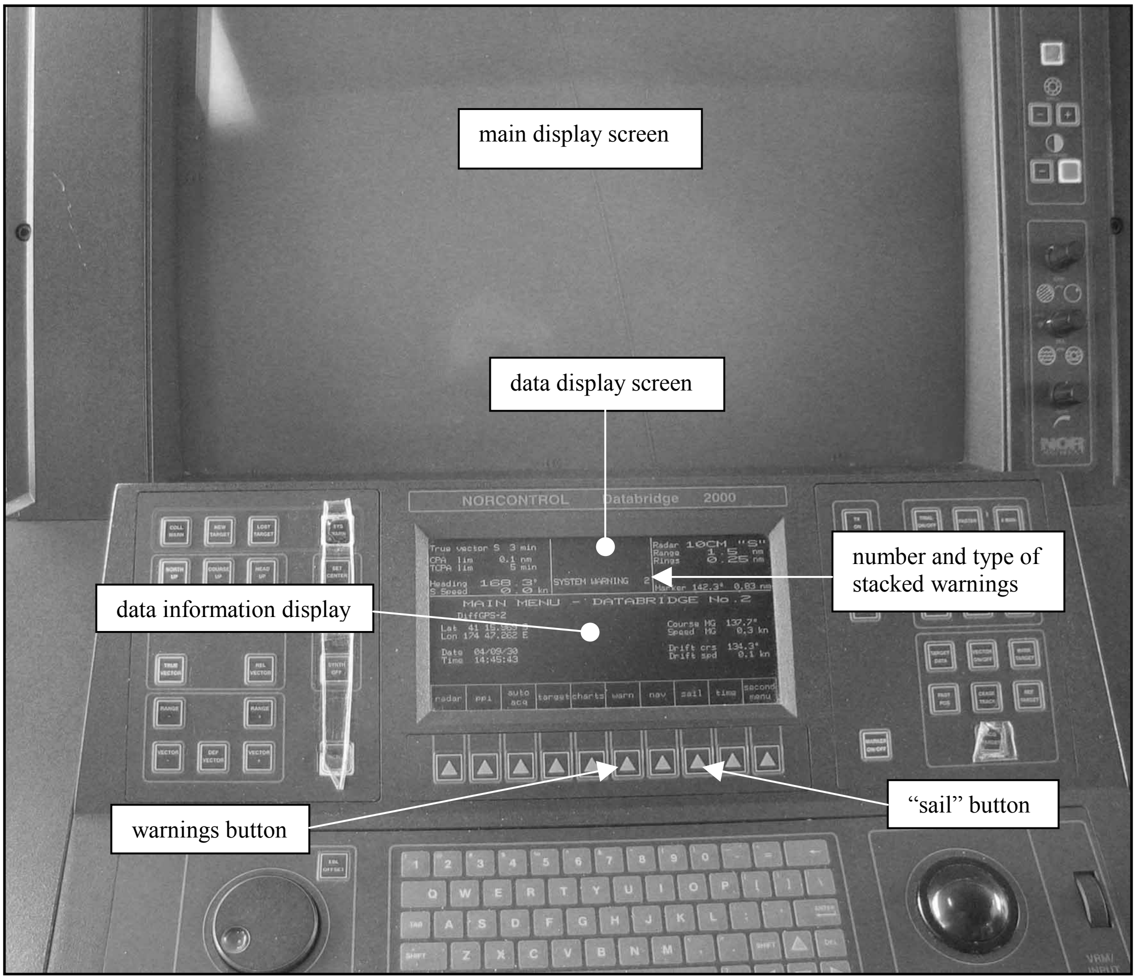

Figure 5
Radar and data screen of the DB2000

6.2 Operational warnings

GANTS provides operational warnings which are included in the bridge watch monitoring and transfer system. Warnings and audible alarms are emitted:

- at danger of collision
- if the quality of the position-fix does not meet the given criteria
- if the ship crosses the border of a given safety contour or approaches a pre-set distance from the safety contour
- if the ship exceeds the limits given for off-track distance from the planned route
- at a given time before course alterations
- at the wheel-over position
- if system or equipment fails.

1.3.6 In addition to the operational warnings listed above, the system reverted to normal autopilot mode from ANTS mode when the off-track jump limit exceeded 12 m in any one-second sampling period. The off-track jump limit is the amount the off-track distance varies in each sampling period. A change of 12 m in any one second equates to a speed of about 23.33 kt away from the planned track.

1.3.7 From data downloaded from the BVR, discernable alarm sounds could be heard above the conversations and other extraneous noises on the bridge. One of these alarm sounds, as the *Aratere* entered Tory Channel, had a distinct double "beep" sound indicating 2 alarms very close together.

1.3.8 The Norcontrol manual stated that the accuracy of the route steered in the ANTS mode is dependent on the accuracy of the positioning system. The *Aratere* was equipped with 2 DGPS receivers to provide accurate positioning for the DB2000 system. However, the accuracy of the DGPS system is dependent not only upon the quality of the error corrections received to amend the raw position signal received (the differential part of the system), but, also on the accuracy of the raw signal which could be affected by the number and positioning of the satellites in the constellation "visible" to the *Aratere*'s aerials at any one time. The *Aratere* had suffered satellite signal loss prior to this occasion, usually in the Sounds themselves where the satellites could become masked due to the close proximity of the surrounding high ground.

1.3.9 The IBS system as installed on the *Aratere* consisted of an autopilot type AP2000, 2 radar/ARPA station type DB2000s, a conning information display system, and an ECDIS that was connectable to the ANTS system to create and verify the route to be steered. Once the route had been uploaded into the DB2000 computer, the ECDIS could be disconnected from the ANTS system.

