Report of the investigation

of an accident on the bulk carrier

mv *Diamond Bulker*

with the loss of two lives

when at anchor in Lough Foyle,

Londonderry, Northern Ireland

on 5 April 2000

Marine Accident Investigation Branch
First Floor, Carlton House
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Extract from

The Merchant Shipping

(Accident Reporting and Investigation)

Regulations 1999

The fundamental purpose of investigating an accident under these Regulations 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.

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GLOSSARY OF ABBREVIATIONS AND ACRONYMS

AB	-	Able Seaman
ABC	-	Airways, breathing, and pulse
Cat	-	Category
CO_2	-	Carbon Dioxide
CPR	-	Cardiac Pulmonary Resuscitation
CTS	-	Counter Terrorism Search
CTSA	-	" " " Advisor
Dwt	-	Deadweight
ETA	-	Estimated Time of Arrival
GB	-	Great Britain
HQNI	-	Headquarters Northern Ireland
IMDG	-	International Maritime Dangerous Goods
IMO	-	International Maritime Organization
IRTU	-	Industrial Research and Technology Unit
LMT	-	Logistics, Maritime and Transportation (Department within DETR)
MAIB	-	Marine Accident Investigation Branch
MRSC	-	Maritime Rescue Sub-Centre
NI	-	Northern Ireland
RESA	-	Royal Engineers Search Advisor
REST (NI)	-	Royal Engineers Search Team (Northern Ireland)
RIB	-	Rigid Inflatable Boat
RN	-	Royal Navy
RNLI	-	Royal National Lifeboat Institution
ROI	-	Regimental Order Instruction
RUC	-	Royal Ulster Constabulary
SAR	-	Search and Rescue
SCBA	-	Self-Contained Breathing Apparatus
SOLAS	-	Safety of Life at Sea
SNONI	-	Senior Naval Officer Northern Ireland
SWL	-	Safe Working Load
UTC	-	Universal Co-ordinated Time
VHF	-	Very High Frequency Radio
VOC	-	Volatile organic compound
WICS	-	Working In Confined Spaces

Marine Safety Agency (MSA) and The Coastguard Agency (TCA) merged in April 1998 and are now known as the Maritime and Coastguard Agency (MCA).

GLOSSARY OF TERMS

Class	-	Classification Society
Scribe	-	Serviceman appointed to record details of discussions
Plumbed	-	Capable of being reached
"Cougar"	-	Trade name of particular type of service radio
"CONGENBILL"	-	Code name for particular Bill of Lading
Helevac	-	Service code name for evacuation by helicopter
Ambu-resuscitor	-	Service code name for resuscitation equipment
Sapper	-	Royal Engineers' name for trained soldier

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SYNOPSIS

MRSC Belfast notified this accident to the Marine Accident Investigation Branch (MAIB) at 0020 on the morning of Thursday 6 April 2000. The investigation started the same day with the appointed inspector visiting the vessel in Londonderry later that day.

Diamond Bulker is a 28,460dwt bulk carrier, Philippine owned, Canadian managed and currently trading between South America and Northern Ireland. The vessel with a crew of 20 Philippine nationals, carried a cargo of bulk coal loaded in Barranquilla, Colombia, for discharge at Lisahally berth No 3, Londonderry, Northern Ireland. The vessel's arrival was delayed due to bad weather, and she did not anchor in Lough Foyle, County Londonderry, until 1848 on 5 April.

Military intelligence had reason to carry out a search of *Diamond Bulker* on arrival, and made preparations to assemble a combined naval, marine and specialised army search team for the operation. It was agreed that the specialist army search team would carry out the search, with the marines providing armed support and help when requested. The holds were to be searched if there was time, but only after they had been ventilated. No self-contained breathing apparatus (SCBA) sets would therefore be required.

The first attempt was aborted due to *Diamond Bulker*'s late arrival. On confirmation of her actual arrival and anchoring, the boarding party, under the command of a naval team leader, boarded the vessel at about 2100. Once on board, part of the team went to the bridge, while the marines and the army search team secured the deck area. The army staff sergeant in charge of the army search team having quickly examined a bulkhead mounted plan of the vessel, went forward and briefed his team. Half would search forward to aft on deck, while the other half would search the engine room. Both parties were to meet and search the accommodation. During this briefing, the forward army search team was fitted out with emergency breathing kits and gas detectors. The marines, who were attempting to enter a hatch, were told to leave the searching to the army staff. The staff sergeant then returned to the accommodation with the corporal and one of the sappers, to plan in detail the search procedure forward, using the bulkhead plan. Once completed, the staff sergeant went back to the bridge, while the corporal and the sapper returned to the forecastle.

On resuming the search forward, the two army sappers decided to enter the hatch previously opened by the marines. No pre-entry tests were carried out, and, shortly after entering, both men became unconscious and fell. The marines in attendance called for help and while that was being sought, the army corporal decided to enter the space himself, again without testing the atmosphere. He, too, became unconscious. The staff sergeant ran forward, realised the problem, and immediately rushed back for the ship's SCBA sets. These were brought to the scene, and rescue attempts put into action by the service personnel and the ship's staff. Shore authorities were informed and the emergency services organised to attend. Initially, two of the sappers were found alive but, despite revival attempts by other servicemen, only one sapper, Parris, survived. He was lifted to the main deck and eventually airlifted by helicopter to a local hospital. The other two casualties were brought ashore by boat at a latter stage.

The subsequent investigation has resulted in recommendations to the Royal Navy and Army on training, and to the MCA on the availability of dedicated SAR helicopter services in Northern Ireland.

SECTION 1 - FACTUAL INFORMATION

1.1 PARTICULARS OF VESSEL AND INCIDENT

Vessel

Name	:	*Diamond Bulker*
Official No	:	000170
Port of Registry	:	Manila, Philippines
Owners	:	Transportes Navieros Inc Manila, Philippines
Managing Agents	:	Fairmont Shipping Canada Ltd
Classification Society	:	Nippon Kaiji Kyokai (NK)
Gross Tonnage	:	16,721
Deadweight	:	28,460 tonnes
Overall Length	:	169.00m
Breadth	:	27.20m
Maximum Draught	:	9.745m
Year of Build	:	1994
Type	:	Bulk Carrier
No of Holds/gear	:	5 with 4 x 30.5t SWL deck cranes
Main Engine	:	B&W 5S50MC 4869kW @ 108 rpm
Propulsion	:	Five blade fixed pitch propeller

Accident

Date and Time	:	5 April 2000, about 2140 UTC
Place of Incident	:	Lough Foyle, near Londonderry, NI
Injuries	:	Two dead, plus one seriously injured due to lack of oxygen
Damage	:	None

Photograph courtesy of FotoFlite

Figure 1

Diamond Bulker

1.2 BACKGROUND TO BOARDING

Diamond Bulker is owned by Transportes Navieros Inc of Manila, Philippines although the beneficial nationality is Hong Kong, China. The vessel is managed by Fairmont Shipping Canada Limited, and is currently trading between South America and Northern Ireland, the bulk cargo being coal of different grades. The vessel has a crew of 20, all Philippine nationals recruited through a local crewing agency, and all with varying degrees of previous sea-going experience.

The vessel loaded a cargo of 23,159 tonnes of bulk coal in Barranquilla, Colombia in the middle of March and sailed from there for Londonderry, Northern Ireland, on 21 March 2000. This cargo consisted of two grades of coal:

7,645 tonnes of coal in bulk - 10 x 200 mm
15,514 tonnes of coal in bulk - 0 x 200 mm

The coal was carried in all five holds with No 1 hold containing both grades, 1,890 tonnes of the larger size at the bottom with 1,465 tonnes of the smaller grade on top. This cargo was carried under the terms of a "CONGENBILL" Charter Party, dated 6 December 1999.

1.3 NARRATIVE

1.3.1 On 26/27 March 2000, an intelligence officer boarded *HMS Cottesmore,* a Northern Ireland patrol vessel, and briefed the command on the likelihood of a search being carried out on a vessel which would be going into Londonderry early the following month. This discussion also included the possibility that it would involve army personnel who would require both safety briefs and accommodation.

A few days later, on 31 March, the military authorities confirmed that arrangements should be made to carry out a search of the bulk carrier *Diamond Bulker* on her arrival from South America with a cargo of coal for discharge at Lisahally berth No 3, Londonderry, Northern Ireland.

That meeting, held in Belfast, was attended by representatives of the navy support and boarding team, the marine armed support team, the specialist army search team, and naval intelligence. Various intelligence topics were discussed, including whether or not the holds of the vessel should be searched. The nominated search team leader, a naval officer, who had been involved in ship searches for the previous two years, stated that, in his opinion, items were unlikely to be stowed within a bulk cargo. The reasons for this were: the difficulty of unseen access, the method under which the cargo was discharged, and the likely atmosphere within the holds.

This operation was unusual in that the army was involved. Normally the navy and marines carry out ship searches, with the navy providing the boarding officer, and the marines providing the boat handling and search parties. These ship searches usually cover ferries and small single-hold coasters etc, not large multiple-hold cargo vessels.

1.3.2 On Sunday 2 April, a further meeting was held to confirm that the operation was on, and that men and materials should start to be assembled. The question of whether

or not the holds of the vessel should be searched was discussed with the army staff sergeant leading the specialist search team, who stated that he did not have, readily to hand, SCBA sets necessary for searches in confined spaces, such as ship holds. He did however, say they could be obtained. The availability of suitably trained users of such equipment was not raised, as the discussion concluded that the holds would not be searched unless ventilated first. The extent of pre-planning was limited because the information available was restricted to the knowledge that the vessel was a bulk carrier, that the cargo was coal, and that she had left South America on 21 March. No drawings or details of the vessel were available.

The search party was to consist of a naval search team leader, his deputy, a naval coxswain, a naval intelligence officer responsible for the operation, six marines as a protection party, a royal engineer sergeant as a specialist search advisor, a search team of six army engineers, and a search dog and handler.

The six marines were under the command of a corporal, while the royal engineers search team (REST) consisted of a corporal in charge, two lance corporals and three sappers. One of the lance corporals would act as a scribe during the operation and would be attached to the team leader. The royal engineer specialist search advisor (RESA) was to advise the party on search procedures and the equipment needed after assessing the risks involved.

The search party assembled on board *HMS Cottesmore* in Belfast on Monday 3 April and sailed at about 0800 that day for Londonderry. After departure, an attempt was made to secure an update of the target vessel's arrival, but SNONI were unable to help. The target vessel was expected to reach Lough Foyle, County Londonderry sometime on Tuesday 4 April. The sea was rough during the passage north, causing some of the search team to be seasick. Fortunately, a telephone call to Londonderry Port established that the vessel was not due for another two days, so *HMS Cottesmore* returned to Belfast and disembarked the army personnel.

On Wednesday afternoon 5 April, at about 1400, the army search team reboarded *HMS Cottesmore* in Belfast, with the vessel sailing north again to Lough Foyle later that day. On approaching Lough Foyle, a large vessel at anchor was identified on the radar and assumed to be *Diamond Bulker*. A boarding brief was then held at 1800 which the captain of *HMS Cottesmore* attended, together with the naval search team leader, his deputy, the specialist army staff sergeant, the corporal in charge of the marine support party, intelligence staff and a corporal in charge of the boat section. The intelligence staff gave an overview of the reasons for the search, while the team leader outlined the boarding procedures. Once on board, the search team leader, his deputy, the staff sergeant, the intelligence staff and the scribe would go to the bridge, where the staff sergeant would get plans of the vessel while the scribe took a narrative of events. The dog handler would search the accommodation, while the engineer search team split up and searched the upper deck until the vessel plans were available. The engineer search teams would be given the marine party to assist and to provide close-armed support. The staff sergeant pointed out that his team should carry out any specialist searching, since they carried the necessary equipment. Communications were discussed, and it was agreed that the navy and marines would continue to use their Cougar red spot radios, with the engineers staying with their ordinary Cougar sets.

The navy search team leader, having established that *Diamond Bulker* was likely to move alongside early next morning, decided that the boarding should take place at

night, with the search being completed at, or near, midnight so as to minimise the interference with port operations. The conference then broke up. The staff sergeant then gave an outline operational brief to his search team, together with a warning to be careful of needles, razor blades etc when searching the accommodation. Once contact had been made with *Diamond Bulker*'s master, the boarding would proceed as planned.

1.3.3 At noon on Wednesday 5 April, *Diamond Bulker* was about 91 miles from the port of Londonderry. The weather was moderate with cloudy skies, good visibility, wind southerly force 5 with rough seas. This caused the vessel to roll and pitch moderately. The vessel's speed was about 14 knots with an ETA at the pilot station of 1830. She was off Malin Head at about 1610 with one hour's notice given to the engine room at 1636. The bridge controls were tested at about 1800 and the pilot boarded at 1809. At 1848, the vessel anchored in Lough Foyle, off Moville, and the pilot left at 1900. At 2000, the third officer took over the anchor watch as normal.

At about 2100, *Diamond Bulker*'s master received a brief message via the VHF from *HMS Cottesmore*, saying that a military board and search operation was to be carried out shortly on his vessel, under powers contained within the NI Emergency Provision Act. He was asked to confirm which side the pilot ladder was rigged, and was advised that a search team would be boarding shortly. Soon after that message, at about 2110, three RIBs, containing the military party, appeared alongside *Diamond Bulker* and boarded using the pilot ladder. The first RIB contained the naval search team leader, an army scribe, and a marine support party. The second contained an RN coxswain (deputy leader), army dog handler and dog, the staff sergeant, and the remainder of the marines. The third RIB contained the remainder of the army search team, plus their equipment. The search team totalled 17 men and the dog. The vessel's deck lights were on, providing a reasonable level of illumination on the main deck.

1.3.4 On boarding, the naval search team leader was met by an AB who, on being asked to take them to the master, first checked with the duty officer, the third mate, via his VHF set, that the master was on the bridge. By this time the two other RIBs had arrived alongside, and the remainder of the search team had assembled on board. The specialist search team leader, the army staff sergeant, then quickly briefed his corporal on the initial phase of the search, before joining the naval search team leader, his deputy, and two others, on their way to the bridge. Their first action was to explain the situation to the master to comply with the legal requirements of the NI Emergency Provisions Act 1996, and to arrange the search routine.

This initial phase consisted of the dog and his handler carrying out a general search of the deck, while the army engineers split up into their usual search teams of two, and started to carry out a quick cursory search of the deck and hatch coamings. While the initial deck search was being carried out, the marines carried out a quick search of the forecastle and forecastle stores. During this initial period the army corporal monitored the general situation and guarded the specialist search equipment stacked on deck next to the pilot ladder.

1.3.5 On the bridge, the staff sergeant, having introduced himself to the master, asked for plans of the ship. While these were being obtained he went back down to "A" deck to study one of the General Arrangement plans mounted on one of the accommodation alleyway bulkheads. After a quick study, he returned to the main deck to speak to the corporal regarding the areas to be searched. He found all the

Figure 2

General view of forecastle store
Note open hatch in corner leading down into N°1 hold

teams forward in the forecastle, as well as two marines who had just come out of the forecastle paint store. As they appeared to him to be suffering from the effects of paint fumes, he ordered his army team to get its confined space entry equipment from the boarding point. Having ensured that they were carrying emergency escape kits, as well as safety lamps and oxygen-content test equipment, he went forward again to the forecastle. Just as he got there, he saw one of the marines starting to enter a hatch inside the forecastle. He ordered the marine out, and said that the search was to be conducted by, and under, the direction of the army search team as stated at the pre-boarding briefing and that nobody should enter the holds. This was said in the presence of the two marines and the three army engineers, Corporal Gaulder, Sapper Naivalurua and Sapper Parris.