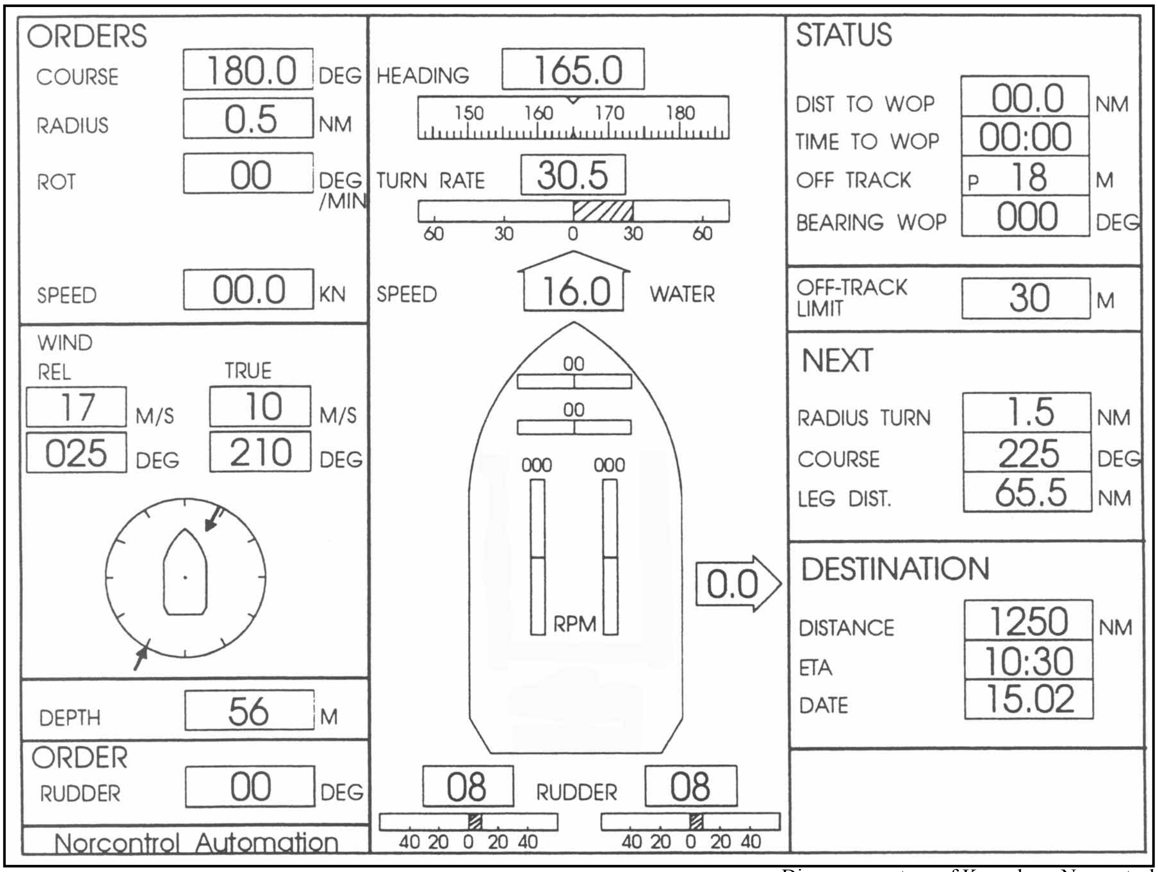

Diagram courtesy of Kongsberg Norcontrol

Figure 6
Layout of a conning display screen

1.3.10 The AP2000 was an adaptive autopilot with track keeping functions connected to the main DB2000 computer, a magnetic compass and a distribution unit. The distribution unit provided connections for feedback from the rudders, connections to the steering gear and to external alarms.

1.3.11 The DB2000 was an ARPA radar system that also provided the computing power for the integration of the external sensors such as differential global positioning system (DGPS), Doppler log, Loran C, radar, gyro compass, and transmitting magnetic compass with the uploaded track information.

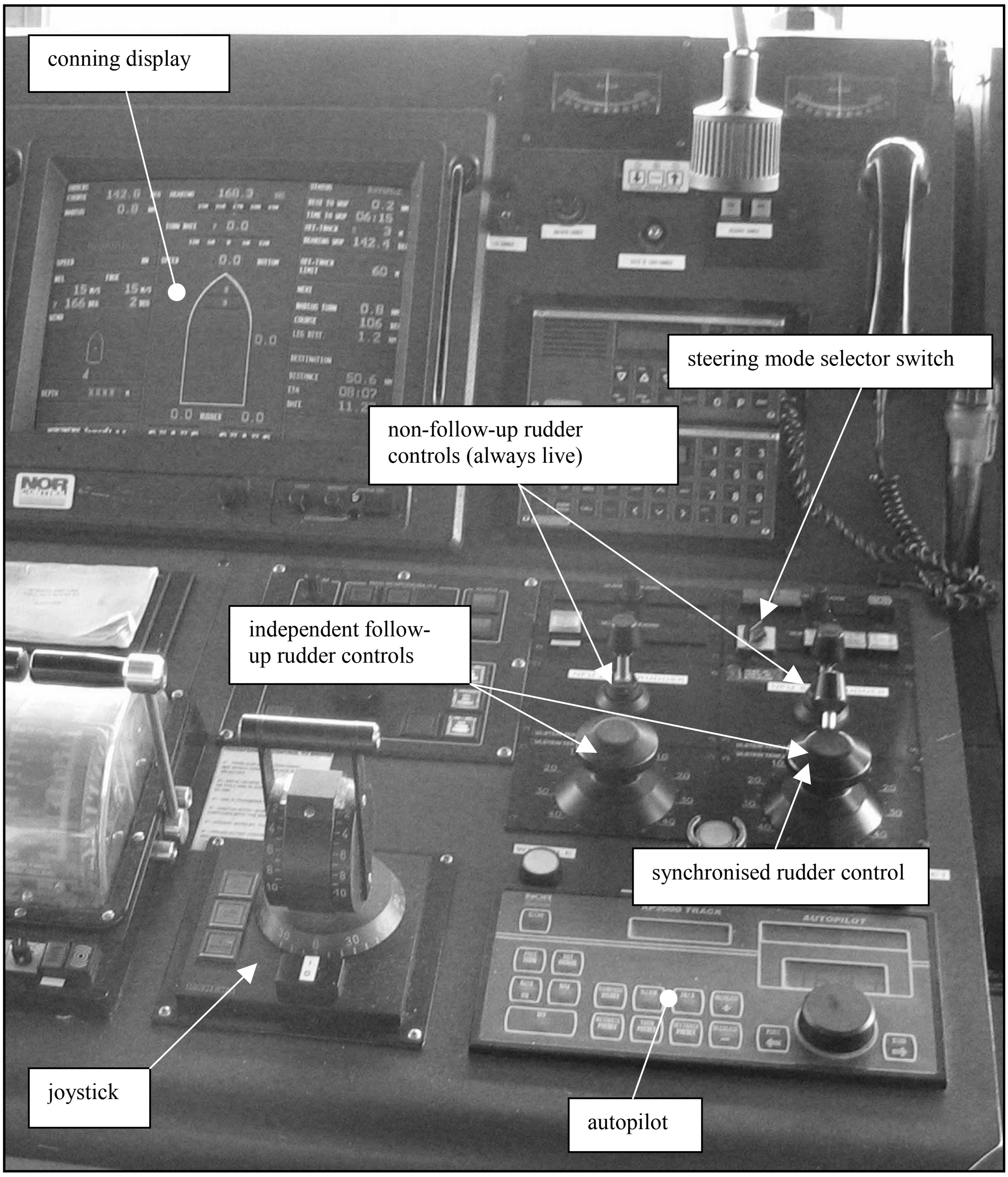

Figure 7
Steering selection controls

1.3.12 Each DB2000 also had a data screen below the main radar screen (see Figure 5) used to display relevant information concerning the: ARPA radar; ship's position, course and speed; and radar, operational and system warnings. The system warnings became stacked, with the display showing the number of warnings stacked (see Figure 5). These warnings could be viewed by pressing each warning button below the display. This action cycled through the warnings, displaying the warning and cancelling it. Although each radar operated independently and received its signals from separate scanners, the data screen displayed information relevant to the radar above it and the combined operational and system warnings. Cancelling an operational or system warning on one DB2000 also cancelled the warning on the second DB2000.

1.3.13 The conning display unit was a cathode ray tube display mounted centrally on the main console. The information displayed (see Figure 6) included:

- heading
- rate of turn
- speed
- engine settings
- rudder settings
- bow thruster settings
- wind direction and speed
- depth of water
- waypoint and course information
- off-track limits and distance off track
- course and rudder orders
- mode of operation in differing colours dependent upon mode:
    - manual steering mode, text colour blue-green
    - automatic steering mode, text colour blue
    - ANTS steering mode, text colour yellow.

1.3.14 Once the information from the external sensors had been integrated, the DB2000 computer system provided the necessary information to the autopilot to enable inter-waypoint navigation and track following functions to be selected.

1.3.15 Once autopilot was selected on the steering panel of the main console, pressing the "sail" button once on the DB2000 (see Figure 5) selected inter-waypoint mode, and pressing the "sail" button twice selected the track following mode.

1.4 Navigational

1.4.1 The Admiralty Sailing Directions New Zealand pilot (NP51) sixteenth edition described Tory Channel as:

> Tory Channel, separated from Queen Charlotte Sound by Arapawa Island is entered from Cook Strait between East Head (41°12'.7S 174°19'.4E) and West Head, 3½ cables WSW, whence the route leads generally W for about 9 miles into Queen Charlotte Sound.

1.4.2 Opposite the entrance to Tory Channel from Cook Strait, Okukari and Whekenui Bays lie directly ahead of ships entering. In the bays the bottom is relatively flat and gently shelving towards the land with no obstructions shown on the chart (see Figure 1).

1.4.3 Marlborough District Council navigation bylaws 2002, stated in Part 3 Ships, Masters and Pilots, section 3.2 Directions for transiting Queen Charlotte Sound, paragraph (i) (c) that:

> For the purposes of these Bylaws, that part of Queen Charlotte Sound forming Tory Channel, from Dieffenbach Point to East Head, shall be deemed to be a narrow channel in accordance with Maritime Rules Part 22.9 – Collision Prevention, Narrow Channels and the provisions of that Rule shall apply.

1.4.4 Marlborough District Council navigation bylaws 2002, stated in Part 3 Ships, Masters and Pilots, section 3.3 Tory Channel that:

> (iii) The pilot or master (if pilot exempt) of every ship, whether inward bound or outward bound shall broadcast, or cause to have broadcast, an initial radio message addressed to 'All Ships', giving warning of transit of the eastern entrance to Tory Channel. This message shall be broadcast not less than 10 (ten) minutes before the ship reaches the following points:
>
> (a) for an outward bound ship the line drawn in a direction of 320° (T) from Scraggy Point Light; and
>
> (b) for an inward bound ship that point forming the intersection of the line of the Leading Lights and the seaward arc of a circle, radius 0'.6 nautical mile, centred on West Head Light
>
> (c) in addition to the requirements of 3.3 (iii) (a) and (b) the broadcast will also include the time the ship is expected to be abeam of East Head Light (K4265)
>
> (d) the area contained within the boundaries described in 3.3 (iii) (a) and (b) is identified as the Tory Channel Entrance Controlled Navigation Zone and is shown in Schedule 8
>
> This message is to be transmitted on marine VHF Channel 19 and may be repeated, if practicable, on marine VHF Channel 63 – the local marine VHF Channel most likely to be monitored by small craft.
>
> (v) Where two ships of 500 gross tonnes or more are likely to pass each other in the vicinity of the eastern entrance to Tory Channel, the outward bound ship shall have priority and the inward bound ship shall wait clear of the entrance until the outward bound ship is clear.
>
> (vi) The requirements of clause 3.3 (v) shall not apply where the pilot or master (if pilot exempt) of the outward-bound ship has advised the pilot or master (if pilot exempt) of the inward bound ship to proceed inwards.
>
> (vii) In observing clauses 3.3 (v) and (vi) only one ship at any one time is permitted to navigate within the Tory Channel Entrance Controlled Navigation Zone as is shown in Schedule 8.

1.4.5 Marlborough District Council navigation bylaws 2002, stated in Part 3 Ships, Masters and Pilots, section 3.5 General requirements that:

> (i) The master of every commercial ship shall ensure, when navigating within harbour limits, that:
>
> (a) automatic steering 'pilot' devices, if fitted, are not to be used, unless a helmsman is standing by, to take over manual steering immediately on this being required, in the immediate vicinity of the helm or wheel

1.4.6 The International Regulations for Preventing Collision at Sea, 1972 (Colregs), apply to all vessels upon the high seas and in all waters connected therewith navigable by seagoing vessels. In New Zealand, Maritime Rules Part 22 gives effect to the Colregs. Part 22 provides the steering and sailing rules for ships, as well as standards for the installation, performance and use of lights for collision avoidance and the sound and light signals used for communication of safety information. There are minor editorial changes between the Colregs and Part 22, but the changes do not alter the meaning of the rules pertaining to this occurrence.

1.4.7 The paragraph of Maritime Rules Part 22 relevant to this investigation are:

> 22.9 Narrow Channels
>
> (1) A vessel proceeding along the course of a narrow channel or fairway must keep as near to the outer limit of the channel or fairway which lies on its starboard side as is safe and practicable.

1.4.8 The International Convention on Standards of Training, Certification and Watchkeeping, 1978 as amended in 1995 (STCW-95) contained requirements (amongst others) for the basic principles, guidelines and responsibilities for navigational watchkeeping. Maritime Rules Part 31A, Amendment 1 Crewing and Watchkeeping Unlimited, Offshore and Coastal (Non-Fishing Vessels) implemented New Zealand's obligations under STCW-95 for these principles, guidelines and responsibilities.

1.4.9 The paragraphs of Maritime Rules Part 31A, Amendment 1 relevant to this investigation are:

> **31A.20 Duty of Master**
> (1) The master of a ship must ensure that the voyage is planned observing the following requirements:
> (a) the intended voyage must be planned in advance, taking into consideration all pertinent information, and any course laid down must be checked before the passage commences.
> (c) prior to each voyage, the master of every ship must ensure that the intended route from the port of departure to the first port of call is planned using adequate and appropriate charts and other nautical publications, that contain accurate, complete and up-to-date information regarding those navigational limitations and hazards which are of a permanent or predictable nature and which are relevant to the safe navigation of the ship on the intended voyage.
> (d) prior to each passage, the master must verify the planned route taking into consideration all pertinent information:
> (e) the verified planned route must be displayed clearly on appropriate charts and must be available continuously to the officer in charge of the watch.
>
> **31A.21 Duty of Officer in Charge of a Navigational Watch**
> An officer in charge of a navigational watch on a ship must -
> (a) verify each course to be followed before using it; and
> (b) carry out his or her navigational watchkeeping duties in accordance with the directions of the master; and
> (c) in carrying out watchkeeping duties -
> (i) when the ship is at sea, have regard to the requirements and operational guidelines for navigational watchkeeping set out in Appendix 1; and...
>
> **Appendix 1 - Navigational Watchkeeping at Sea**
> (1) The master of every ship must ensure that watchkeeping arrangements are adequate for maintaining a safe navigational watch. Under the master's general direction, the officers of the navigational watch are responsible for navigating the ship safely during their periods of duty, when they will be particularly concerned with avoiding collision and stranding.
>
> (8) Performing the navigational watch
> (b) The officer in charge of the navigational watch must, during the watch, check the course steered, position and speed at sufficiently frequent intervals, using any available navigational aids necessary, to ensure that the ship follows the planned course.
> (c) The officer in charge of the navigational watch must have full knowledge of the location and operation of all safety and navigational equipment on board the ship and must be aware of and take account of the operating limitations of such equipment.
> (e) Officers of the navigational watch must make the most effective use of all navigational equipment at their disposal.
> (l) The officer in charge of the navigational watch must bear in mind the necessity to comply at all times with the steering gear requirements in Part 23. The officer of the navigational watch must take into account -
> (i) the need to station a person to steer the ship and to put the steering into manual control in good time to allow any potentially hazardous situation to be dealt with safely; and
> (ii) that with a ship under automatic steering it is highly dangerous to allow a situation to develop to the point where the officer in charge of the navigational watch is without assistance and has to break the continuity of the look-out in order to take emergency action.

1.4.10 The passage plan in use for the journey from Wellington to Picton had not been authorised for use by the appropriate manager at Interislander. However, the management were aware of the plan in its draft form. The passage plan had been amended from the original plan by another master to keep the ship to the starboard side of the channel and had been uploaded into the DB2000 at some time prior to the master's and mate's current tour of duty. However, the master and mate were aware of the change to the passage plan.