The staff sergeant then returned to "A" deck with the corporal and one of his team, to show the corporal, using the ship's general arrangement plan, how he wanted the search carried out. The army search team was to be split into its usual two-man teams, with each team being allocated marine guards. One team was to search the engine room before moving upwards into the accommodation, while the other was to search the deck area, starting from the forecastle working aft. The dog handler had a general search brief and was also allocated a marine guard. Bearing in mind the experience of the marine coming out of the paint store, the briefing included a comment that nobody should enter the hold until the staff sergeant was satisfied with the condition of the cargo, and declared it was safe to enter. This briefing was between the corporal and the staff sergeant. The other team member stood a few metres away. Following this briefing, the staff sergeant returned to the bridge, while the other two returned to the main deck and the search team.

1.3.6 On regrouping his search team, the corporal split the party into two teams: one to start in the engine room, the other to continue its work in the forecastle. Two marines were attached to each team to assist as required, and to provide a guard. Of the two remaining marines, one accompanied the dog handler, while the other remained with the corporal.

The search team forward consisted of Sappers Parris and Naivalurua, together with Marines Brunning and McNaught. In addition to their normal army clothing and equipment, Parris carried a pouch containing items such as screwdrivers, pliers etc and a torch, while Naivalurua carried a personal radio tuned to their army network. The two marines were equipped as normal for boarding duties, together with a personal radio tuned to the navy network. The two networks are independent and secure. With both teams briefed, the engine room team went aft, and the forward team went back to resume their search of the forecastle area. The corporal told them that if they felt dizzy when entering a space, they should put on their emergency breathing sets.

On re-entering the forecastle, the team started where it had previously stopped, by the open hatch to the space below. Having overheard the comment the staff sergeant made earlier on specialist searches, when he had ordered Marine Brunning out of the hatch, Sappers Parris and Naivalurua decided that they would start where Brunning had stopped. Both were carrying emergency breathing sets, although Parris did not know how to use one. While one of the marines shone his torch down the hatch, Naivalurua went into the hatch and started climbing down. Naivalurua did not pre-test the atmosphere in the space and, as Parris had not attended a Work in Confined Spaces (WICS) course, he neither understood what

Figure 3

View of entry hatch showing vertical ladder and first platform

Figure 4

Close up of entry hatch to N°1 hold

the procedure was, why it was necessary, nor how his emergency breathing equipment worked. He carried one because Naivalurua did.

1.3.7 Once Naivalurua had entered the space and was a few rungs down, Parris climbed in and also started to move down. After Parris had descended a few rungs, he heard a clang, but could not see anything. Marine McNaught, who was at the top of the hatch and had been shining a torch down the ladder, also heard a thud while he was talking to another of the team in the forecastle. Parris called out to Naivalurua to see if he was all right, and then he, too, lost consciousness, and fell off the ladder. McNaught, who had thought that somebody had slipped, saw a body on top of the cargo and turned away to pass this information on. He then heard another thud. Marine Brunning, who was also by the hatch, had seen Naivalurua reach this first platform and then appear to slip when starting to climb down the second ladder. Just then Parris fell, hitting Naivalurua and causing both of them to fall down on to the next platform. Brunning called out that both men had fallen, whereupon McNaught left the forecastle to tell the corporal about the accident.

Brunning called out to Parris and Naivalurua and, when he received no reply, also rushed out on deck. The corporal, having been told the details of the accident by both McNaught and Brunning, instructed McNaught to get help, while he looked down the hatch to see what he could do. The corporal borrowed a torch from Brunning, and immediately started to enter the hatch; despite a warning from the marine. He managed to get to the first platform, then he too fell. Brunning, who could only see a torch shining upwards, shouted down to the men and, when he again received no reply, rushed out on deck to get help.

1.3.8 Meanwhile, the staff sergeant, having returned to the bridge, told the naval search team leader of his search plans, and questioned the master as to the layout of the ship and the state of the cargo. The master willingly gave all the information requested, as well as stating that the holds needed to be ventilated before they could be entered safely. The master, second officer, third officer, a deck cadet, and an AB were on the bridge at that time. Of the boarding party, the naval search team leader, the staff sergeant, his scribe, and the intelligence officer were present. The coxswain had left to check the numbers aboard with the crew list. The naval search team leader then asked the master to get the crew to open the hatches. The staff sergeant left the bridge, and was making his way down to the forecastle when he met Marine McNaught, who told him about the accident.

The staff sergeant went straight to the forecastle and the access hatch to No 1 hold. Holding a torch, he saw Parris lying on the second platform of the access ladders, with two bodies further down lying on top of the coal. He realised that he could do nothing without the proper equipment, so ran back to the bridge to request SCBA and a helevac for the casualties. This was at about 2205. He then returned to the forecastle, together with a ship's officer, carrying an SCBA set and spare bottle.

After telling the staff sergeant about the accident, Marine McNaught went into the engine room to fetch the marine corporal. Once they were aware of the details, McNaught and the engine room search team immediately went forward to assist as necessary. The RN coxswain, who was also present, accompanied the party forward. En-route, Marine McNaught found Marine Palmer, and after collecting a lifeline, both marines went forward to the forecastle.

Figure 5

General view of N°1 hold looking forward with
forward part of hatch cover in raised position

Figure 6

View inside N°1 hold looking from port to starboard at forward bulkhead
Note bottom of second platform

1.3.9 The staff sergeant was about to put on the SCBA set when the coxswain arrived, together with the rest of the search team. After a quick look down the hold, the coxswain, who was first-aid trained, took the SCBA set and put it on. Marine McNaught, who had arrived with the lifeline, secured it to the coxswain, who then went into the hold and down to the person on one of the landings. After checking him, he shouted up that he was alive and immediately carried out the standard procedure of checking airways, breathing, and pulse (ABC). The low level pressure alarm on the coxswain's SCBA set started to sound, and he had to come back up the ladder and out of the hold.

When *Diamond Bulker*'s master was told about the accident, he went straight to the forecastle. Realising that he could do nothing there, he returned to the bridge where he ordered the ship's second SCBA set to be sent forward. This arrived at the scene shortly afterwards, and the staff sergeant put it on. Directly the coxswain stepped out of the hatch, the staff sergeant took his place. Having rechecked that Parris was still alive, he went back up to the hatch, collected a body line, and returned to tie it round Parris. As he was manoeuvring to do this, the second body, hanging just below, became free and dropped down the last few metres to land on top of the coal. Every time they attempted to pull Parris upwards, the rope slipped round his shoulders. By now the staff sergeant's low air pressure alarm was sounding, and after fixing the emergency air supply mask over his mouth, he had to come back up and get out of the hold. He was, by this time, somewhat affected himself and had to go out on deck to recover. The marine corporal then ran and asked the coxswain, who was also recovering on deck, to call *HMS Cottesmore* and ask for SCBA sets plus an ambu-resuscitor kit. Marine McNaught, in the meantime, had obtained an SCBA set with the spare compressed-air bottle and had entered the hold to continue the rescue attempts. On climbing down, he passed Parris, giving him another emergency air supply on the way, before moving on to recheck Corporal Gaulder and Sapper Naivalurua, whose bodies were lying on top of the coal. Finding no sign of life, he climbed back up to Parris, who still had a faint pulse, and proceeded to give him a further supply of compressed air. He also eased his position by moving his head.

1.3.10 At 2220, the master instructed the ship's crew to open No 1 hatch covers. He followed this by sounding the ship's general alarm at 2225 so that the crew could assist in carrying out any rescue tasks required. When the marine corporal, saw the hatch covers open, he spoke to a number of the crew, and organised them into arranging two rope ladders from the hatch coaming down into the hold. Just at that moment, the extra SCBA sets arrived and both the marine corporal and the marine lance corporal put them on and entered the hold. They saw two casualties lying in a heap on top of the coal at the bottom of the ladder. Both were lying face down, with one man lying on the legs of the other. The man lying over the other, Corporal Gaulder, was pulled clear, turned over and first-aid applied initially by both the marines. Once it was underway, the marine corporal went to the other, Sapper Naivalurua, turned him over and found he had a very weak pulse and shallow breathing.

By this time the coxswain had recovered and, with the hatches then open and the hold ventilated, he climbed in to assess the situation. Various methods of resuscitation were tried on both Corporal Gaulder and Sapper Naivalurua but without any signs of success. Marine McNaught, who was with Sapper Parris, noticed Marine Palmer at the top of the ladder and called to him to get some more air for Parris and to come down and help, as the hold had then been ventilated.

This he did, and between them they cut off Parris's suit and wrapped him in blankets to keep him warm until the paramedics arrived.

They moved Naivalurua on to a stretcher, which they carried into a more open area, and noticed that his pulse had stopped. Both the coxswain and the marine corporal applied mouth to mouth and CPR, while at the same time getting the stretcher on to a cargo net ready to lift it clear of the hold. Naivalurua was then lifted clear and placed on the deck; still on the stretcher. This was at about 2250. The marine corporal continued the resuscitation, together with a member of the first-aid party from *HMS Cottesmore*. Marine Thorne had continued to try to revive Corporal Gaulder, but when the coxswain and the marine corporal went to assist, they found he was not breathing, and that fluid was seeping from his nose. They quickly manoeuvred him into a cargo net and he, too, was lifted out of the hold and laid on to the deck where resuscitation attempts continued. The time was approximately 2303. They continued to try to revive Corporal Gaulder until the paramedic team arrived on board at about 2355. Shortly after this, the two casualties on deck were pronounced dead, and all resuscitation attempts stopped.

1.3.11 Parris, who was slowly recovering consciousness and was being attended to by the marine corporal and Marines McNaught and Palmer, was left in position until the paramedics arrived. The requested medivac helicopter arrived at 2400. About 10 minutes later the paramedics were satisfied Parris was fit to be moved, so they placed him on a stretcher and lifted him out of the hold on to the deck. At 0019, the helicopter lifted off, and took Parris to the local hospital for further treatment.

When not in the hold, the coxswain continued to update the naval search team leader on the bridge about the extent of the casualties, and what outside help would be required. He informed *HMS Cottesmore*'s commanding officer, who, in turn, organised the assistance required.

At 0205, the bodies of the two casualties were removed from the ship. The vessel remained at anchor until 0545, when the steering gear and bridge equipment was tested in readiness for the pilot to board, and for the vessel to proceed to her berth. At about 0815, the pilot boarded and the vessel moved upriver towards her berth at No 3 berth Lisahally. She was secured alongside at 0943 with the agent and the stevedores boarding at 1120; cargo discharge started from No 2 hold at 1135.

1.4 VESSEL CERTIFICATION

At the time of the incident, *Diamond Bulker* was fully in class, with all statutory survey certificates valid. She was manned by experienced and certificated officers.

She carried two sets of SCBA, plus two spare compressed air cylinders for each set. Both sets were manufactured by Sabre. Both SCBA sets, together with three of the four spare compressed air bottles, had been sent ashore in the USA in November 1999 for an annual equipment check, and for the three bottles to be refilled. They were returned on board on 5 November 1999.

The fireman's checklist, completed every month by the third officer, shows that all six bottles were checked regularly and, in March 2000, the air pressure within the bottles ranged from full to a minimum of 150 kg/cm^2 (70% capacity). At the time of

the accident, each of the SCBA sets had a 150 kg/cm^2 bottle fitted, ie at least 70% or something in the order of 20 minutes' use time.

During the accident, both SCBA sets were carried forward, together with two spare air bottles. Following the accident, three air bottles were sent ashore for recharging; the other three remaining full and ready for use. The April checklist records this and states that on departure from Londonderry all six bottles were charged ready for use.

1.5 CREW PARTICULARS

1.5.1 The vessel was sailing with a crew of 20, consisting of the following:

Deck	Engine
Master	Chief Engineer
Chief Mate	First Assistant Engineer
Second mate	Second Assistant Engineer
Third mate	Third Assistant Engineer
Bosun	Electrical Engineer
AB	Oiler
AB	Motorman
Cadet	Cadet
Cadet	Cadet
Cadet	
Cook	

All crewmembers were Philippine nationals.

1.6 DESCRIPTION OF VESSEL

Diamond Bulker is a steel bulk cargo vessel with accommodation and engine room aft. She has five holds, numbered forward to aft, each fitted with a steel two-part, centre hinged, hatch cover, opened and shut hydraulically using local controls. She is fitted with four 30.5t SWL pedestal deck cranes, each hold being plumbed by one or more of the cranes.

She has a raised forecastle and poop deck with accommodation aft covering four decks. The forecastle contains a paint locker, bosun's store, and a general storage area. Also inside the forecastle is an access hatch to the forward starboard end of No 1 hold. Access to the forecastle is through two steel weathertight doors, recessed into the forecastle; one on the starboard side and one on the port side.

No 1 hold has a total grain capacity of 5319.76m^3 (including the hatchway) with approximate dimensions of:

Width (mean)	=	21.4m
Length	=	17.2m
Depth	=	13.6m

1.7 ROYAL NAVY INVOLVEMENT AND TRAINING

1.7.1 The naval vessel involved in this operation, *HMS Cottesmore*, is based at Faslane on the Clyde, but operates as a patrol vessel for Northern Ireland. Before taking up her duties, she was refitted during 1997 at which time the ship's company attended a course on the complexities and dangers associated with Northern Ireland. In addition, a number of the company, including the coxswain involved in this incident, attended a week's course in search awareness at the army National Search Centre, Rochester.

Procedures for carrying out stop and search operations on merchant shipping in Northern Ireland have been in force for some years, although the majority of the searches have concentrated on ferries and small coasters. In these operations the boarding party were usually made up of marines who checked the contents of lorries while discussions were held with the drivers over details of their journeys. Actual ship and hold searches were rarely carried out, due to the limited time available. Most of these searches were performed in sheltered river and estuary areas while the vessel was approaching the port or terminal.

1.7.2 The naval search team leader had been involved in ship searches for the previous two years, and, therefore, had some experience of the problems likely to be encountered. He had attended a two-week course for Unit Search Advisors at the National Search Centre, Rochester, in 1996 and had acted as SNONI's Search Advisor for 12 months, closely liaising with the army in all maritime search matters. He had paired the Royal Engineer Search Team with the Royal Marines, not only for close protection, but also because the Royal Marine detachment was more familiar with the maritime search environment. It was hoped that this pairing would generate mutual support and a pooling of knowledge. His primary objective was to ensure that the operation went smoothly, that all legal requirements were complied with, and that the appointed scribe recorded the detail. Communication between the naval and marine parties was maintained using their secure network. The naval search team leader and his deputy, the coxswain, each had a radio, and the army scribe had a radio tuned in to the secure army network.

It was also his intention that the operation should not interfere unduly with the normal commercial operation of the vessel and port. It was this consideration, and the fact that the vessel arrived late, that influenced the decision to carry out the search operation at night while *Diamond Bulker* was at anchor in Lough Foyle.