1.4.11 The passage plan made reference to an off-track limit of 10 m for the course between the East Head alter course position and the commencement of the turn, and an off-track limit of 20 m from the commencement of the turn until after passing Te Uira-Karapa [Clay] Point. The passage plan also stated that the "latest turn" position was with Whekenui Point 0.45 nm ahead. This was the last position where:

> ... the use of full helm should bring vessel onto track if the turn from the leads is delayed until this point.

The ship would regularly exceed the passage plan off-track limits as it entered and left Tory Channel due to other traffic in the channel, the force of the tidal streams or the weather. The commencement of the turn could also be similarly delayed.

1.4.12 The master later stated that if the ship had been another 5 to 10 seconds further along the track it was following, he would probably have put the engines to full astern, let go the anchors and driven the ship up into Okukari/Whekenui Bay.

1.5 Personnel information

1.5.1 The master of the *Aratere* first went to sea in 1957, gaining his master's certificate of competency in 1968 and the STCW-95 revalidation course at the appropriate time. Interislander and its predecessors had employed him for the previous 30 years, being confirmed in rank as master in 2002, after having served as relief master for about the previous 6 years.

1.5.2 The mate of the *Aratere* first went to sea in 1961 gaining his master's certificate of competency in 1973 and the STCW-95 revalidation course at the appropriate time. He worked for several New Zealand shipping companies until joining Interislander in 1994. He had served as third mate, second mate and mate on the company's ships and as relief master on board the *Arahura* for a short period. He had been mate on the *Aratere* since April 2004.

1.5.3 The crew of the *Aratere* comprised live-aboard crew and walk-on crew who joined the ship for their particular shift and left again at the end of their shift. The live-aboard crew comprised the master, night master, mate, second mate, chief engineer, second engineer, 3 watchkeeping engineers and the boatswain. The remainder of the crew were walk-on crew. The walk-on crew were on duty for a return trip between Wellington and Picton and crew change occurred during cargo and passenger exchange.

1.5.4 One of the seamen on each shift was designated as quartermaster but it was not a company requirement for the quartermaster to be present on the navigating bridge when the ship was at sea. He was summoned to the navigating bridge by telephone or pager as and when he was required. Depending where the seaman was this could take some time. Interislander considered that as both the master and duty navigating officer were on the bridge during the Marlborough Sounds transit and both were qualified as helmsman, either of them could take control of the helm in an emergency.

1.5.5 The live-aboard crew worked a 7-day roster, living on board for 7 days followed by 7 days' leave. The crew changeover occurred on a Thursday. At the time of the incident the live-aboard crew were in the sixth day of their 7-day roster.

1.5.6 The master and mate received training in the use of the IBS and ANTS fitted on the *Aratere* consisting of 2 weeks' familiarisation on board while the ship was in service. The training was predominantly hands-on operation of the equipment during the regular running of the vessel and given by other officers experienced in the equipment's use. Only the original crew of the ship received their initial training from the manufacturer.

1.6 Climatic and tidal conditions

1.6.1 On 29 September 2004 at about 1600, the weather description in the *Aratere*'s logbook was of a northwesterly wind of about 30 kt, with a southerly swell of about 1.5 m height, blue skies with 3 eighths cloud and good visibility.

1.6.2 The Admiralty Sailing Directions New Zealand pilot (NP51) sixteenth edition stated in relation to the tidal streams in the Tory Channel:

> Tidal streams are strong in Tory Channel and very strong in the entrance, as indicated on the charts. Tide-rips form in the approaches, also indicated on the charts. For the latest information see the daily timetable in *New Zealand Nautical Almanac*.

1.6.3 The predicted tides for Wellington as detailed in the New Zealand Nautical Almanac for 29 September 2004 were:

Wellington							
High Water		Low Water		High Water		Low Water	
0456	1.6 m	1112	0.6 m	1729	1.7 m	2349	0.7 m

1.6.4 The range of tides tabulated in the New Zealand Nautical Almanac for Wellington was 1.03 m for the spring range and 0.93 m for the neap range. The range at the time of the occurrence was 1.1 m and therefore a large spring tide.

1.6.5 Tidal stream rates were shown on the chart for specific geographical positions designated by a magenta diamond shape enclosing a letter, known as a tidal diamond. The rates shown are for average spring or neap tides referred to high water at Wellington. If the tidal range is greater than normal (e.g., full or new moon coinciding with perigee) the rates will be increased roughly in proportion. The spring rates for diamond "A" in Tory Channel entrance as shown in Figure 1 were:

Position	Time	Direction	Rate
Diamond "A"	1529	280º	5.5 kt
	1629	290º	6.9 kt
	1729	301º	6.6 kt

1.6.6 The New Zealand Nautical Almanac also contained tabulated data for the Tory Channel giving the general direction of flow and the commencement of flow in that direction. The data for 29 September 2004 were:

Time/Dir.	Time/Dir.	Time/Dir.	Time/Dir.
0223/Westerly	0918/Easterly	1449/Westerly	2123/Easterly

1.6.7 The effect of the tidal stream was to push the *Aratere* to the north of the intended track whichever way the tide was flowing; this was to starboard when the ship was entering Tory Channel from Cook Strait.

1.7 Bridge resource management

1.7.1 Bridge Resource Management (BRM) is the use and co-ordination of all the skills and resources available to the bridge team to achieve the established goal of optimum safety and efficiency.

1.7.2 The use of BRM helps eliminate the potential for one-person error, and aids the flow of information between members of the bridge team, and between the bridge team and the outside world. Part of the flow of information between members of the bridge team is challenge and response and the use of closed-loop communications to ensure that orders and information are heard and understood.

1.7.3 When used effectively, BRM ensures that all the bridge team members share a common view of the intended passage, maintain situational awareness, anticipate dangerous situations, acquire all relevant information and act upon it in a timely manner, avoid an error chain being formed, and aims to prevent preoccupation with minor problems.

1.8 Human factors

1.8.1 Human factors is that branch of science and technology that includes what is known and theorised about human behavioural, cognitive and biological characteristics that can be validly applied to the specification, design, evaluation, operation and maintenance of products, jobs, tasks and systems to enhance safe, effective and satisfying use by individuals, groups and organisations[2].

1.8.2 One aspect common to many automated systems is their ability to function in different operating modes. In its most general sense a "mode" can be defined as "the manner of behaviour" of a given system. A common element in the design of almost all modern equipment is that a single set of displays and controls is used to carry out different functions depending on the mode selection.

1.8.3 In complex automated systems both modes and reference values can be changed manually or automatically. Because events in the environment can initiate a mode transition automatically, it is possible for an operator to have difficulty in maintaining adequate mode awareness in relation to a system. Mode awareness refers to the operator's knowledge and understanding of the current and future status and behaviour of a system.

1.8.4 Inadequate mode awareness can lead to mode error. Mode error occurs when an operator loses track of which mode the device is in, or confuses which actions are appropriate for a particular mode. The occurrence of a mode error indicates that there has been a breakdown in human-machine interaction.

1.8.5 Decision-making, the assimilation of information before an action is carried out, and the associated behaviour can be separated into 2 basic types: analytical and intuitive. Analytical decisions are knowledge-based and exhibit themselves in rule-based and knowledge-based behaviour. They tend to be slower and take a large proportion of the available cognitive processes, leaving less time for other tasks. Intuitive decisions are skill-based and are based on experience gained over many years. They are rapid and take less of the available cognitive processes but they are susceptible to biases, which may result in an incorrect decision.