1.7.3 Although aware that there were set procedures for entering confined spaces, it was not envisaged that any of the navy or marine personnel would be involved in such events, as a specialised army search time was responsible for undertaking the actual search. Both the naval search team leader and his coxswain had received training in using breathing apparatus, but neither was trained in confined space entry procedures. They were familiar with the emergency air breathing sets, as they form part of the ship's standard equipment. These, however, would not be part of the normal equipment carried during boarding operations.

The normal ship search routines practised covered general public areas and private cabins, as well as service spaces, but did not involve any in-depth searches. As stated earlier, this was due to the limited search time available.

1.7.4 During the MAIB visit to *HMS Neptune*, Faslane, the home base of *HMS Cottesmore,* the naval search team leader was interviewed, and expressed his view of the operation. He reaffirmed that, although the question of hold searches was raised and discussed at the operational planning meetings, it was decided that holds should not be searched unless ventilated, and then only if there was sufficient time available. He intended to finish the search at, or about, midnight so as not to interfere with the projected docking. His recollection is that while on the bridge, the staff sergeant said that he would set up two search parties; one forward, covering the fore part of the vessel, forecastle stores etc, working aft along the main deck, while the second would start from the engine room and work upwards to the main deck. Both parties would then meet and search the accommodation. This operation was estimated to take about two hours. On the staff sergeant's return to the bridge, after briefing the search teams, he said that he had needed to stop a marine from entering the holds while he was briefing the team. He then asked if the holds were to be searched and was told yes, if there was time, but that they would need to be ventilated first. As the sergeant left to brief his men, he met the marine, who told him that there had been accident.

The coxswain confirmed various points when the MAIB inspector conducting the investigation telephoned him. These included the composition of the crew in the RIBs. He also commented that, when he was in the forecastle, one of the ship's two SCBA sets brought forward had an empty air bottle, while the other had only 3 or 4 minutes worth of air left in it.

1.8 ROYAL MARINE INVOLVEMENT AND TRAINING

1.8.1 The marine commandos involved in this operation are normally based in Belfast, and are under the command of the senior naval officer at Moscow Naval Base, Belfast. Their duties include board and search operations in conjunction with the navy.

As stated earlier, these searches are usually on ferries and small coastal craft, and involve a cursory check of vehicles, their contents, and general discussions with the drivers as to their destination, and where they have come from. Their searches follow the pattern generally used by the navy in Northern Ireland.

In this particular operation, it was intended that their duty was to provide close-armed protection to the specialised army search team, and to assist where necessary. They were not to become involved in the search routine, unless they were asked to do so by the army search team. A boarding briefing was given during the early evening of 5 April after arrival in Lough Foyle and attended by, among others, the naval search team leader, the royal engineer search advisor, the corporal in charge of the marines, the naval intelligence officer and the coxswain. At this meeting, although most of those present understood that the marines were to "provide protection and assist the royal engineers", the marines themselves were under the impression that the royal engineers were there to augment the marines' own search capability. They would carry out their normal cursory search routine and indicate to the specialists any areas that warranted closer inspection.

1.8.2 Search Training

The three-day search training course undertaken by marines is conducted at *HMS Cambridge,* Plymouth. The marines are introduced to the general requirements of boarding and search operations, as well as background knowledge on the legal status and necessary documentation. Lectures are given on health and safety issues, including safe systems of work, search requirements in enclosed and/or confined spaces etc. The dangers of various cargoes likely to be met during merchant vessel searches are addressed, with reference being made to information available in ship documents. This includes various IMO *Codes of Safe Practice* as well as IMO *International Maritime Dangerous Goods Code (IMDG)* books likely to be found on the bridge. Practical training is given in search procedures on vessels. The training highlights specific dangers relating to ship service and accommodation areas. This includes an awareness of fire-fighting and lifesaving equipment carried, and associated inspection problems.

The marines are not trained in any specialist search and handling procedures. They are given outline instruction on the layout of various merchant vessels. The emphasis is to treat all merchant vessels as a variation on a theme, that is, all ships have basically the same layout.

Although there are lectures on the procedures and routines involved in entry into enclosed spaces, no specific training on SCBA sets is given. If, during searches, the marines encounter what could be a defined enclosed space, the atmosphere should be tested first, using a gas detector set. If it is registered as dangerous, they do not enter. The marines do not carry emergency breathing kits. If there is any doubt about conditions within a space, they do not enter, but arrange for either the crew to make the space safe, or for a specialist team to attend.

Instruction on dress and equipment required for board and search routines is given, together with advice as to what should be selected when operating in different areas of the world. During searches each pair of marines carries a Cougar red spot radio tuned in to a secure network. This network is common to the rest of the marine party and, in this case, to the navy. This enables each pair to maintain contact with each other, as well as with the command. In this operation, the network is also capable of being monitored by the parent vessel, *HMS Cottesmore.* The normal dress worn does not include any form of harness or lifting point - the official view is that in the event of any difficulty there will be sufficient items of equipment on board the vessel to provide a rescue harness.

The instructors at *HMS Cambridge* acknowledged that one of the weaknesses in marine training is that they have neither sufficient time nor actual ships on which to carry out practical exercises. Within the foreseeable future, the current training school is to be relocated to another naval base, from which easy access to a variety of merchant shipping can be obtained. It is not clear if this move will include additional course time, and a review of the course content.

All the marines involved in this operation had attended the *HMS Cambridge* course and, with their previous experience of search operations on small coasters and ferries in Northern Ireland, could be considered as relatively well-versed in board and search routines.

1.9 ROYAL ENGINEER INVOLVEMENT AND TRAINING

1.9.1 Basic Training

The royal engineers involved in this operation are based at Antrim, Northern Ireland, and are part of 51 Field Squadron; a troop specialising in searching for illegal weapons, munitions, and radio equipment. All members undergo a standard basic training, which last about four months. This consists of two, two-week training courses in search techniques, plus a further four weeks on a specialist detail concerning Northern Ireland.

Each engineer's (or sapper, as he is known) training covers route, body, buildings (occupied and unoccupied), vehicle, rail-line, and venue searches. There is no specific training in ship searches.

The search team involved with *Diamond Bulker* attended the Northern Ireland search course at the National Search Centre, Rochester from 18 to 29 October 1999. Successful completion of this course allows an individual to participate in searches for a period of three years, provided they are involved in searches, or undergo continuation training, at least every four months.

Sapper Parris, the only one who survived in the hold, had been involved in five search operations in Northern Ireland since January 2000. None of these involved ship searches or entry into confined spaces.

1.9.2 Work in Confined Spaces (WICS)

Corporal Gaulder who led the team both during their basic specialist search course, and on the *Diamond Bulker* search, had also attended a four-day working-in-confined-spaces course for both "Authorised Persons" (AP's) and "Authorised Entrants" (AE's) held at Rochester from 2 to 5 November 1999. The certificate which he obtained was valid for two years. (AE's are qualified to enter a confined space but only AP's can give permission to do so).

This WICS course identifies five categories, or CAT's as they are known, of confined spaces, all based on buildings or sewage systems. Each CAT refers to flooding, with only CAT 4 referring to the use of gas monitors. All refer to the use of a rescue winch, implying that each person in the WICS team will be wearing a rescue harness, to which a lifting wire can be connected. Even the lowest level of WICS category (CAT 1) states that two WICS-trained staff are required in addition to the supervisor. Among the equipment with which the WICS staff are made familiar is the emergency breathing apparatus (EBA) and a gas monitor. There is no reference within the course to the kind of chemicals and substances which might be stored in buildings, or their degree of toxicity and care required when handling. When questioned by the MAIB inspector, staff members said that, in the event that they were asked to search, say, a chemical factory, they would seek the guidance of a professional chemist.

Of the five CATs, the standard equipment that has to be available for the lowest category, CAT 1, is:

1 x mobile telephone
1 x gas detector
1 x escape breathing apparatus (EBA)
1 x tripod and winch
1 x intrinsically safe torch
1 x full body harness (escape)
1 x personal protective equipment (PPE)
1 x manhole lifting equipment

There is also a requirement for each member of a WICS team likely to enter a confined space to carry:

1 x gas detector
1 x escape breathing apparatus (EBA)
1 x intrinsically safe torch

The 25 Engineer' Regimental Operating Instruction 3-16, *Work in Confined Spaces (WICS)*, defines a confined space, and states what equipment should be available for each category. It also states under "Concept of Operations":

Once the WICS team has been tasked, it is to deploy to site with necessary personnel and equipment according to the category given in the tasking. Once on site, the team is to ventilate the confined space as much as possible and the supervisor is to test the atmosphere in the confined space with a Gas Detector and visually confirm that the category of the confined space is correct.

Once the category of the confined space has been confirmed the supervisor informs the emergency services that he is about to enter a confined space and the team completes the task according to the Standard Operating Procedures (SOPs) detailed in this RO1.

Under the heading of "Co-ordinating Instructions" it states:

Tasking To avoid confusion over which category a confined space belongs to, the WICS team should be bid for by WICS aware staff only. RESAs should be available to units for advice on the category system. All WICS taskings should come from HQNI and should be cleared through the Regimental Ops centre.

There is nothing in the Regimental Order suggesting that before any category decision is reached, particularly in the case of ship searches, an investigation should be made into what the space is used for, what is normally carried in it, and what is currently being carried or stored in it.

Of Corporal Gaulder's search team, he was qualified as an "Authorised Person" with only Sappers King and Naivalurua qualified as " Authorised Entrants". Nobody else had completed the WICS course.

1.9.3 Operational Guidelines

The army issues a fairly comprehensive manual of guidance on search operations which covers not only the legality of such operations, but also the safety of personnel. Advice on minimising the disruption to normal life, as well as security, resources, costs and the value of the operation, together with the desirability of

carrying out the operation in daylight, are all considered. The main essence of the guidance document is that all operations require and need good planning prior to the start, with all actions recorded and correctly noted.

One particular point made in the document is:

Communications. Effective communications between all agencies participating in the operation are essential. The problems of radio compatibility etc may require special consideration in joint military and police operations and when other civil agencies are involved.

Within the section covering the information considered necessary to formulate a search operation is a reference to:

Extraordinary features. Extraordinary features which cannot be searched without specialist assistance e.g. ponds, slurry pits, sewers, farm complexes, industrial and technical installations and equipment, storage and enclosed areas.

Also contained within this manual under the heading of "ORDERS" is a particularly relevant section stating:

CTS Orders. CTS orders follow the standard military operation order format and sequence. They are usually given orally and may be followed by written confirmatory orders. Specialists brought in for particular operations are unlikely to have intimate knowledge of the local area so may need additional briefing.

A further significant section within the manual is:

Need. CTS procedures and equipment are evolutionary and are developed to match changes in the threat. These developments can only be successful if they are founded on a sound base of both the terrorists' and the security forces' procedures, techniques and equipment. This data should be passed up and down the CTS chain of command and sideways between the police, military, research, and training establishments etc. The requirement is to enable:

a. Search teams to operate with up to date equipment and procedures.
b. Shortcomings in procedures and equipment found on operations to be addressed promptly.
c. Operational CTS resources to be used effectively.
d. Research effort to be targeted at areas of greatest need.
e. Training to be up to date.

An additional document made available to the MAIB, dated June 2000, and identified as *Annex A to NSC 07.9*, includes a section 0577 which reads:

Trains, aeroplanes and ships. If a detailed search of a large vehicle such as a train, aeroplane or ship is necessary, it must be individually and carefully planned. The search advisor should combine the principles of vehicle and venue search, in order to devise a logical sequence that ensures nothing is missed. An appropriate expert, usually an engineer with experience of the vehicle concerned, should be used as a guide and to gain access to sealed and mechanical areas. Further notes on the search of aircraft and ships are contained in Annex 1, Appendices 1 and 2.

Note: Appendix 2 to Annex I - Notes on the Search of Ships. Not yet produced.

1.9.4 Both the staff sergeant and Sapper Parris were interviewed, and were able to contribute usefully to the investigation.

Sapper Parris said that he had not attended a WICS course and had never been involved in a ship search nor, apart from the Royal Navy ship that took them to *Diamond Bulker,* ever been on such a large vessel. He had no prior knowledge of the vessel before boarding, other than her name and that she carried coal. He also said that when Naivalurua and he were standing by the open hatch, both assumed that they were to search that space. At the time he was sure that he was not aware that it would lead into the hold - it was just a space.

The staff sergeant confirmed that the squadron had sent 39 people on the search course, five teams of six men each, with the remainder attending part of the time while attending other refresher courses. The ideal was that everybody underwent WICS training, but an operational command decision was made that only two men out of each search team should be trained as AE's. All team members were "WICS aware", as this was part of their basic search team training, but normally only two would receive further training in confined space searching.

After the final briefing, and before the search team boarded the RIBs, a signal was sent to HQ requesting permission to carry out the search. This is standard procedure. Permission was granted and preparations went ahead as planned.

Selection of the kit to be carried is based on a combination of experience and risk assessment. Originally, as the holds were not to be searched, breathing apparatus was not going to be carried. The staff sergeant decided, however, that if they were to carry gas monitors, it would be as well to carry a couple of WICS sets, just in case. Two intrinsically safe torches were also added. No SCBA sets were included, as it had been decided earlier that the holds would not be entered unless ventilated. It was his assessment, based on available information, that he would be working up to a Category 1 WICS team level.

1.9.5 The MAIB inspector visited the National Search Centre, Rochester, where discussions were held with the training team regarding the accident, its causes, and what training was available to personnel likely to be involved in ship searches.

It soon became apparent that the training staff had virtually no knowledge of the incident, other than knowing the members of the team involved. They had no idea of the size of *Diamond Bulker*, the time needed to carry out searches, or indeed any concept of the dangers likely to be met in searching a merchant vessel. When asked to become involved in ship searches, their approach was to use the same criteria as that developed over the years for searching buildings. This is reflected in the answer the MAIB received in response to that very question:

The organisation and control of a marine search is based on military teaching of Mission Command and the principles, procedures and techniques laid down in Reference B. There is likely to be an Operational Commander, controlling the whole operation and a Royal Engineer Search Advisor (RESA), controlling the search phase of the op.

The RESA will determine procedure for safe working as dictated by his search estimate. (planning procedures)

This reference B relates to *ME Vol 2 Pam 6A Counter Terrorist Search* dated 1993 - a standard army training manual used by the National Search Centre for training army search teams.

Similarly, the initial comment, when asked how the search would be conducted, indicated that they would expect to be able to obtain plans of the vessel, preferably before her arrival, together with details of her cargo. Their approach to the possibility of a dangerous cargo being on board, was to state that they would ask an appropriate authority about the dangers, and then plan accordingly. They had no information as to what constituted a dangerous cargo, no knowledge of the existence of the *IMDG Code* issued by IMO, or the standard IMO *Code of Safe Practice for Bulk Cargoes.*

When asked what experience of ships in general do search teams, and particularly their leader, obtain prior to undertaking ship searches, they stated that:

Currently RESA/REST(NI) receive no practical training in marine search. Reference B, para's 0577 and 0657, shown in Annex A, direct RESAs to use/consult an expert.

1.10 THE CARGO AND ITS CARRIAGE

1.10.1 As stated earlier, the coal cargo carried on *Diamond Bulker* was:

7,645 tonnes of coal in bulk - 10 x 200 mm
15,514 tonnes of coal in bulk - 0 x 200 mm

It was loaded in bulk in Barranquilla, Colombia, for discharge in Londonderry, Northern Ireland. No additional advice or details were supplied to the vessel regarding carriage conditions. Presumably it was assumed that she would observe the carriage conditions as contained in the IMO *Code of Safe Practice for Bulk Cargoes.* In Appendix B, under Properties and Characteristics, paragraph two, states:

Coals may be subject to oxidation, leading to depletion of oxygen and an increase in carbon monoxide in the cargo space (see also section 3 and appendix F)

The reference to Section 3 relates to the safety of personnel and ship, and makes the point that the shipper should inform the master, prior to loading, if any chemical hazards exist with the cargo. In this case the master stated that no unusual hazard was identified. Appendix F relates to the use of an "Enclosed Space Entry Permit" system.

1.10.2 Under "General requirements for all coals," the code recommends the following:

Section 3.5
The ship should carry on board the self-contained breathing apparatus required by SOLAS regulation II-2/17. The self-contained breathing apparatus should be worn only by personnel trained in its use (see also section 3 and appendix F).

Section 3.9
The atmosphere in the space above the cargo in each cargo space should be regularly monitored for the presence of methane, oxygen, and carbon monoxide. Records of these readings should be maintained. The frequency of the testing should depend upon the information provided by the shipper and the information obtained through the analysis of the atmosphere in the cargo space.

1.10.3 The SOLAS II-2/17 referred to above, describe an approved type and capacity of a self-contained breathing apparatus required to be carried on board. This states:

A self-contained compressed air operated breathing apparatus, the volume of air contained in the cylinders of which shall be at least 1,200 litres or other self-contained breathing apparatus which shall be capable of functioning for at least 30 minutes. A number of spare charges, suitable for use with the apparatus provided, shall be available on board to the satisfaction of the Administration.

The same chapter contains a requirement that the equipment shall be stored as to be easily accessible and ready for use.

1.11 ENVIRONMENTAL CONDITIONS WITHIN THE HOLDS

1.11.1 When the MAIB received notification of the accident, it arranged for a staff member of the Industrial Research and Technology Unit (IRTU), an agency of the Northern Ireland Department of Enterprise Trade and Investment, to attend on-site to carry out environmental tests. The brief was to investigate the atmospheric conditions in the sealed No 5 hold prior to ventilation, and for a chemical analysis of coal samples from No 2 and No 5 holds, with a view to establishing if similar atmospheres had existed in each.

No 5 hold cargo sampling point cover was unscrewed, and an air sampling tube lowered 2 to 3 metres into the hold atmosphere. Oxygen, carbon monoxide, hydrogen sulphide, and explosive gas levels were measured using a calibrated gas surveyor portable gas meter. Volatile organic compound (VOC) measurements were also taken using a PID/VOC meter. A qualitative examination of the atmosphere for carbon monoxide was carried out using Dräger tubes.

Samples were taken from the surface of the coal cargo in holds No 1 and 5 for chemical analysis and examination.

1.11.2 The gas readings recorded in No 5 hold were as follows:

Gas Parameter	Result
Oxygen	13.1%
Carbon Dioxide (Qualitative result)	> 1%
Hydrogen Sulphide	< 5 ppm
Carbon Monoxide	15 ppm
Volatile Organic Compounds (VOC's)	< 2 ppm
Lower Explosive Limit (LEL)	< 1%

These readings resulted in IRTU concluding:

The results of the atmospheric monitoring in cargo hold No 5 indicated that oxygen depletion had taken place with elevated levels of carbon dioxide prevailing. There were trace amounts of carbon monoxide but these are not considered significant. There was no evidence of hydrogen sulphide or volatile organic compounds (VOC's) in the atmosphere. The atmosphere was not explosive in nature.

The minimum permissible oxygen level is 19.5%. Between 8-10%, mental failure, fainting, unconsciousness, ashen face, blueness of lips, nausea and vomiting occur.

1.11.3 When *Diamond Bulker* revisited Londonderry in June, again with a cargo of coal, the chemist revisited the vessel, and carried out a series of gas checks before any hold was opened. These gave the following results:

Hold No	Carbon Dioxide %	Oxygen %
1	0.8	14.4
2	0.2	17.7
3	0.1	17.3
4	0.7	10.1
5	1.9	8.8

The report goes on to discuss the readings and concludes with the following statement:

It should be noted that the precise oxygen and carbon dioxide levels measured in cargo hold No 1 on 27 June 2000 cannot be directly equated to those levels which were in the confined space where the fatalities occurred. The overall readings however demonstrate that in all the cargo holds, oxygen depletion and carbon dioxide generation took place in varying degrees, during the shipment of coal from Colombia to Londonderry in Northern Ireland.

1.12 RESCUE AND RETRIEVAL ACTIONS

1.12.1 When the accident was reported to the bridge, the coxswain who, at the time, was close to the engine room entrance, immediately went forward to the forecastle. After a quick look down the hatch to confirm the situation, he went out on deck to use his radio to tell both the naval search team leader and *HMS Cottesmore* that a helicopter evacuation was needed, and that three of the army search team had been seriously injured and required hospital treatment. The naval search team leader on the bridge, having been updated by the coxswain, continued to liaise with *HMS Cottesmore* regarding what rescue and medical facilities would be required, and what was available.

When *Diamond Bulker*'s master was told of the accident, he ordered the SCBA sets to be taken forward. Once aware of what was required, the general alarm was sounded and the crew directed to assist as required. No 1 crane was activated, and the hatch cover on No 1 hold opened. Other crew members provided blankets, ladders and cargo lights, as the rescue attempts gathered pace. The navy advised that the master and crew were at all times co-operative, and assisted as required.

Once aware of the accident, the navy operations room, Belfast, notified the police, ambulance service, and the fire service. They responded by mobilising their rescue and incident teams, and started to make their way towards Magilligan Point; considered to be the most suitable embarkation point for transfer by boat to *Diamond Bulker.* MRSC Belfast, part of the civilian Maritime and Coastguard Agency, who normally become involved in maritime accidents at an early stage, became aware of the accident while monitoring the emergency frequencies. Their first indication of any problem was a message, timed at 2246, advising that a helicopter from RCC Kinross, R177, had been tasked from Prestwick to evacuate three naval personnel from *Diamond Bulker* at anchor in Lough Foyle.

1.12.2 MRSC Belfast's operational capacity was geared to maritime incidents, whereas the military were not. Any indiscriminate intervention had the potential to cause confusion and uncertainty. They therefore chose to offer their assistance, and respond to positive requests accordingly. With little information available, MRSC discreetly questioned Navy Ops in Moscow Camp, Belfast, who eventually confirmed that they were co-ordinating the incident responses and were then more open about what was required.

Communication traffic between the helicopter, R177, the RUC, Altnagelvin Hospital, and the navy on board *Diamond Bulker* continued from 2258, when various parts of the emergency system were activated and brought into play. The RUC resource was called at 2323, the fire resource at 2339, the coastguard Castlerock resource at 2348 (arriving on scene at 0023), the ambulance resource at 2339 and the Portrush lifeboat at 0002 (arriving on scene at 0121).

At 2351, R177 advised that she would be establishing contact details with the vessel shortly, confirming at 2353 that she would be over the site in five minutes. R177 arrived off the vessel at 2359, and was in direct contact with the naval boarding officer. At 0008, the helicopter landed a medic on *Diamond Bulker* with the casualty (Sapper Parris) being lifted off at about 0019.

At 2325, the emergency services originally tasked and assembled at Magilligan Point, were partially stood down. Some units started to pack up ready to return to their stations. At 0054 the lifeboat was released with the Castlerock Coastguard unit standing-down at 0101. At 0142, the two bodies, together with police and ambulance personnel, came ashore in RIBs. By 0211, all fire and ambulance personnel and equipment had left Magilligan Point.

1.12.3 Subsequent to this operation, a meeting was held between the MOD liaison officer, members of SNONI's navy operations team the fire service and MRSC Belfast. Given that MRSC Belfast are SAR professionals, it was agreed that in the event of similar situations of this type in the future, navy operations would retain co-ordination, but MRSC would take an active role in co-ordinating civilian and declared SAR resources on their behalf.

It was also agreed that if navy operations required a multi-emergency services response, it could be initiated by a single call to the MRSC Belfast. They, in turn, will activate their emergency planning room and request liaison officers from the other emergency services and from navy operations. A formal chain of action and command has now been issued to that effect.

1.12.4 One point of concern which will have a serious impact on rescue actions within Northern Ireland, is the loss of the military search and rescue helicopters based in Belfast.

Currently, the coastguard relies on the goodwill and availability of these military Wessex helicopters for a quick response in emergency situations. The major drawback is that, apart from the obvious primary demands of the military, none of the helicopters are fitted for night flying, not all carry winch equipment, and they have limitations in their lifting capability. Furthermore, they are due to be phased out on 31 March 2002 as they will have reached the end of their service life.

With the departure of this helicopter squadron, the nearest helicopter base is RNAS Prestwick or RAF Valley in Anglesey. Both of these squadrons have helicopters fitted for SAR but, due to their GB base, the shortest flying time to Northern Ireland in good conditions is about one hour.

This lack of locally declared SAR helicopter coverage in a populated area close to a vibrant marine community, as well as its proximity to international shipping lanes, is likely to have a significant impact on the future rescue capability of MRSC Belfast. In this particular incident, the first moves to organise an urgent request for a helicopter were made at about 2205, with the Prestwick-based helicopter eventually arriving at 2400. Bearing in mind that this incident occurred in protected waters, with the ship at anchor and within a mile of a shore with landing and road transport facilities, it illustrates the disadvantages of not having the close support of locally-based SAR helicopters.

1.13 COMMENTS BY SERVING OFFICERS AND MEN

1.13.1 Although difficulty was experienced in making contact with the marine party, due to their operational commitments, one comment made was that the boots worn by the army personnel during the search were too large, and not flexible enough for climbing vertical steel ladders on ships. A more flexible type like those used by marines would be more suitable for climbing ladders, and moving about on steel decks and structure. The MAIB was advised that the footwear worn by the army search team during the incident was part of an "all in one" rubber suit issued to them by the Royal Navy.

1.13.2 One view expressed was that if ship searches are to be included in the training curriculum of the National Search Centre, Rochester, then the management structure requires modification. No representatives of the navy, customs and excise, or other marine anti-terrorist units are currently involved in the training management, and, for specialist search team training in ship searches to be undertaken, their input is necessary. All these organisations have current experience of the complexity of shipping and are in a position to make significant contributions to both the basic training and specialised courses.

SECTION 2 - ANALYSIS

2.1 THE STATE OF THE VESSEL

2.1.1 Prior to the boarding, an anchor watch was being kept on *Diamond Bulker*, but the majority of the crew were watching television in the crew's mess. All hatches were closed, and had been since departure from Colombia on 21 March. The deck lights were on, and the main engine was on stand-by for the vessel moving alongside during the following morning. *Diamond Bulker* was following a normal anchorage routine, with the crew resting while waiting for a projected move alongside the following morning.

2.1.2 As per national and IMO requirements, she carried two SCBA sets together with a minimum of two spare compressed air cylinders. The condition of these SCBA sets in November 1999 is known from documentation on board. Their condition at the time of the accident has been recorded by the military staff as being poor - one bottle empty and another with only 3 to 4 minutes of air left in it.

These comments are contrary to the bottle condition as recorded in the vessel's March 2000 checklist. Here they are stated to be between 70-100% full. There is no obvious reason for this discrepancy other than to say that, under the stress of the moment, loose face masks, heavy demand due to the exertions, and time lapses may offer a possible explanation. It should be said that, even if all the air bottles had been fully charged, it is unlikely that the two deceased people could have been saved.

The upkeep of emergency equipment is vital for the safety of crew members, and the officer in charge of the SCBA sets appears to have maintained an acceptable standard of maintenance. As mentioned earlier, with only three bottles being sent ashore for re-charging in Londonderry, it is possible that, in the confusion, the presence of full spare bottles was overlooked.

2.1.3 Another aspect contained within the IMO *Code of Safe Practice for Solid Bulk Cargoes* is the recommendation that the atmosphere within the holds should be regularly monitored, and the reading recorded. When the master was asked if such readings were taken, he stated that none were, as he had not been advised that the coal was in any way likely to have a chemical reaction.

He was aware that there was likely to be an oxygen deficiency, as well as a carbon dioxide atmosphere within the holds, and that they would require venting before entry. His crew were aware of this and would not enter the holds without the correct equipment, or unless proper precautions had been taken. The master states that the reason no moisture or CO_2 readings were taken during the voyage was that the weather was so bad that he felt it was unsafe for the crew to go on deck to take readings from the cargo holds.

Monitoring of these cargoes is recommended by IMO, as there exists the possibility that the actual carriage conditions of the cargo may differ from what the master expects. Not only is it a safe precaution, but it also provides an opportunity to train and test both crew and equipment.

2.2 SEARCH PROCEDURES

2.2.1 The search procedures under which this specialist army search team carried out its duties were, and remain, based on building and groundwork searches. No special training is offered, or guidance given on ship searches.

It was apparent that the staff sergeant and his team had no concept of the size of the vessel or difficulties they were likely to meet when carrying out an operation on a merchant vessel. The standard army search procedures refer to obtaining a plan of the building to be searched during the planning stage, a procedure that could not be followed on this vessel. Plans of vessels can usually only be obtained from the owners, and even then they may not be readily available. In the case of foreign-registered vessels, probably not for a few days. Given that searches are supposedly snap decisions based on recent intelligence, approaches to owners are out of the question, even from a time point of view. Plans are available on board, but to interpret them into a sensible, time-based, search routine requires a level of pre-knowledge of the type of vessel; something that the army does not currently have.

To release a search team into a situation without adequate training and safety information is dangerous and inexcusable. The staff sergeant in charge of this specialist search team was placed in a situation that was not of his making. He had received no previous training in the searching of ships, certainly not of large bulk carriers, and although told that the cargo was coal and therefore unlikely to be an area used for contraband, did not have the detailed background information to readily appreciate the dangers associated with the cargo, nor what equipment was likely to be needed. The sergeant treated the level of risk as a Category 1 and, even then, did not carry with him all the equipment recommended for that level of risk. This might have been influenced by the security information given as to the reason for the search, plus an expectation that rescue equipment would be available on board the vessel. The one item that should have been taken was a full body harness. Neither the army search team, nor the marines were carrying or wearing any harness or clothing fitted with a lifting point. It was suggested that it was always possible to rig a lifting sling using ropes, fire hoses etc. This may be true but when speed is essential and the space has a difficult access, a secure attachment point on clothing, or a harness, can be a life saver.

During the search briefing carried out on 2 April, the question of searching the holds was discussed and a decision made that if they were to be searched, it would be done after the holds had been ventilated. As the staff sergeant did not have SCBA sets readily available, nor more than three men trained in their use, this was a sensible decision. It does, however, raise the question as to how thoroughly the pre-planning of this operation had been carried out. By the time the staff sergeant became involved, his senior officers had already committed him to the task. As RESA he was required to prepare a search estimate and form a safe operational plan of work. Given his lack of experience in ships and their dangers, with no ship plans or details of the cargo available, he was in an impossible situation. It did not help that with the pre-boarding briefing taking place on a Sunday, the equipment stores were closed. The rationale behind the decision to commit a specialist army search team to undertake an operation in an environment totally alien to it, and without any training or technical support, is difficult to understand or support.