1.8.6 Skill-based behaviours are those that rely on stored routines or motor programmes that have been learned with practice and which may be accomplished without conscious thought. Ideally, an operator exercising a skill would make the decision to do so and then monitor their own behaviour to ensure that the correct skill was exercised. However, if the central decision-maker, the brain, is busy with another activity (for example being pre-occupied with another problem, possibly far removed from the immediate task) they may make the correct initial decision, inadvertently exercise the wrong skill but then fail to monitor their own activity and remain completely unaware of the mistake they have made.

1.8.7 Rule-based behaviours are those for which a routine or procedure has been learned. The components of a rule-based behaviour may comprise a set of discrete skills. Rule-based behaviours or procedures are common in any complex system. Rule-based behaviours are not stored as patterns of motor activity but as sets of rules and are thus stored in long-term memory. When actioned these skills involve both the central decision-maker and working memory.

[2] Christensen, Topmiller, and Gill 1988. Human factors definitions revisited. *Human Factors Society Bulletin, 31, 7-8.*

1.8.8 Knowledge-based behaviours are those for which no procedure has been established. They require the operator to evaluate information and then use their knowledge and experience to formulate a plan to deal with the situation.

1.8.9 When an unexpected event occurs, an individual's workload suddenly increases as they react to the situation. The effect of this sudden increase in workload can be minimised by having practised contingency plans in place, thus saving the need to go through the involved cognitive process of forming a plan, evaluating whether it would be successful and then implementing it. Contingency planning reduces an individual's workload and the likelihood of load shedding.

1.8.10 Humans can suffer from hazardous attitudes from which hazardous thoughts develop and affect the standard of their decision-making. These attitudes depend upon an individual's characteristics and the type of environment in which they are operating. Factors that can influence decision-making are commercial pressure, peer-pressure and the corporate environment in which the decisions are made.

1.8.11 Attention is the capacity to maintain some level of alertness during the activities of the day and is a primary aspect of perceptual functioning. Alertness is the ability to maintain optimal sensitivity to external stimuli. Channelled attention, where an operator starts to focus their attention on one source of information to the exclusion of all others, is an example of load shedding.

1.8.12 Vigilance can be described as the ability to sustain attention on a task for an extended period of time. Research has shown that there is a progressive decline in performance with the time on the task. This progressive decline in performance is termed the "decrement function" or "vigilance decrement". Studies suggest that the vigilance decrement is complete within 20 to 35 minutes after the initiation of the vigil, and at least half of the final loss is completed within the first 15 minutes[3].

2 Analysis

2.1 The master's comment that had the ship been slightly further along the track, rather than turn the ship he would have probably put the propulsion full astern, dropped anchors and put the ship aground, indicated prudent seamanship. Had the master delayed assuming manual control, by possibly as little as 5 seconds, the ship would not have been able to make the turn to port and would probably have grounded at speed on the steep northern shore of the entrance, away from the gently shelving bottom in Okukari and Whekenui Bays. The consequences of such a grounding would have been severe.

2.2 Although Okukari and Whekenui Bays are gently shelving, the soundings are a minimum of about 120 m apart in the outer reaches of the bay and obstructions such as rocks may exist that are not represented on the chart. Obstructions such as these, if hit, may also have caused considerable damage to the ship.

2.3 The passage plan in use at the time of the incident appeared to be an attempt to comply with the Marlborough District Council navigation bylaws 2002 and Maritime Rules Part 22 section 22.9 Narrow Channels. These rules required the ship to be kept as near to the outer limit of the channel or fairway which lies on its starboard side as is safe and practicable. However, keeping to the starboard side of the channel reduced the safety margin between the ship and the shore available to the bridge team in the event of an equipment malfunction. As only one vessel of 500 gross tonnes or more was allowed in the Tory Channel Entrance Controlled Navigation Zone at one time, it would be more prudent for the master to keep the ship to the centre or

[3] H.J. Jerison, Experiments on vigilance: V. The empirical model for human vigilance, Wright Air Development Center Technical report No. WADC-TR-58-526. Wright-Patterson Air Force base, Ohio: Aero Medical Laboratory, Wright Air Development Center, 1959. W.H. Teichner, The detection of a simple visual signal as a function of time of watch. *Human Factors*, 1974, 16, 339-353.

deeper water part of the channel within this area. The master could then con the ship towards the starboard side of the channel before exiting the controlled area.

2.4 The passage plan included off-track limits set for each of the course legs. For entering Tory Channel, the limit was 10 m, and during the turn, 20 m. The mate did not mention to the master the off-track distance until the ship was at least 35 m off track, and possibly 65 m off track, considerably in excess of the limits stated in the passage plan. Good BRM advocates keeping as close as possible to courses as laid down in the prepared passage plan and not exceeding the "safe" off-track limits except under exceptional circumstances. That no safe off-track limits had been set, which the ship must not exceed without the bridge team intervening to bring the ship back on course and the regularity of the ship exceeding the advisory off-track limits was less than prudent passage planning. More prudent passage planning would have set off-track limits at which intervention was required and off-track limits that must not be exceeded. Also the setting of a point at which the ship must commence its turn to ensure that all navigational dangers were passed at a minimum safe distance should be included.

2.5 The distance off track at which the mate started advising the master could not be verified from the data download from the BVR. However, that the mate did not comment on the off-track distance until it was considerably greater than that specified in the passage plan, and the master's comment that he had seen a far greater off-track distance indicated that there was no shared common view of the passage plan and the intended passage. The master having said that he had seen 85 m in the past may have lulled the mate into a false sense of security that the already excessive off-track distance was still within tolerance.

2.6 It is probable that the DB2000 system defaulted to autopilot mode at some time prior to the planned alter course position for commencing the major turn to port. Neither the mate, with the con of the vessel, nor the master was aware of this mode transition. Being unaware of the mode transition to autopilot, both the mate and the master expected the ANTS system to automatically alter course at the correct point and were not expecting to have to intervene manually. This was an example of mode error and a breakdown in human-machine interaction. However, the master thought that when he changed into manual steering mode the colour of the text on the display showing the mode in which the steering was operating changed from yellow (ANTS mode) to blue-green (manual mode). The colour however may not have changed, or have changed from blue to blue-green, the master applying a skill-based behaviour, his mind considering that when he moved the changeover switch the colours changed as he thought because "they always do". Had it done so it would indicate that it had been operating in ANTS mode prior to the master's action and had been malfunctioning. However, the maintenance technicians and the manufacturer could find no indication of any malfunction.

2.7 It is possible that the *Aratere*'s aerials became masked from a satellite, for a short period, to such an extent the DGPS reverted to dead reckoning mode. This would cause the DB2000 to revert to autopilot mode and sound an alarm.

2.8 It is possible that the difference in the relative speeds of the ground and water tracks, from the Doppler log, due to current and tidal rips in the area caused the DB2000 system to revert to autopilot mode and sound an alarm.

2.9 It is possible that at some point the sideways motion of the vessel away from the programmed track, coupled with a small variation in the received DGPS position, exceeded the off-track jump limit of 12 m in any one sampling period. This would cause the DB2000 system to revert to autopilot mode.

2.10 If any of these alarms or warnings coincided with another alarm or warning, such as off-track limits being exceeded or approaching an alter course position on the DB2000, they would become stacked and the mate or master may have inadvertently accepted the system warning using a skill-based behavioural pattern as they were routinely expecting an alter course alarm. The distinctive double "beep" sound heard as the vessel entered Tory Channel may have been an alarm for the ANTS system reverting to autopilot at almost the same time as an alarm for an approaching waypoint, off-track limit or other anticipated alarm, and as such may have gone unnoticed.