Furthermore, the standard of operational pre-planning in this exercise was poor. The boarding party which embarked on *HMS Cottesmore* was transported to Lough Foyle

and found no *Diamond Bulker*. They asked the harbourmaster where she was, and were told that she had been delayed due to bad weather. They were also told the new date and time of arrival. That information was available by 1000 on Monday morning 3 April soon after *HMS Cottesmore* had left Belfast. Although it is understood that *HMS Cottesmore* attempted to get an update on the target vessel's arrival through SNONI, no update was supplied. Neither the Londonderry harbourmaster, nor the vessel's agent, have any record of being asked for an arrival update.

Under CTS Orders (prior to June 2000) there is no reference to ship searches and, although there is reference to specialists being brought in, it would not be unreasonable for the army to assume that that specialist function would be handled by the navy. Even after the tragedy, apart from stating that search must be individually and carefully planned, there is still no advice on ship searches.

2.2.2 The other major omission in the army search procedures relates to an appreciation of what cargoes can be, or are likely to be, carried on merchant vessels. Again the manual refers to obtaining specialist information from essentially local or authoritative sources. In international shipping, cargo manifests can be made available but, in obtaining them prior to the vessel's arrival, the element of security will be lost, presumably nullifying the object of the operation. In any case, the manifest in itself will not supply the sort of information that the search team must have to carry out an operation safely. The search teams must have access to a copy of the *IMO International Maritime Dangerous Goods Code*, (IMDG Code) together with up-to-date copies of the various codes of practice for the carriage of cargoes. These provide detailed and general guidance as to the carriage of cargoes and the dangers associated with them.

2.2.3 Only three of the specialist search team of six had attended the WICS course, and were qualified to use a WICS set. This was one more than recommended by operational command. As it was the normal practice to split the search team into parties of two, an anomaly had already been created in that in one search team, only one of its members could enter a confined space. The training and operational manual identifies a number of situations which require varying levels of specialised WICS equipment but, again, nothing relating to the problems likely to be encountered during ship searches. This omission is at variance with the section headed, *CONSTRAINTS AND CONCEPTS*, and in particular under para 0305 c in the Royal Engineers' Regimental Operating Instructions: *Searchers must work to practised procedures.*

Considerable space in the operational manual is devoted to the command structure but, at the end, all serious safety decisions are passed down to RESA - in this case the staff sergeant. The manual also states, in para 0306, *The local operational commander normally exercises overall command..... He should be CTSA and have a sound understanding of the capabilities and methods of operation of the various agencies taking part.* In this case, the staff sergeant had not been given sufficient information or guidance, nor did the naval search team leader fully appreciated the lack of marine knowledge and experience of the army search team. Both the army and navy had a mutual respect for each other's professionalism and, therefore, neither explored the other's knowledge or capability.

The failure of the army to provide WICS training to all members of their teams, due to an operational command decision, needs to be re-assessed urgently. These teams are expected to be ready to attempt what can be highly dangerous searches in an

alien environment. By not equipping them fully for those operations, they are exposing them to be unnecessary (and avoidable) risks. These risks can be reduced substantially by ensuring all team members are properly trained before being exposed to search operations.

This failure also placed an additional, and an unnecessary, burden on the staff sergeant. As highlighted earlier, with his search team only partially qualified in WICS, the extent and thoroughness of any search he is ordered to undertake will be constrained by his inability to give his men freedom to search. Their training is geared for thoroughness, with a high risk and stress factor; weak or incomplete training works against the very reason for the search.

2.2.4 In the case of the marine support party, it was the inspector's understanding that it was there to provide armed support, and to assist as required. This does not appear to be the view of the marines - it was their understanding that after the briefing, "*the royal engineers were present to augment our normal search capability*". Having been paired with the royal engineer search teams, they followed their normal cursory search routines. They proceeded to follow this routine but in their eagerness to assist, they unwittingly created a situation that led ultimately to the tragedy. One of their standard operating practices was to leave a door/hatch open if they considered it warranted further, later investigation. The first security sweep of the forecastle followed their normal practice and ensured that the army search team would be uninterrupted while carrying out their search.

However, they then proceeded to start searches without any apparent reference back to the staff sergeant or the corporal of the specialist search team. This was in accordance with their normal routine, but it was not the procedure that had been agreed during the early evening briefing. The search procedures which the marines had experienced on other ships consisted of opening and looking into the back of vehicles etc and talking to their drivers. Although the marines had received some theoretical training, combined with base camp practical training exercises on merchant ship searches, they, like the army, had no actual experience of searches on large merchant vessels. They were familiar with ships, but not with such large bulk carriers. Their knowledge of cargoes, the dangers associated with them and, where the relevant information could be obtained, was covered during their training but, over time, with lack of use, the importance of this information may have became blurred.

Despite being aware that the hatch led down into the hold and that that hold contained coal, a marine did start to enter and it was only the fortuitous presence of the sergeant that prevented him becoming one of the casualties. This illustrates that, the marines were not themselves fully aware of the dangers.

2.2.5 The navy was in overall command of the operation. It provided the transport to the site, and both the search team leader and his deputy were in the boarding party. The army operational manual states that the overall commander is responsible for the planning and execution of the search operation. It has to be assumed that a similar instruction applies in the navy operational manual. As stated earlier, although the boarding routines were explained to the army in some detail, the naval search team leader did not appreciate the extent of the army's lack of knowledge of ships, or the dangers associated with them. He accepted that the staff sergeant was an expert in searching, identifying, and dealing with all types of military equipment and explosives, but did not know that all the army personnel were totally unfamiliar with ships and what they might carry.

Again, it appears to be a case of mutual respect for each other's professionalism, impeding planning procedures. Each of the services involved had its own operational guidelines based on its own service procedures. The commander should have had a sound understanding of the agencies taking part. For a complex operation like this, group training, with the navy, marines and the army engineers working together, should have been carried out on a sizeable merchant vessel before any actual operations were mounted. No rehearsals or in-depth briefings were carried out, as is evident from the lack of understanding between the parties on search procedure routines and the "who does what" scenarios.

2.2.6 Given the high profile this operation was given, it is surprising that, while understanding the reasons for the temporary suspension of the search while the accident was being dealt with, the ship search operation was not completed.

The search had barely begun at the time of the accident, so in no way could the operation have been curtailed on the basis that it had been completed anyway. If the operation was important enough to involve a specialist search team, it was also important enough to be completed. The original search team was quite properly considered to be so traumatised by events as to be unfit to continue and stood down. SNONI have suggested that it was their understanding that the RUC would carry out a full search once the vessel was alongside. The RUC however advise that that was not their understanding, and that once the vessel was alongside, they carried out a normal investigation into the deaths of the two soldiers. They have indicated that they received advice that the search had been completed, and therefore no further searches were carried out.

2.3 TRAINING, GUIDANCE AND ASSISTANCE

During the course of this investigation, an officer from HM Customs and Excise, Liverpool, contacted the MAIB inspector. This call was made because some years earlier they had been involved in helping the army set up an early WICS-type course. On hearing of the accident they made contact to see if they could be of any assistance, bearing in mind their earlier involvement in the WICS course.

Their experience of operating a highly efficient SCBA user course, coupled with various operational search techniques developed for shipboard use, was offered to the staff of the National Search Centre, Rochester. It is understood that since this accident a number of staff from the centre have visited Liverpool and an active dialogue is underway between Liverpool and Rochester. It is also understood that HM Customs and Excise have suggested/offered to provide an officer as a specialist advisor on marine searches so the army can develop a degree of expertise and experience.

Two members of the Intelligence Service from Northern Ireland have also visited Liverpool since the accident, and have attended a full three-week course in SCBA sets and search procedures. A significant part of this course relates to the development of a safe method of work, as well as the use of risk assessment.

2.4 EFFECTIVENESS OF RESCUE ATTEMPTS

2.4.1 When the marines knew that the army search team had fallen or slipped in the hold, they immediately followed standard procedure by calling for assistance before attempting a rescue. Corporal Gaulder, who was just outside on deck, immediately sent one marine to call for further assistance while he attempted a rescue. No attempt was made to check the atmosphere before entry, presumably because it was assumed that the falls were the result of slipping, rather than something more serious. Although Corporal Gaulder had previously briefed both sappers on the possibility of using the WICS sets, in his urgency to assist, he failed to consider alternative causes for his men collapsing. Although his intentions were highly commendable, he broke the cardinal rule of attempting a rescue in a confined space alone when not properly equipped. The Code of Safe Working Practices for Merchant Seamen, Chapter 17, para 17.2.3 states:

No one should enter any dangerous space to attempt a rescue without taking suitable precautions for his own safety since doing so would put his own life at risk and almost certainly prevent the person he intended to rescue being brought out alive.

2.4.2 Although each pair of marines was carrying secure radio sets, as was Corporal Gaulder, neither the corporal nor the marines were able to use this equipment to notify others of the accident - it had to be done by word of mouth. Despite attempting to use his radio to call for help both in and out of the forecastle, Marine McNaught was forced to run into the accommodation to summon help. Although the army and the marine radio sets were not on a common wave band, the army scribe and the naval search team leader each had the appropriate radio, and were standing together on the bridge. Unfortunately neither of these secure network radios will work once inside a steel structure such as the accommodation of a ship. To equip a boarding and search party with radios that have severe operating limitations in this type of operation is obviously unwise. One of the reasons for carrying radios is to provide a quick and efficient means of communication between all parties. This operating limitation meant that valuable time was lost from the outset of the accident, due to the need for all messages to be hand/voice carried from one end of the vessel to the other. It also meant that several minutes were lost before the vessel's SCBA sets were sent from the bridge to the forecastle.

2.4.3 The lack of any dedicated SAR helicopters in Northern Ireland was mentioned earlier in the report, and it should be noted that it took nearly 1¼ hours for the helicopter to arrive on site. Although a medical team from *HMS Cottesmore* arrived on board at 2250, it was not until about 2355 that a paramedic team arrived. Whether the presence of a locally-based SAR helicopter, and an earlier transfer to Altnagelvin Hospital, would have resulted in a different outcome, only the medical staff can say. It certainly would have allowed a doctor and a medical team to be on site much earlier.

2.5 SEARCH CONTROL

2.5.1 The circumstances under which this accident occurred have raised concern on four specific points:

1. Was the specialist search team as a whole aware of the dangers of entering an enclosed space such as a hold?

Regarding the first point, there is no doubt that entry to, and the search of, holds was raised and discussed at the meeting held in Belfast on 31 March which the army staff sergeant did not attend. During this meeting it was decided that if time allowed the holds be searched, they would be ventilated first. A further meeting was held on Sunday 2 April, which the staff sergeant did attend. It was at this meeting that the question of entering the holds was raised and a decision reached that they would only be entered if there was time and after they had been ventilated. Following a further meeting held on board *HMS Cottesmore* on 5 April, the staff sergeant gave an outline operational brief to his army team paying particular attention to the dangers involved in accommodation searches.

After boarding, the staff sergeant went forward and arranged for the deck search team to carry confined space emergency and test equipment. The team forward were, therefore, aware that they were likely to encounter confined spaces during the search. Sapper Naivalurua had attended a WICS course, and was therefore familiar with the procedures.

2. Did the staff sergeant instruct his search team not to enter the hold until it had been ventilated?

When the staff sergeant ordered the marine out of the access hatch in the forecastle he also stated that nobody should enter the holds. This was said in the presence of the two marines and the three engineers undertaking the search forward.

During the search briefing carried out in the accommodation between Corporal Gaulder and the staff sergeant, instructions were given to restrict the search to the deck until the staff sergeant was satisfied that the hold was safe to enter. Sapper Parris, who was nearby at the time, cannot remember what was said then or later when the corporal briefed the search team to continue the search.

3. Were individual team members forward aware of the dangers?

Corporal Gaulder and Sapper Naivalurua would have been aware of the dangers, as not only had they attended a WICS course, but both had been present when the staff sergeant instructed them to carry emergency breathing sets and test equipment. Sapper Parris probably was not aware, as he had not attended a WICS course, and only carried the set because Sapper Naivalurua carried one.

4. Were Sappers' Parris and Naivalurua instructed to search the hold?

The answer to that is "No". Sapper Parris has stated that at no time was he given any direct order to enter the hold. He cannot remember what instructions were given by the corporal on resuming the deck search and, with both other members involved having died, this point cannot be pursued further.

2.5.2 The army search team were instructed to search the upper deck, and it is possible that if the hatch found in the forecastle had not been opened, nor a marine attempted to enter, it would not have been touched. The army personnel might well have assumed that if a marine, who supposedly knew about ships, felt safe enough to try and enter the hatchway, then it was safe for the army to do so too.

Perhaps this assumption, combined with a lack of basic ship knowledge, created the situation that ultimately led to the death of the two sappers. Their ignorance of the dangers inherent in cargo vessels carrying bulk cargoes, together with a false sense of security, brought about by the well-intentioned, but misguided, attempts to assist in the search by the marines, caused them to enter the hold.

SECTION 3 - CONCLUSIONS

3.1 FINDINGS

The Vessel

1. *Diamond Bulker* was seaworthy on arrival at Lough Foyle with all certificates valid, and was manned by experienced and certificated officers and crew. (Ref: 1.4)

2. The vessel carried two SCBA sets, together with four spare compressed air cylinders. All six air bottles were noted as being between 70-100% full in March. Three were refilled after the accident. (Ref: 1.4, 2.1.1)

3. No moisture or CO_2 readings were taken during the voyage due to bad weather preventing safe access on deck. (Ref: 2.1.3)

4. The results of atmospheric testing carried out on the holds of *Diamond Bulker* showed that in all the cargo holds, oxygen depletion and carbon dioxide generation took place in varying degrees, during the shipment of coal from Colombia to Londonderry in Northern Ireland. (Ref: 1.11.2, 1.11.3)

Search Procedures

5. The search procedures under which this specialist army search team carried out its duties were, and remain, based on building and groundwork searches. No special training is offered, nor guidance given on ship searches. (Ref: 1.9, 2.2.1)

6. The staff sergeant in charge of this specialist search team was placed in a situation which was not of his making. He had received no previous training in the searching of ships, certainly not of large bulk carriers and, although told that the cargo was coal, and therefore unlikely to be an area used for contraband, did not have the detailed background information to readily appreciate the dangers associated with the cargo, nor what equipment was likely to be needed. (Ref: 2.2.1)

7. During the search briefing carried out on Sunday 2 April, and during discussions on board *Diamond Bulker*, the question of searching the holds was discussed and a decision made that if they were to be searched, it would be done after the holds had been ventilated. (Ref: 1.3.2, 1.3.8, 2.2.1)

8. The staff sergeant instructed Corporal Gaulder not to enter the holds until he declared them safe to enter. (Ref: 1.3.5, 2.5.1)

Training & Equipment

9. Neither the army search team, nor the marines, were wearing any body harness or clothing fitted with a lifting point. It was suggested that it was always possible to rig a lifting sling using ropes, fire hoses etc. This may be true, but when speed is essential and the space has a difficult access, a secure attachment point on clothing, or a harness, can be a life saver. (Ref: 2.2.1)

10. The quality of the operational pre-planning has to be questioned when the boarding party embarked, was transported to Lough Foyle by *HMS Cottesmore* and then found no *Diamond Bulker*. Her arrival had been delayed by two days because of bad weather on the voyage. All it needed was a telephone call to the Londonderry harbourmaster to find out. That information had been available from 1000 on Monday morning, soon after *HMS Cottesmore* had left Belfast. Although it is understood that *HMS Cottesmore* attempted to get an update on the target vessel's arrival through SNONI, no update was supplied. Neither the Londonderry harbourmaster, nor the vessel's agent, have any record of being asked for an arrival update. (Ref: 1.3.2, 2.2.1)

11. The search teams should, and indeed must, have access to a copy of the IMO International Maritime Dangerous Goods Code (IDFG Code), together with up to date copies of the various codes of practice for the carriage of cargo. (Ref: 2.2.2)

12. Only three of the specialist search team of six had attended the WICS course, and were qualified to use a WICS set. As it was the normal practice to split the search team into parties of two, an anomaly had already been created in that in one search team, only one of that team could enter a confined space. The training and operational manual identifies a number of situations that require varying levels of specialised WICS equipment but again, nothing relating to the problems likely to be encountered during ship searches. This omission is at variance with the section headed, *CONSTRAINTS AND CONCEPTS* and in particular under para 0305 c. *Searchers must work to practised procedures* in the Royal Engineers' Regimental Operating Instructions. (Ref: 2.2.3)

13. In the case of the marine support party, it is the inspector's understanding that they were there to provide armed support, and to assist as required. This does not appear to be the view of the marines - it was their understanding that after the briefing, "*the royal engineers were present to augment our normal search capability*". Having been paired with the royal engineer search teams, they followed their normal cursory search routines. They proceeded to follow this routine but in their eagerness to assist, they unwittingly created a situation that led ultimately to the tragedy. One of their standard operating practices was to leave a door/hatch open if they considered it warranted further, later investigation. (Ref: 2.2.4)

14. Although both marines and the army personnel were carrying Cougar radios, the initial communication on the accident had to be done by word of mouth. The army and marine radio sets were not on a common wave band, but both the army scribe and the naval search team leader had the appropriate radio, and were standing together on the bridge. The failure of these secure network radios to work when inside a steel structure, such as the accommodation of a ship, had a significant impact on the speed at which SCBA sets could be utilised. (Ref: 2.4.2)

15. The lack of any dedicated SAR helicopters in Northern Ireland, and the time it took for the helicopter to arrive on site (nearly 1¼ hours), resulted in a significant delay in providing medical facilities to the casualties. (Ref: 2.4.3)

3.2 OTHER FINDINGS

1. The coxswain and the marine party provided, and continued to provide, first-aid and resuscitation to all three casualties until such times as they recovered or were pronounced dead by medical staff.

2. The master, officers, and crew of *Diamond Bulker* were co-operative throughout the operation, and provided every assistance during the subsequent emergency and rescue operation.

3.3 CAUSE OF THE ACCIDENT

The cause of the accident was low oxygen and increased carbon dioxide levels present in No 1 hold due to an ongoing oxidation process in the cargo of coal.

3.4 CONTRIBUTORY CAUSES

1. Despite the instructions contained in the army operational manual (para 0306), the staff sergeant had not been given sufficient information or guidance, nor had the naval search team leader fully appreciated the lack of marine knowledge and experience of the army search team. Both the army and the navy had a mutual respect for each other's professionalism, and therefore neither explored the other's knowledge or capability.

2. The army's failure to provide WICS training to all members of the team was due to an operational command decision. These teams are expected to be ready to attempt what can be highly dangerous searches in an alien environment. By not equipping them fully for those operations, they are exposed to unnecessary and avoidable risks. These risks can be substantially reduced by ensuring that all team members are properly trained before being exposed to search operations.

3. Although some pre-planning had been carried out, there was a general lack of detailed and combined planning. No rehearsals involving both the marines and the royal engineers had been carried out, nor had the briefings been sufficient for a complex operation involving three differing services. There were misunderstandings, a lack of clarity and poor cohesion from the start of this operation. Not even the arrival time and date of the target vessel was re-checked.

4. Although the marines had received some theoretical training, combined with base camp practical training exercises on merchant ship searches they, like the army, had no actual experience of large merchant vessel searches. They were familiar with ships, but not necessarily with such large bulk carriers.

5. Although the boarding routines were explained to the army in some detail, the naval search team leader did not appreciate the extent of the army's lack of knowledge of ships, or the dangers associated with them. The weakness in procedures which dictates that the commander should have a sound understanding of the capabilities and methods of operation of the various agencies taking part, makes no allowance in the pre-planning phase for either an inter-service exchange of relevant experience, nor a proper evaluation of the capabilities of the participants.

6. Corporal Gaulder made no attempt to check the hold atmosphere before entry, despite having previously briefed both sappers on the use of the WICS sets. In his urgency to assist, he failed to consider possible causes for his men collapsing. His intentions were highly commendable, but he broke the cardinal rule of not attempting a rescue alone.

SECTION 4 - RECOMMENDATIONS

Headquarters, Northern Ireland is recommended to:

1. Investigate fully the perceived need for a specialist army marine search team, and to discuss with the appropriate service authorities what level of training is required to provide that service.

Headquarters, Engineer in Chief (A) is recommended to:

2. Consider whether the requirement for specialised marine search teams on deep sea ships might be better served by utilising the existing marine search teams, and provide them with what additional specialist training is considered necessary.

The Director, National Search Centre, Rochester is recommended to:

3. Investigate and provide suitable marine training for specialised army search teams likely to be engaged in the search of shipping.

The Commanding Officer, 25 Engineer Regiment, Royal Engineers, Massereene Barracks, Antrim, NI is recommended to:

4. Investigate the provision of VHF radio sets capable of being used within steel structures. Although commercially available VHF sets are not "secure" they could be used during ship searches - any interested party would already be aware that a search was being carried out.

5. Ensure that all staff involved in specialised search teams are fully trained in the use of emergency breathing equipment (WICS) and the requirements of the Confined Space Regulations 1997.

The Senior Naval Officer, Northern Ireland is recommended to:

6. Investigate the use of footwear similar to that used by the marines during ship searches, to provide a better grip on steel surfaces for army personnel.

7. Issue instructions stating that in combined operations involving army, marine and naval personnel, all parties must be made aware of the experience and limitations of those likely to be involved at an early stage. On site is too late.

8. Ensure that pre-planning is thorough, arrival times are checked, and that all parties are aware of the risks associated with a particular cargo on the target vessel and that they are familiar with each other's search routines and procedures.

9. Investigate the provision of VHF radio sets capable of being used within steel structures. Although commercially available VHF sets are not "secure" they could be used during ship searches - any interested party would already be aware that a search was being carried out.

The Director, LMT and the Maritime and Coastguard Agency are recommended to:

10. Consider, in the light of this accident, deploying a dedicated SAR helicopter in Northern Ireland, bearing in mind the projected phasing out of the Belfast-based Wessex helicopters on 31 March 2002 and the delay which occurs in responding to accident calls due to the minimum flying time between GB and Northern Ireland.

SECTION 5 - SUBSEQUENT ACTIONS

5.1 NATIONAL SEARCH CENTRE, ROCHESTER

1. A training needs analysis has been conducted by Headquarters Engineer in Chief (Antrim) which defines the Corps requirement for WICS training. A copy of that analysis was not made available to the MAIB.

2 The National Search Centre WICS course for AP's and AE's has been extended from 3 and 2 days respectively to 5 days each.

3. A National Search Centre instructor has attended the HM Customs and Excise Commercial Vessel Rummage Team course at Liverpool. The Dangerous Goods Code has been obtained for use by instructors. A close liaison is now maintained with the staff at HM Customs and Excise Training Centre at Liverpool.

4. With effect from the next course starting 22 January 2001, elements of the RESA (Rest of the World) Course, which is more orientated towards shipping and offshore energy installations, are being incorporated into the RESA (NI) Course.

5. Planning Aide Memoire, Point 6, Annex A (Pam 6A) is being re-written with a deadline of 31 March 2001. The vessel search paragraphs will be revised.

6. All courses are being re-designed as part of the Systems Approach to Training to meet the customers' stated requirements. Deadline end November 2001.

5.2 HM CUSTOMS AND EXCISE NORTH WEST, LIVERPOOL

1. Two instructors from the National Search Centre, and also a further two from Moscow Naval Base, have attended separately its Commercial Vessel Search training Course in Liverpool. This intensive training course lasted three weeks, largely aboard "live" commercial vessels in the port and gives officers a safe system of work in all aspects and areas of commercial vessel search. It includes the identification of all types of confined spaces, their potential atmospheric and physical hazards, gas detection and confined space search equipment.

2. In addition, both teams of instructors were introduced to Ship Search Risk Assessment and the mandatory "Permit to Enter" for any confined space search as operated throughout the UK by its own officers.

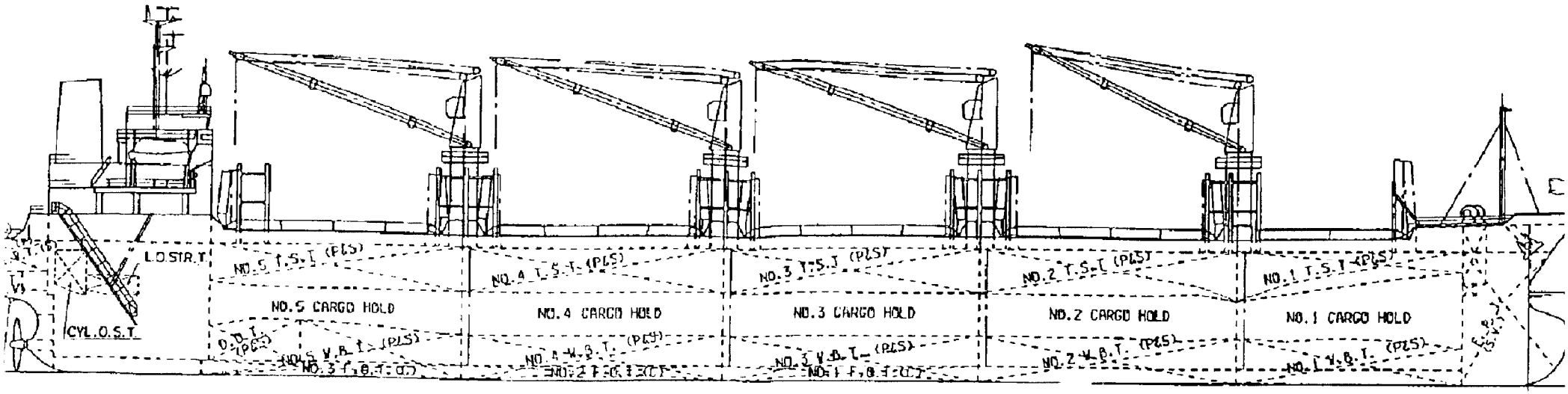
3. The training also included ship search planning and co-ordination, interpretation of various ships plans, engine room systems, the correct use of personnel protective equipment, use of fall arrest and full body harnesses as well as the dangers of shipboard electrical plant and "standby" equipment during search operations.

4. The HM Customs lead instructor personally participated in the training of both teams and is satisfied that knowledge and skill levels have been greatly enhanced. HM Customs have offered their assistance for any time in the future to both teams, along with any further training which they may require.

An active open dialogue has now been promoted and exists between the army (NSC), navy (Moscow camp) and HM Customs, Liverpool, with the prevention of shipboard accidents being the primary and ultimate aim.

Marine Accident Investigation Branch
March 2001

1. General Arrangement of *Diamond Bulker*



C HOLD (GRAIN)

NAME		POSITION FRAME	CAPACITY m³	CAPACITY CF	B.G. m	K.G. m
HOLD	HOLD	165-194	5021.76	177334.45	-60.84	7.61
	MATCH VAR	160-165	298.00	10523.87	-59.50	14.37
	SUM		5319.76	187857.92	60.56	7.99
HOLD	HOLD	131-165	7773.43	274483.37	-34.95	7.00
	MATCH VAR	126-160	463.00	16382.63	-30.20	14.36
	SUM		8236.43	290866.00	30.94	7.70
HOLD	HOLD	97-131	7796.75	275341.52	- 9.85	7.30
	MATCH VAR	126-160	463.90	16382.63	- 9.50	14.36
	SUM		8260.65	291724.15	- 9.83	7.73
HOLD	HOLD	63- 97	7934.10	280061.24	17.55	7.90
	MATCH VAR	58- 92	463.90	16382.63	17.90	14.36
	SUM		8398.00	296443.87	17.55	7.66
HOLD	HOLD	30- 63	6044.10	245243.13	40.11	7.65
	MATCH VAR	34- 58	463.00	16382.63	41.00	14.38
	SUM		7408.20	261620.76	43.38	8.09

WATER BALLAST TANK (100% FULL) S.G. = 1.025

NAME		POSITION FRAME	CAPACITY m³	WEIGHT MT	B.G. m	K.G. m
FORE PEAK TANK	C	194- F.P.	735.26	772.08	-76.82	7.18
No.1 W.B.T.	P	165-194	316.25	324.86	-60.15	1.20
	S	165-194	316.25	324.86	-60.15	1.20
No.2 W.B.T.	P	131-165	610.07	625.32	-36.28	1.82
	S	131-165	609.73	625.03	-36.28	1.82
No.3 W.B.T.	P	97-131	382.10	391.65	- 9.53	1.38
	S	97-131	382.10	391.65	- 9.53	1.38
No.4 W.B.T.	P	63- 97	360.87	369.89	17.31	8.42
	S	63- 97	360.87	369.89	17.31	8.42
No.5 W.B.T.	P	20- 63	273.04	279.87	42.63	8.76
	S	29- 63	273.04	279.87	42.63	8.75
No.1 T.S.T.	P	165-194	240.05	246.05	-60.82	12.18
	S	165-194	240.05	246.05	-60.82	12.18
No.2 T.S.T.	P	131-165	410.63	420.90	-36.83	1.63
	S	131-165	410.63	420.90	-36.83	1.63

FUEL OIL TANK (100% FULL) S.G. (HEAVY OIL) = 0.950 DIESEL OIL

NAME		POSITION FRAME	CAPACITY m³	WEIGHT MT	B.G. m	K.G. m
No.1 FUEL OIL T.	C	97-131	508.80	484.41	8.66	16.03
No.2 FUEL OIL T.	C	63- 97	511.80	486.21	17.70	7.90
No.3 FUEL OIL T.	C	20- 63	221.84	210.84	40.89	8.76
SUM			1243.64	1181.46		
D.O.T.	P	30- 42	68.35	60.13	51.52	2.50
	S	30- 42	68.35	60.13	51.52	2.50
SUM			136.64	120.26		
TOTAL			1380.30	1301.72		

Diamond Bulker - General Arrangement

2. Cargo details

CODE NAME: "CONGENBILL". EDITION 1994

BILL OF LADING

TO BE USED WITH CHARTER-PARTIES

B/L No 1

Reference No

Shipper

CARBONES DEL CARIBE S.A.

consignee

TO ORDER

Now address

BURKE SHIPPING SERVICES LTD.
ADMINISTRATION BUILDING
LISAHALLY TERMINAL
LONDONDERRY N.IRELAND BT 47UB

Vessel

~~DIAMOND BULKER~~

Port of loading

BARRANQUILLA, COLOMBIA

ORIGINAL

Port of discharge

LISAHALLY TERMINAL, LONDONDERRY, N.IRELAND

Shipper's description of goods			Gross weight
7.645	M/T COAL IN BULK	10 x 200 MM	7.645.000 kls
15.514	M/T COAL IN BULK	0 x 200 MM	15.514.000 kl
~~23.159~~			~~23.159.000 kls~~

CLEAN ON BOARD

ONE ORIGINAL B/L RETAINED ON BOARD TO BE HANDED TO MESSRS BURKE SHIPPING SERVICES LTD.AT DISCHARGE PORT AGAINST WHICH BILL THE CARGO MAY BE PROPERLY RELEASED.