2.11 If the non-follow-up rudder controls had been accidentally moved, this would have taken the steering out of autopilot control, causing a different and more strident alarm to sound. It is unlikely that this alarm would be confused with the other alarms. The steering would have reverted to hand steering and the ship would probably have swung off course and not maintained a relatively steady course that was followed.

2.12 It is probable that the ANTS system was functioning correctly throughout the voyage but had, for whatever reason, reverted to a different mode of steering which went unnoticed by the bridge navigating team. The master being able to re-engage ANTS mode very shortly after the incident, that it worked correctly for the remainder of the passage and on subsequent voyages when permitted to be used evidenced this. Also, neither Norcontrol nor the shore-based maintenance technician in Wellington could find any other evidence in the data retrieved from the system, to suggest a failure of the system.

2.13 Because the ECDIS charts had not been corrected for a considerable time, the system could not be used officially. However, this had no effect on the outcome of the occurrence as no pertinent corrections had been issued for the chart since the partial hardware failure of the equipment. At the time of the incident a corrected paper chart was available on the chart table, but this was situated behind the main console and would have required the master or mate to have left the manoeuvring controls to look at it.

2.14 Although the original crew had received training in the use of the IBS prior to the commissioning of the ship, many of that crew had since been assigned to other ships, retired, left the company's employ or were on a different shift from the master and mate. The training the master and mate had received in the use of the IBS and the ANTS track especially had been from their peers and was at least second hand, if not more, with the consequent lack of in-depth knowledge of the functioning of the system itself. The training, while not necessarily lacking in content, was carried out during a short familiarisation period where hands-on operation was more to the fore than knowledge of the system itself.

2.15 The Norcontrol GANTS system is only as accurate and efficient as the inputs it receives from exterior sources and the level and standard of monitoring and understanding of the system that the human operator exercises. The IMO guidance circular notes that:

> Automatic steering may only be useful where precise manoeuvring is required, if the automatic control system supports the required precision, e.g. by considering speed through the water for rudder control.

2.16 The manufacturer ran courses on its IBS, and the IMO guidance circular recommended that the shipping company establish a training programme for all officers with operational duties involving IBS. The IMO guidance circular further recommended that the shipping company have personnel ashore capable of supervising, training and evaluating the company's operational procedures and use of the IBS. At the time of the incident Interislander did not have a dedicated person ashore dealing with training of sea staff in the use of the IBS and had no formalised policy to carry out this training to the standard recommended by IMO. However, Interislander was not aware of the IMO recommendations.

2.17 The IMO circular giving guidance on the IBS was sent by the MSA to Interislander. However, the MSA's method of transmittal, by email, of this important information did not guarantee receipt by the intended recipient, nor did the procedures in place at the time adequately document to whom this information was sent and if it had been received. No record or memory of receipt could be found at Interislander so whether or not it was received could not be proved. However, Interislander was therefore denied the opportunity of the guidance to ensure that its policies and procedures conformed to best practice for the safe use of the IBS.

2.18 The master's action in turning the ship to port was probably a "gut reaction" or an intuitive, skill-based decision of trying to distance the ship from the main perceived danger of running aground. He may also have had the hazardous thought of "I can do it". However, the position at which he reacted was about 200 m past the position noted in the passage plan as being the latest position to commence turn with full helm to regain track. However, this was not the last possible position at which the vessel could commence its turn and remain a safe distance from all navigational dangers. Such a position was not documented; there may therefore have been an element of luck in the successful turn.

2.19 As a result of automation, machines have become "partners" on the bridge of a modern ship, and vigilant behaviour is an important element in this partnership. With the advent of automatic control and computing systems for the acquisition, storage and processing of information, the human operator has been relieved of many routine but active controlling activities that were necessary in less sophisticated systems. The operator's role has evolved along more managerial lines in which much time is spent in the passive monitoring of dials, video screens and other sources of information for occasional critical stimuli that demand decision and action. Viewed in the context of an automation-orientated bridge, in which failure to detect critical signals can often be disastrous, vigilance assumes considerable significance. At the time of the incident the mate had been on watch for about an hour and a quarter and it could be expected that his performance would have declined from when he assumed the con of the vessel due to vigilance decrement.

2.20 Both the mate and the master were aware of the different methods of manually steering the ship and the required procedures to change from one method to another and the engagement of the autopilot and ANTS system. They were aware that the 2 non-follow-up rudder controls were always "live". However, the ergonomics of the bridge design were that if the master stood in his usual position in front of the starboard chair, the mate standing approximately on the centreline had to reach over to use these controls. The controls were obviously placed with one-man-bridge operation in mind but were unable to be reached from the sitting position in either chair. For the officer who had the con of the vessel to be ready to operate the controls at a moment's notice during critical points of the voyage required them to be standing within easy reach of these controls.

2.21 A shore-based company employee engaged the master in conversation shortly after the master arrived on the bridge. Although this conversation was of short duration, it may have distracted the master at a time when his full attention was required for preparing to enter Tory Channel. The master may have also become subconsciously preoccupied with the content of that conversation, which may have slowed his analytical decision-making as a proportion of his cognitive processes may have already been in use with the preoccupation. The presence of the other officers and a family on the bridge as the master arrived on the bridge may also have distracted the master and/or the mate. They were ushered off the bridge as the *Aratere* entered Tory Channel, but the ship's position at which they left the bridge was closer to the Tory Channel entrance than was allowed under Interislander operational procedures.

2.22 As there was no formulated contingency plan for the scenario that unfolded in this occurrence, the master and mate were required to formulate a plan, evaluate whether it would be successful and then implement it in a very short period of time. This suddenly increased their workload and the need for a large proportion of their cognitive processes to be involved.

2.23 As the mate's workload increased, he began to channel his attention into the conning display and the distance off track, which he was calling out to the master. His attention excluded relevant information from external visual sources, the radar and other navigational devices or practices such as parallel indexing. Although the mate had not relinquished the con of the vessel he appeared to be waiting for the master to react as he channelled his attention into the conning display.

2.24 BRM training emphasises the need to recognise "hazardous thoughts" and replace them with opposite "safe thoughts". Three hazardous thoughts and their opposite safe thoughts, as used in BRM concepts, were relevant to the master and mate of the *Aratere* when they entered Tory Channel.

Hazardous Thought	Safe Thought
I can do it	Why take chances
It won't happen to me	It could happen to me
We've always done it this way	It's about time we changed

2.25 Both the mate and the master held pilot exemptions for Queen Charlotte Sound including Tory Channel and had transited the Tory Channel entrance hundreds of times in a year. Both were at risk from the routinisation of the passage. With routinisation, operators become more concerned about the mechanics and accomplishment of tasks than their meaning. Thus an operator can underestimate the amount of risk that routine tasks can pose for the safety of the ship. Good BRM ensures that routine tasks are adequately supervised and that appropriate procedures are implemented to reduce this routinisation.

2.26 Good BRM utilising closed loop communications would have them call and accept the alarm, reading it out and getting an affirmative reply so that the entire bridge team maintained situational awareness and a common view of the intended passage.