ALL TERMS, CONDITIONS, LIBERTIES, EXCEPTIONS, CLAUSES AND ARBITRATION CLAUSES OF THE CHARTER PARTY DATED 6TH DEC.1999 AND ANY ADDENDA THERETO ARE HEREWITH INCORPORATED.

FREIGHT PAYABLE AS PER CHARTER PARTY DATED 6TH.DEC.1999

(Of which on deck at Shipper's risk; the Carrier not being responsible for loss or damage howeoever arising)

Freight payable as per
CHARTER-PARTY dated 06/12/99

FREIGHT ADVANCE.

Received on account of freight:

Time used for loading _____ days _____ hours.

SHIPPED at the Port of Loading in apparent, good order and condition on board the Vessel for carriage to the port of Discharge or so near thereto as she may safely get the goods specified above.

Weight, measure, quality, quantity, condition, contents and value unknown.

IN WITNESS Whereof the Master or Agent of the said Vessel has signed the number of Bills of Loading indicated below all of this tenor and date, any one of which being accomplished the others shall be void.

FOR CONDITIONS OF CARRIAGE SEE OVERLEAF

Freight payable at	Place and date of issue BARRANQUILLA MARCH 21/2000
Number of original Bs./L. THREE(3)	Signature

DIAMOND BULKER
MASTER

Printed and sold by
Fr. G. Knudtzone Bogtryideri A/S, 55 Toldbodgade, DK-1253 Copenhagen K.
Telefax +4533931184
by authority of the Baltic and International Maritime Council (BIMBO), Copenhagen

AGENTES MARITIMOS DEL CARIBE LTDA. - LICENCIA 074

TELEX: 31382 – TELEFONO: 3457411 – CARRERA 53 No. 70-112 – BARRANQUILLA, COLOMBIA

LINEA:_____

MANIFEST of the cargo shipped on board the M/V _____ flag: _____ of NRT _____ captain _____ Crew _____

MANIFIESTO de la carga embarcada a bordo de M/N DIAMOND BULKER Bandera: FILIPINA del porte de TNR 10.429 capitan MALAGA ARNEL N. Trip20-

from _____ to _____ sailed _____ consigned to _____

en el puerto de BARRANQUILLA,COLOMBIA con destino a LONDONDERRY N. IRELAND salido MARCH 21 /2000 a la consignación de TO ORDER

B/L No. Número	Shippers Remitentes	Consignees Consignatarios	Marks & Numbers Marcas & Números	Quantity Cantidad	Description Contenido	Gross Weight Kilos Neto Kilos Bruto	REMARKS OBSERVACIONES
1	CARBONES DEL CARIBE S.A.	TO ORDER		7.645	M/T COAL IN BULK 10 X 200 MM	7.645.000 kls	
				15.514	M/T COAL IN BULK 0 X 200 MM	15.514.000 kls	
				23.159		23.159.000 kls	

TRANSPORTES NAVIEROS INC. DIAMOND BULKER MANILA

MASTER

3. Copy documents of ship's SCBA sets maintenance

DELIVERY RECEIPT

1222

AIR-SEA SAFETY & SURVIVAL
120 Williman Street
CHARLESTON, SOUTH CAROLINA 29403
(803) 723-2722

DELIVER TO: M/V DIAMOND BULKER
c/o Carolina Shipping Co.

SHIP DATE	11-5-99
SHIP VIA	PU & Del
OUR NUMBER	3898
YOUR NUMBER	R409201 RCV

QUAN. ORDERED	QUANTITY SHIPPED	√	STOCK NUMBER	DESCRIPTION
1	1	ea	#11636	SABRE Cylinder Hydro + Recharge
1	1	ea	#11442	SABRE Cylinder Hydro + Recharge
1	1	ea	#11481	SABRE Cylinder Recharge

TRANSPORTES NAVIEROS INC. DIAMOND BULKER MANILA

NO. OF PACKAGES	WEIGHT	RECEIVED IN GOOD CONDITION BY	DATE
3	30#		11-5-99

PLEASE NOTIFY US IMMEDIATELY
IF ERROR IS FOUND IN SHIPMENT

24 HOUR SERVICE
CHARLESTON FIRE & SAFETY, INC.
3329 Business Circle
N. Charleston, SC 29418
(843) 767-3080 • Fax (843) 767-5596

Kidde

INSPECTION REPORT

CERTIFICATE OF INSPECTION
NOT VALID UNLESS COMPLETED AND SIGNED

	TYPE OF EQUIPMENT	Date Completed
3	SCBA Cylinder	11/3

THIS CERTIFIES that the above equipment was inspected and left in operating condition.
BY: K. V. Cleaver

TO: SOA
AIR-SEA SAFETY & SURVIVAL
~~MARINE SAFETY EQUIPMENT~~
120 WILLIMAN STREET
~~CHARLESTON, SC 29403~~

FOR INSTALLATION:
M/V Diamond Bucker

INSPECTION TESTS MADE

Visually inspected, hydrostatic tested two (2) Self Contained Breathing Cylinders S/N 11636 and S/N 11442

Visually Inspected / Recharge one(1) Self Contained Breathing Cylinder S/N 11481

CONDITION OF EQUIPMENT AS FOUND

Three Self Contained Breathing Cylinders received in good conditions

REPAIRS MADE

Hydrostatic Retested two (2) Self Contained Breathing Cylinders S/N 11636 and 11442
Recharge three Self Contained Breathing Cylinders S/N 11636; 11442; 11481

Hydrostatic Test were Yes

REMARKS

Cylinders returned in good condition All Inspections performed were Satisfactory.

YES	NO	INSPEC. ACK. BY OWNER'S REP:	SERVICE INSPECTOR SIGNATURE:	DATE: 11/3/99

FROM : BMA*LTDA

JUL. 28. 2000 6:25PM P 2
PHONE NO. : 57 5 3581883

FIREMAN'S OUTFIT - CHECKLIST

BRIDGE	NOV 1999	DEC 1999	JAN 2000
SET - A			
SCBA MASK	GOOD	GOOD	GOOD
FIRE AXE	✓	✓	✓
HELMET	✓	✓	✓
P. CLOTHING	✓	✓	✓
B. BOOTS	✓	✓	✓
GLOVES	✓	✓	✓
SAFETY LAMP	✓	✓	✓
SPARE BATTERY	✓	✓	✓
OXYGEN BOTTLES	A B (C)	A B (C)	A B (C)
	FULL 175 165	FULL 173 160	FULL 172 155
UPPER DECK			
SET - B			
SCBA MASK	GOOD	GOOD	GOOD
FIRE AXE	✓	✓	✓
HELMET	✓	✓	✓
P. CLOTHING	✓	✓	✓
B. BOOTS	✓	✓	✓
GLOVES	✓	✓	✓
SAFETY LAMPS	✓	✓	✓
SPARE BATTERY	✓	✓	✓
OXYGEN BOTTLES	D (E) F	D (E) F	D (E) F
	FULL 181 FULL	FULL 175 FULL	FULL 154 FULL
REMARKS :		REMARKS :	REMARKS :
GOOD WORKING CONDITION		GOOD WORKING CONDITION	GOOD WORKING CONDITION
1 REFERENCE 3 SPARE BATTERIES AT CAPTAIN'S, S. CAROLINA 3/c Cook		3/c	

FROM : BMA*LTDA JUL. 28. 2000 6:26PM P 3
PHONE NO. : 57 S 3581883

FIREMAN'S OUTFIT - CHECKLIST

BRIDGE	FEB 2000	MARCH 2000	APRIL
SET - A			
SCBA MASK	GOOD	GOOD	GOOD
FIRE AXE	✓	✓	✓
HELMET	✓	✓	✓
P. CLOTHING	✓	✓	✓
R. BOOTS	✓	✓	✓
GLOVES	✓	✓	✓
SAFETY LAMP	✓	✓	✓
SPARE BATTERY	✓	✓	✓
OXYGEN BOTTLES	A B (C)	A B (C)	(B) E D
	FULL 170 152	FULL 170 150	170 200 (FULL) FULL
UPPER DECK			
SET- B	GOOD	GOOD	GOOD
SCBA MASK	✓	✓	✓
FIRE AXE	✓	✓	✓
HELMET	✓	✓	✓
P. CLOTHING	✓	✓	✓
R. BOOTS	✓	✓	✓
GLOVES	✓	✓	✓
SAFETY LAMPS	✓	✓	✓
SPARE BATTERY	✓	✓	✓
OXYGEN BOTTLES	D (E) F	D (E) F	(A) C F
	FULL 152 FULL	FULL 150 FULL	FULL 200 (FULL) 209 (FULL)
REMARKS		REMARKS	REMARKS
	GOOD WORKING CONDITION	GOOD WORKING CONDITION	* REPLACED SAFETY FLASHLIGHT * RECHARGED 3 ORA BOTTLES AT L'OCEAN, N. ZEALAND GOOD WORKING CONDITION

4. Copy of IRTU Reports

irtu
INDUSTRIAL RESEARCH & TECHNOLOGY UNIT

REPORT ON

INVESTIGATION INTO THE DEATHS OF TWO SOLDIERS

ON BOARD CARGO SHIP M.V. DIAMOND BULKER

TI200000990

Mr Alan Rushton – Inspector, MAIB
Department of the Environment
Transport and The Regions
Marine Accident Investigation Branch
First Floor, Carlton House
Carlton Place
Southampton
Hampshire SO15 2DZ

Our Ref: KMcG/Ind/NMcC

Your Ref: MAIB 1/10/201

Date: 14th June 2000

17 ANTRIM ROAD LISBURN BT28 3AL **TELEPHONE** +44 (0) 28 9262 3000 **FACSIMILE** +44 (0) 28 9267 6054 **E-MAIL** info@irtu.detini.gov.uk **WEB** www.irtu-ni.gov.uk

CONTENTS

1. SUMMARY

The investigation by the Industrial Research and Technology Unit (IRTU) into the deaths of two soldiers on board the cargo vessel M.V. Diamond Bulker has now been completed.

Our findings strongly indicate that the atmosphere encountered by the soldiers entering the Cargo Hold in the vessel was depleted in Oxygen and also contained increased Carbon Dioxide levels. This depletion in the atmospheric Oxygen content is considered to be as a result of the cargo of coal undergoing an oxidation process.

2. UKAS ACCREDITATION

Opinions and interpretations expressed herein are outside the scope of UKAS Accreditation. The tests included in this report are not included in the UKAS Accreditation Schedule for this laboratory.

3. INTRODUCTION

The investigation described in this report was carried out at the request of Mr Alan Rushton of the Marine Accident Investigation Branch (MAIB) of the Department of the Environment Transport and the Regions (DETR) and authorised by his letter of instruction of 10 April 2000.

Mr K McGuinness of IRTU was requested to attend the cargo vessel M.V. Diamond Bulker docked at Lisahally docks, Londonderry on 7 April 2000. Several days previous a number of military personnel from the Royal Engineers had entered a Cargo Hold of the above vessel during a 'board and search' operation. The entry point was via a manway and the Hold covers were shut at the time of entry. On entering Hold No 1, two soldiers were overcome, possibly as a result of the atmospheric conditions, and suffered fatal consequences.

Mr McGuinness's brief was to investigate the atmospheric conditions in the sealed No 5 Hold before the space was ventilated and Hold No 1 which was already opened and awaiting discharge of the coal cargo. A further request was made for examination of coal samples from No 5 and No 1 Holds with a view to establishing if similar atmospheres existed in each.

4. VISIT TO VESSEL

Mr McGuinness reported to Mr G McGahy of Burke Shipping Services and was taken to Mr A Rushton of MAIB on board the Diamond Bulker around noon on 7 April 2000. Also present were Mr P McDonnell of McKinty & Wright Solicitors and the Master of the vessel. Mr Rushton explained that the incident in which the two fatalities occurred had taken place in Cargo Hold No 1, but the hatch covers had been opened at the time of the incident to allow the rescue operation to proceed. Hold No 5 however, which is similar to Hold No 1, had been kept sealed in order to preserve the atmospheric conditions for subsequent monitoring. The cargo of coal had been loaded in Colombia two weeks previous to the incident and there were no reports of ventilation of the Cargo Holds.

Mr McGahy informed McGuinness that two type of coal was loaded onto the vessel:-

Type A – 10mm x 200mm particle size

Type B - 0mm x 200mm particle size

Cargo Hold No 1 contained Type A coal (bottom layer) 1,890 tonnes, and Type B coal (top layer) 1,465 tonnes. Cargo Hold No 5 contained Type B coal only.

Mr McGuinness was directed to Hold No 5, which had a sealed sampling point approximately 75mm in diameter normally used for temperature monitoring of the cargo. Mr McGuinness asked if temperature records for this particular cargo were available but the Master indicated that no temperature readings were taken.

The cover to the access point was loosened and removed. An air sampling tube was inserted into the Cargo Hold's atmosphere approximately 2-3m from the level of the Hold covers. The Oxygen, Carbon Monoxide, Hydrogen Sulphide and Explosive Gas levels were measured using a calibrated Gas Surveyor portable gas meter. Volatile Organic Compound (VOC) measurements were also taken using a PID/VOC meter. A qualitative examination of the atmosphere for Carbon Dioxide was carried out using Dragar tubes.

After atmospheric monitoring the covers of Hold No 5 were opened for unloading of the cargo. The heavy rain falling onto the surface of the coal cargo gave rise to steam and was clearly visible.

A sample of the cargo from Hold No's 1 & 5 was provided to Mr McGuinness by Mr McGahy of Burke Shipping Services for laboratory examination. These coal samples were removed from the surface region of the cargo.

The samples were assigned the following IRTU Laboratory Identification No's:-

Cargo Hold No 1 - 200000990/1

Cargo Hold No 5 – 200000990/2

5. LABORATORY TESTS

A sieve analysis was carried out on both samples to confirm that the coal particle sizes were similar at the surface of the cargos.

A test rig was constructed in which coal samples were placed and air passed through the bulk material to establish if a reduction in Oxygen had occurred. No meaningful results could be obtained, as it was not possible to establish the correct ratios of coal to air so that measurable Oxygen reductions could be determined.