2.27 Neither the master nor the mate had ensured that a helmsman was standing by to take over the manual steering immediately as required by the Marlborough District Council navigation bylaws 2002 and Maritime Rules Part 31A, Amendment 1. However, it was not company practice to have a helmsman in the wheelhouse, rather to rely on the master or duty navigating officer to steer when or if required. In this case, as with other emergency situations, there would not be sufficient time to summon the helmsman to have any meaningful effect. Effective BRM training would have alerted the navigational team to the hazardous thought of "we've always done it this way" and replaced it with the opposite safe thought of "it's about time we changed". However, expecting either the master or duty navigating officer to act as helmsman in an unexpected emergency situation greatly increases their workload at a time when they may be preoccupied with other issues. This may also leave the other officer in isolation for decision-making at a critical time.

3 Findings

Findings are listed in order of development, not in order of priority.

3.1 The *Aratere* did not make a planned automatic turn to port in the entrance to Tory Channel because the ship was probably in autopilot rather than in ANTS, as the master and mate thought it to be.

3.2 Recovery from the situation required swift intervention by the bridge team to initiate the turn manually and prevent the ship grounding.

3.3 Had the master or mate delayed their reaction to the perceived failure of the ANTS system any longer, the ship would have been placed in grave peril and would probably have grounded.

3.4 The ANTS system was probably working correctly and, had it been in operation at the time, would have made the planned turn.

3.5 The DB2000 system probably defaulted from the ANTS mode to autopilot mode without the change being noticed by the mate or master. Any alarms that sounded for a mode change for whatever reason were probably either not heard or attributed to a different alarm message. The distinct double beep may have been a mode change to autopilot masked by another expected alarm.

3.6 The presence of additional personnel on the bridge beyond the limits set in Interislander's operational guidelines may have been a distraction to the mate and master.

3.7 The system's method of displaying warnings and alarms on the screen, where only the number and type of warnings were initially visible, required the operator to enter a menu system to read and acknowledge the warning. This made the warning or alarm less evident to the operator and possibly ignored.

3.8 The DB2000 system probably defaulted to autopilot mode because:

- the system received an erroneous signal from an external input such as the DGPS due to aerial masking or incorrect differential signal reception
- the system received such conflicting information from the ground and water speeds of the Doppler log that the information was discarded as erroneous or
- parameters for the off-track jump limit were exceeded.

3.9 The master's action in turning the ship hard to port was probably an intuitive skill-based action which, although rapid and required less of the cognitive processes, was susceptible to bias and could have resulted in an incorrect decision being made.

3.10 The master started the turn some 200 m past the position in the passage plan designated as the latest point to start the turn with full rudder applied. The ship passed within about 100 m of a rock that was awash at chart datum and was close to grounding.

3.11 A helmsman was not available on the navigating bridge but had one been, the time taken to position him at the wheel and take over steering would have been too long to avoid a grounding.

3.12 The *Aratere* did not suffer any damage that affected its seaworthiness or navigability.

3.13 The *Aratere* was correctly certified and manned at the time of the occurrence.

3.14 Although the master and mate were 6 days into a 7-day shift, crew fatigue was not considered to have contributed to this incident.

3.15 The standard of Bridge Resource Management was less than optimal.

3.16 There was no contingency plan available for the situation the master and mate encountered, thus their workload suddenly increased at a critical part of the voyage.

3.17 The master and mate probably did not share a common view of the intended passage.

3.18 The mate was not using all the navigational aids available to him on the bridge of the *Aratere*. His reliance on one main aid may have reduced his situational awareness and may have resulted in his channelling his attention into the off-track error displayed on the conning display.

3.19 Although on the MSA's email distribution list, Interislander had possibly either not received or mislaid the guidance contained in the IMO guidance circular for the operational use of IBS.

3.20 The procedures that the MSA had in place, as the Government's representative at IMO, for the promulgation and recording of information from IMO, were less than optimal to ensure that all relevant parties received the information.

4 Post-incident actions

4.1 After the occurrence the MSA imposed conditions on the *Aratere* under section 55 of the Marine Transport Act that when the ship was being navigated in pilotage waters a person had to be at the wheel, steering the ship.

4.2 On 4 October 2004 the Marlborough District Council harbourmaster issued a direction pursuant to section 650C(3)(a) of the Local Government Act 2002 that stated:

> **Use of Automated Navigation Systems**
>
> The use of automated navigation systems that act on their own (for example, linked to GPS or DGPS receivers), without immediate preceding direction of the Master or Officer of the Watch, within the areas set out below, is prohibited.
>
> **Areas to which this Direction apply:**
> - Queen Charlotte Sound/Tory Channel pilotage district
> - Pelorus Sound pilotage district
> - French Pass
>
> This Direction will remain in force until further notice.

5 Safety Recommendations

Safety recommendations are listed in order of development, not in order of priority.

5.1 On 30 May 2005 the Commission recommended to the General Manager, Interislander, Toll NZ Consolidated Limited that he:

5.1.1 define safety-critical areas for the standard voyage for vessels within the company's fleet. Institute and implement contingency plans for abnormal procedures such as, but not limited to, integrated bridge system and steering system partial and complete failures within these areas.(041/05)

5.1.2 institute abnormal procedures' contingency plan training on board to familiarise the master, officers and crew with the operational procedures to be undertaken in any such emergency.(042/05)

5.1.3 instigate a programme of training and practice to reinforce bridge resource management techniques amongst members of bridge navigation teams on board the company's vessels.(043/05)

5.1.4 implement training for all masters and officers who serve, or may serve, on board the company's vessels fitted with integrated bridge systems (IBS). Training to include the use and understanding of IBS, and the use of automatic navigation and track steering in line with the guidance contained in the International Maritime Organization circular MSC/Circ.1061.(044/05)

5.2 The Operations Manager, Interislander replied to the preliminary safety recommendations, which were subsequently adopted unchanged as the Commission's final safety recommendations. That reply dated 26 May 2005 was (in part):

> Safety recommendation 041/05
>
> Interislander accepts this recommendation and has already begun this process. We expect full implementation by end June 2005
>
> Safety recommendation 042/05
>
> Interislander accepts this recommendation and has already begun this process. We expect full implementation by end June 2005

Safety recommendation 043/05

Interislander accepts this recommendation and has already begun this process. Interislander is committed to becoming world leaders in safe navigation. It has appointed specialists currently considered to be world leaders in this field. They have completed an assessment of the Interislander fleet and put forward a training proposal that will achieve Interislander's goal of excellence in this field. The first course has been completed, and a series of further courses will be run over the following months. Completion of this first phase is expected by November 2005

Safety recommendation 044/05

Interislander accepts this recommendation and has already begun this process. We expect full implementation by end August 2005

5.3 On 17 June 2005 the Commission recommended to the Director of Maritime Safety that he:

5.3.1 review the procedures for distribution of International Maritime Organization circulars to ensure all affected parties promptly receive International Maritime Organization documentation and the distribution and receipt are adequately recorded.(045/05)

5.4 The Director of Maritime New Zealand replied to the final safety recommendation, the reply dated 1 July 2005, was (in part):

The Maritime Safety Authority accepts the intent of this recommendation for a review of our internal procedures for distribution of IMO circulars. It is our view that documentation of receipt of IMO circulars should be achieved during the routine ISM audit process on board, thereby ensuring that the intended recipient, i.e. the vessel's Master, has received the required information, rather than the company only.

Approved on 30 June 2005 for publication

Hon W P Jeffries
Chief Commissioner

Annex 1

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Ref. T2/8.01

MSC/Circ.1061
6 January 2003

GUIDANCE FOR THE OPERATIONAL USE OF INTEGRATED BRIDGE SYSTEMS (IBS)

1 The Maritime Safety Committee, at its seventy-sixth session (2 to 13 December 2002), adopted the annexed Guidance for the operational use of Integrated Bridge Systems (IBS), which has been developed to support the safe operational use of an IBS by promoting procedures necessary to ensure adequate knowledge of system functions for Mode Awareness, Situational Awareness and Workload Management in addition to traditional seamanship.

2 The aim of the Guidance is to define the basis for minimum criteria on the operation, training and quality control for Integrated Bridge Systems. This Guidance is applicable to the operation of ships fitted with Integrated Bridge Systems (IBS), which include Integrated Navigation Systems INS (B) or (C), as per resolution MSC.86(70).

3 Member Governments are invited to bring this Guidance to the attention of all parties concerned.

ANNEX

GUIDANCE FOR THE OPERATIONAL USE OF INTEGRATED BRIDGE SYSTEMS

Introduction

This guidance supports the safe operational use of an IBS by promoting procedures necessary to ensure adequate knowledge of system functions for Mode Awareness, Situational Awareness and Workload Management in addition to traditional seamanship.

The aim is to define the basis for minimum criteria on the operation, training and quality control for Integrated Bridge Systems.

1 Scope

This guidance is relevant to the operation of ships fitted with Integrated Bridge Systems (IBS), as per resolution MSC.64(67), annex 1, which include Integrated Navigation Systems INS (B) or (C), as per resolution MSC.86(70).

2 Definitions

For the purpose of this guidance, the following definitions apply.

2.1 Mode awareness

Mode awareness is based on the knowledge and purpose of various operation modes included in the IBS. Use of different operation modes should follow bridge procedures based on company automation policy.

2.2 Situational awareness

Situational awareness is the mariner's perception of the navigational and technical information provided at the INS workstation, the comprehension of their meaning and the projection of their status in the near future, as required for timely reaction to the situation that can be expected from his/her trained skills in the operation of the INS.

2.3 Failure analysis

The failure analysis aims to demonstrate that the system has a fail-to-safe functionality. The failure effects and their consequences are assessed for the installed components.

3 Bridge procedures

The bridge procedures, provided for the ship, should implement the functions, capabilities and limitations of the installed IBS. Especially the documentation should include clear instructions about conditions under which automatic control functions may be used or not.

Note: Automatic steering may only be useful where precise maneuvering is required, if the automatic control system supports the required precision, e.g. by considering speed through water for rudder control.

The Company should have personnel ashore capable of supervising, training and evaluating the company Operational Procedures and operational use of the Integrated Bridge System.

3.1 Vessel Operating Manual (VOM)

The Vessel Operating Manual (VOM) should incorporate the Company policy for implementing and using automation and the Integrated Bridge System.

The operational manual consolidates and abbreviates the manufacturer's operational manuals to a comprehensive operational manual without detailed technical information.

The VOM should clarify the integration and the priority of sub-systems within the control system. Special emphasis should be laid on the effect of sub-systems on the total outcome of navigation control. Advantages and disadvantages between control and automation modes should be explained in a clear form. It should be clearly indicated for which situations, the different modes are designed.

The VOM should indicate corrective actions to be taken when the system gives alarm.

Operating limitations and their reasons should be thoroughly explained.

A description of the checklists and purpose of the specific items should be included in the VOM.

Terminology for standard Call-Outs should be developed by the Company and presented in the VOM.

Note: Where the VOM includes other items connected to the IBS, such as cargo handling or other vessel sub-systems the resulting functions, capabilities and limitations should be addressed.

3.2 Normal procedures

Standard Operating Procedures for normal situations should cover normal operation at different stages of the passage including the vessel's operational limits, manoeuvring trial data and ship's data including squat and anchoring.

The route should be divided into zones according to the nature of navigation, as follows:

- Sea passage;
- Shallow waters, pilotage waters and fairways; and
- Harbour areas.

The standard operating procedures should be documented in the form of checklists demonstrating transition from one zone to another. The items to be listed are e.g. manning of the bridge and the use of automated equipment including the selection of subsystems and their modes of operations.

Manual or automatic heading, track and speed control modes and the required actions for changing modes should be clearly presented in the graphical or checklist flow chart form, if not clearly indicated by the equipment itself.

3.3 Emergency and abnormal procedures

Emergency and abnormal procedures are essential for optimum Workload Management.

The emergency procedures refer to SOLAS Conference 29.11.1995 'Decision support system for masters on passenger ships (SOLAS/Conf.3/46, Annex, page 14, regulation 24.4). Operation of

Integrated Navigation, Control and Communication systems should be considered in the following procedures:

- Blackout;
- Fire;
- Stranding;
- Collision;
- Man-over-board situations;
- Unlawful acts threatening the safety of the ship and the security of its passengers and crew;
- Emergency assistance to other ships;
- (the list is not complete)

All emergency procedures should be presented in a logical structure, e.g. by listing each emergency control mode in the form of a checklist, and by providing appropriate overviews.

The abnormal procedures should focus on alarms and items not generally needed in normal operation. Typical situations are sub-system failures that require decisions regarding the level of automation to be used.

Both emergency and abnormal procedures should carefully consider the failure analysis of the system.

A list of alarms of different subsystems should be harmonized to cover the whole Integrated Bridge System (IBS). Special emphasis should be laid on operational procedures in case of an alarm to switch the system on a lower automation level, manual mode or to switch sensor.

Note: All checklists based on Standard Operational Procedures should be provided in an easy-to-handle, concise and durable form.

3.4 Passage plans

The Passage Plan should be programmed in the Integrated Navigation System. The normal procedures related to the route should be programmed in the waypoint data. The procedures should contain at least the following information:

- Speed and track limits;
- Control mode (e.g. heading, course, track and speed);
- Compulsory radio communication; and
- Reference to the checklists.

The route should be programmed with a safe practice taking into account routeing systems, fairway lines, channel marks, shallow waters and oncoming traffic.

The track limits should be sufficiently large to avoid operationally unnecessary alarms.

Passage planning should conform to resolution A.893(21) - Guidelines for voyage planning.

3.5 Records

The bridge procedures should include clear instructions on marking, starting, ending and storing of records and passage plans provided by the IBS.

Recording should conform to resolution A.916(22) - Guidelines for the recording of events related to navigation.

4 Implementing new technology

A modified IBS should only be put into normal operation after successful functional testing.

During all new equipment or new version tests, the procedure to switch to manual or emergency control should be obvious. The minimum requirement to conduct the procedure is one command per device. The procedure should be documented. A new system should not be operated before new manuals have been delivered and studied.

The test should start in a safe area with the technically simplest mode. The technical level can be increased when the crew is familiar with the mode and when the crew has ensured that the desired operational safety is achieved.

The officers should be aware of which area and which mode testing is allowed. Regular meetings should be held to plan and decide fixed time periods for the proceedings of the technical tests and operational training within the Company limits documented in the Vessel Operating Manual (VOM).

5 Training programme

The company, in co-operation with the relevant manufacturers, should establish a training programme for all officers which have operational duties involving the IBS.

5.1 Knowledge-based training

In designing theoretical training packages, the following items should be amongst those to be considered:

- Manoeuvring characteristics of the ship;
- Operational limitations;
- Propulsion and control systems, both manual and automatic modes of operation and emergency controls;
- Communication systems;
- Integrated Navigation System; and
- Navigation and communications procedures for normal, abnormal and emergency situations.

5.2 Skill-based training

In designing theoretical skill-based training packages, the following items should be amongst those to be considered:

- Handling the ship in normal, abnormal and emergency situations;
- Using all available levels of automation relevant to the operational situation;
- Failure mode control; and
- Adherences to the Company’s Standard Operating Procedures (SOP).

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