6. RESULTS

6. 1 Gas Readings in Cargo Hold No 5

GAS PARAMETER	RESULT
Oxygen	13.1%
*Carbon Dioxide	> 1%
Hydrogen Sulphide	< 5ppm
Carbon Monoxide	15ppm
Volatile Organic Compounds (VOCs)	< 2ppm
Lower Explosive Limit (LEL)	< 1%

** Qualitative result*

6.2 Sieve Analysis of Coal

SIEVE SIZE	Percentage Passing	
	Hold No 1	*Hold No 5*
5.0 mm	24.5	29.7
9.5 mm	37.0	44.7
13.2 mm	45.0	53.1
20.0 mm	56.7	65.0
28.0 mm	65.7	73.5
37.5 mm	74.3	83.2

7. DISCUSSION

The results of the atmospheric monitoring in Cargo Hold No 5 indicated that Oxygen depletion had taken place with elevated levels of Carbon Dioxide prevailing. There were trace amounts of Carbon Monoxide but these are not considered significant. There was no evidence of Hydrogen Sulphide or Volatile Organic Compounds (VOCs) in the atmosphere. The atmosphere was not explosive in nature.

It is our opinion that the Oxygen depletion was due to a process known as ***'Spontaneous Oxidation and Heating of Coal'.*** The oxidation of coal is a solid/gas reaction, which happens initially when air (a gas) passes over a coal surface (a solid). Oxygen from the air combines with the coal, raising the temperature of the coal. In an extreme case fire eruption may occur

As the reaction proceeds, the moisture in the coal is liberated as a vapour and then some of the volatile matter that normally has a distinct odour, is released. Carbon Dioxide is also released. The amount of surface area of the coal that is exposed is a direct factor in its heating tendency. The finer the size of the coal, the more surface exposed per unit of weight (specific area) and the greater the oxidising potential, all other factors being equal.

Cargo Hold No 1 in which the fatalities occurred had an upper layer of Type B coal and therefore the coal surface area would be expected to be similar to Hold No 5 where atmospheric measurements were carried out. The laboratory analysis of the coal samples confirmed that the surface coal was similar in both Cargo Holds.

Segregation of the coal particle sizes is a major cause of oxidation and heating. The coarse sizes allow the air to enter the pile at one location and react with the high surface fines at another location. It may be the case that the lower layer of coarser coal in Hold No 1 has promoted oxidation of the type B layer from beneath. This may have caused a lower atmospheric Oxygen concentration to prevail in Hold No 1 than in Hold No 5.

Elevated levels of Carbon Dioxide would have existed within the depleted Oxygen atmosphere. Given that Carbon Dioxide is a much heavier gas than air causing a lowering of the Oxygen level by displacement, its concentration would have been greatest in the lower regions of the Cargo Holds. Consequently the Oxygen levels in these regions would have been at there lowest. The area where the fatalities occurred was in the lower part of the Cargo Hold due to the 'heaped' effect of the coal.

Oxygen and Carbon Dioxide are present in 'fresh air' at 20.9% and 0.03% respectively. The harmful effects of Oxygen deficiency and increase in Carbon Dioxide levels can be summarised as follows:-

Oxygen Deficiency

Oxygen (% by volume)	**Effects and Symptoms**
19.5	Minimum permissible Oxygen level.
15 -19	Decreased ability to work strenuously. May induce early symptoms in persons with coronary, pulmonary, or circulatory problems.
12 - 14	Respiration increases in exertion, pulse up, impaired co-ordination, perception, and judgement.
10 - 12	Respiration further increases in rate and depth, poor judgement, lips blue.
8 –10	Mental failure, fainting, unconsciousness, Ashen face, blueness of lips, nausea and vomiting.
6 - 8	8 minutes, 100% fatal; 6 minutes, 50% fatal; 4 –5 minutes, recovery with treatment.
4 - 6	Coma in 40 seconds, convulsions, respiration ceases, death.

Elevated Carbon Dioxide Levels

Carbon Dioxide (% by volume)	**Effects and Symptoms**
1 – 2	*Slight increase in depth of respiration with headache and fatigue.*
3	*Severe headache with diffuse sweating. There is a marked loss of efficiency.*
4	*Flushing of face, palpitations.*
5	*Mental depression.*
6	*Hard work impossible. Visual disturbances*
8	*Tremors, convulsions, coma and death by heart failure*

It is an accepted industry norm that any atmosphere with less than 19% Oxygen should **not** be entered by persons without an approved self-contained breathing apparatus (SCBA). The Cargo Holds of the Diamond Bunker are considered confined spaces by virtue of their enclosed nature and as a consequence, there arises a foreseeable specific risk ie asphyxiation.

Regulation 4 (1) of the ***Confined Space Regulations (Northern Ireland) 1999*** makes it a priority to identify measures in the risk assessment which allow the work to be carried out without the need for entry to confined spaces. Where it is not reasonably practicable to avoid entry to the confined space to carry out the work, then the risk assessment must identify the measures and precautions necessary to ensure a ***Safe System*** of working. Such a safe system will give priority to eliminating the source of dangers before deciding on the precautions necessary for entry.

A ***Permit to Work*** is a formal written system and is usually required when there is a foreseeable risk of serious injury in entering or working in a confined space. It is an extension of the safe working procedure providing a ready means of recording findings and authorisations, information on time limits, atmospheric tests, PPE, emergency procedures, etc. A key element in a permit to work system is that a competent person should make decisions and, when necessary in consultation with specialists.

It is our belief that a ***Safe System of Work and Permit to Work*** practice should be operated when entering confined spaces similar to the cargo holds encountered in the M.V. Diamond Bulker.

It is the intention of IRTU to visit a vessel carrying a similar cargo, which is due in Lisahally Docks within the next 3 weeks. Atmospheric monitoring of the Cargo Holds will be carried out with calibrated equipment available for Carbon Dioxide testing.

If the findings are significant then an Addendum to this report will be issued.

KIERAN McGUINNESS
Member of Staff

JOHN E PINKERTON
Principal Scientific Officer

APPENDIX

PHOTOGRAPHS

Hold No 1 (Bottom of Manway)

Hold No 1

Hold No 5

Hold No 5

irtu
INDUSTRIAL RESEARCH & TECHNOLOGY UNIT

Your Ref: MAIB

Our Ref: KMcG/Ind/DS

TI: 200000990

Date: 11 October 2000

ADDENDUM TO REPORT ON

THE INVESTIGATION INTO THE DEATHS OF TWO SOLDIERS ON BOARD CARGO SHIP M.V. DIAMOND BULKER

Mr Alan Rushton – Inspector, MAIB
Department of the Environment
Transport and The Regions
Marine Accident Investigation Branch
First Floor, Carlton House
Carlton Place
Southampton
Hampshire
SO15 2DZ

1. SUMMARY

The additional atmospheric monitoring of the Cargo Holds on the cargo vessel M.V. Diamond Bulker using calibrated equipment by the Industrial Research and Technology Unit (IRTU, has now been completed. This monitoring was subsequent to that carried out on 7 April 2000 following the deaths of two soldiers after entering Cargo Hold No 1 of the vessel.

Our findings confirm that the atmosphere encountered by the soldiers entering the Cargo Hold in the vessel was most probably depleted in Oxygen and also contained increased Carbon Dioxide levels as indicated in our main report of 14 June 2000

Oxygen levels ranged from 17.7% down to 8.8% with Carbon Dioxide levels up to 1.9% prevailing. It was noted that as Carbon Dioxide levels increased across the five Cargo Holds, Oxygen levels became increasingly depleted.

This depletion in the atmospheric Oxygen content is considered to be as a result of the cargo of coal undergoing an oxidation process.

2. UKAS ACCREDITATION

Opinions and interpretations expressed herein are outside the scope of UKAS Accreditation. The tests included in this report are not included in the UKAS Accreditation Schedule for this laboratory.

17 ANTRIM ROAD LISBURN BT28 3AL TELEPHONE +44 (0) 28 9262 3000 FACSIMILE +44 (0) 28 9267 6054 E-MAIL info@irtu.detini.gov.uk WEB www.irtu.ni.gov.uk

3. INTRODUCTION

The additional monitoring described in this Addendum was carried out at the request of Mr Alan Rushton of the Marine Accident Investigation Branch (MAIB) of the Department of the Environment Transport and the Regions (DETR) and authorised by his original letter of instruction dated 10 April 2000.

Mr K McGuinness of IRTU was initially requested to attend the cargo vessel M.V Diamond Bulker docked at Lisahally docks, Londonderry on 7 April 2000 following the deaths of two soldiers after entering a manway in No 1 Hold of the vessel M.V Diamond Bulker.

Carbon Dioxide and Oxygen levels were measured in Cargo Holds No 5 which was kept sealed after the incident. Carbon Dioxide levels were measured however, using semiquantitive methods. Repeat measurements on all the Cargo Holds while still carrying similar cargos, for a similar duration and before opening of the hatches using calibrated equipment, was considered appropriate.

4. VISIT TO VESSEL

Mr McGuinness boarded the Diamond Bulker, which was anchored off the Donegal coast in Lough Foyle on 27 June 2000. Oxygen, Carbon Monoxide, Hydrogen Sulphide and Explosive Gas levels of all the sealed cargo holds (No's 1 - 5) were measured using calibrated Gas Surveyor and GeoTechnical Instruments portable gas meters. All the measurements were carried out in the presence of the ship's captain.

5. RESULTS

The following results were obtained from the atmospheric monitoring in Cargo Holds Nos 1 -5: -

GAS PARAMETER	***Hold No 1***	***Hold No 2***	***Hold No 3***	***Hold No 4***	***Hold No 5***
Oxygen (%)	14.4	17.7	17.3	10.1	8.8
Carbon Dioxide (%)	0.8	0.2	0.1	0.7	1.9
Hydrogen Sulphide (ppm)	< 5	< 5	< 5	< 5	< 5
Carbon Monoxide (ppm)	< 20	< 20	< 20	< 20	< 20

6. DISCUSSION

The results of the atmospheric monitoring in Cargo Holds Nos 1 - 5 of the M.V Diamond Bulker indicated that Oxygen depletion had taken place with elevated levels of Carbon Dioxide prevailing.

Oxygen levels in the five Cargo Holds ranged from 17.7% down to 8.8% with Carbon Dioxide levels maximising at 1.9%. The results generally indicate that as Carbon Dioxide levels increased in the Holds, Oxygen levels became increasingly depleted. It is our opinion that the Oxygen depletion and elevated Carbon Dioxide levels were due to a process known as ***'Spontaneous Oxidation and Heating of Coal'***

It should be noted that the precise Oxygen and Carbon Dioxide levels measured in Cargo Hold No1 on 27 June 2000 cannot be directly equated to those levels which were in the confined space when the fatalities occurred. The overall readings however demonstrate that in all the Cargo Holds, Oxygen depletion and Carbon Dioxide generation took place in varying degrees, during the shipment of coal from Colombia to Londonderry in N. Ireland.

These findings and opinions are in accordance with those outlined the main report (IRTU Ref: TI/20000990) on the fatalities.

KIERAN McGUINNESS
Member of Staff

JOHN E PINKERTON
Principal Scientific Officer

5. Copy of relevant sections from *Code of Safe Practice for Solid Bulk Cargoes*

Section 3
Safety of personnel and ship

3.1 *General requirements*

3.1.1 Prior to and during loading, transport and discharge of bulk materials, all necessary safety precautions, including any appropriate national regulations or requirements, should be observed.

3.1.2 Advice on medical matters is given in the IMO/WHO/ILO *Medical First Aid Guide for Use in Accidents Involving Dangerous Goods* (MFAG). A copy of the MFAG should be on board each ship.

3.2 *Poisoning, corrosive and asphyxiation hazards*

3.2.1 Certain bulk materials are liable to oxidation, which in turn may result in oxygen reduction, emission of toxic fumes and self-heating. Others may not oxidize but may emit toxic fumes, particularly when wet. There are also materials which, when wetted, are corrosive to skin, eyes and mucous membranes or to the ship's structure. In these cases, particular attention should be paid to personal protection and the need for special precautions and measures to be taken prior to loading and after unloading.

3.2.2 It is important, therefore, that the shipper informs the master prior to loading as to whether chemical hazards exist. The master should also refer to appendix B and the necessary precautions, especially those pertaining to ventilation, should be taken.

3.2.3 Shipmasters are warned that cargo spaces and adjacent spaces may be depleted in oxygen or may contain toxic or asphyxiating gases. An empty cargo space or tank which has remained closed for some time may have insufficient oxygen to support life.

3.2.4 Many materials frequently carried in bulk are liable to cause oxygen depletion in a cargo space or tank; these include most vegetable products, grains, timber logs and forest products, ferrous metals, metal sulphide concentrates and coal cargoes.

3.2.5 It is, therefore, essential that entry of personnel into enclosed spaces should not be permitted until tests have been carried out and it has been established that the oxygen content has been restored to a normal level throughout the space and that no toxic gas is present, unless adequate ventilation and air circulation throughout the free space above the material has been effected. It should be remembered that, after a cargo space or tank has been tested and generally found to be safe for entry, small areas may exist where oxygen is

deficient or toxic fumes are still present. **General precautions and procedures for entering enclosed spaces appear in appendix F▷◁. As much publicity as possible should be given to the hazards associated with entry into enclosed spaces. A poster on the subject should be produced. A specimen (reduced format) for such a poster for display on board ships in accommodation or other places, as appropriate, has been included in appendix F.***

3.2.6 When transporting a bulk cargo which is liable to emit a toxic or flammable gas, or cause oxygen depletion in the cargo space, an appropriate instrument for measuring the concentration of gas or oxygen in the cargo space should be provided.

3.2.7 It should be noted that a flammable gas detector is suitable only for testing the explosive nature of gas mixtures.

3.2.8 Emergency entry into a cargo space should be undertaken only by trained personnel wearing self-contained breathing apparatus, and protective clothing if considered necessary, and always under the supervision of a responsible officer.

3.3 *Health hazards due to dust*

3.3.1 To minimize the chronic risks due to exposure to the dust of certain materials carried in bulk, the need for a high standard of personal hygiene of those exposed to the dust cannot be too strongly emphasized. The precautions should include not only the use of appropriate protective clothing and barrier creams when needed but also adequate personal washing and laundering of outer clothing. Although these precautions are good standard practice, they are particularly relevant for those materials identified as toxic by this Code.

3.4 *Flammable atmosphere*

3.4.1 Dust created by certain cargoes may constitute an explosion hazard, especially while loading, unloading and cleaning. This risk can be minimized at such times by ensuring that ventilation is sufficient to prevent the formation of a dust-laden atmosphere and by hosing down rather than sweeping.

3.4.2 Some cargoes may emit flammable gases in sufficient quantities to constitute a ▷fire or explosion◁ hazard. Where this is indicated in the entries in appendix B, the cargo spaces and adjacent enclosed spaces should be effectively ventilated at all times (see also 9.3.2.1.3 for requirements for mechanical ventilation). It may be necessary to monitor the atmosphere in such spaces by means of combustible-gas indicators. It should be recognized that, in general,

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* Refer also to ▷resolution A.864(20), Recommendations for entering enclosed spaces aboard ships.◁

COAL*

(See also appendix A)

BC No.	IMO class	MFAG table no.	Approximate stowage factor (m^3/t)	EmS no.
010	MHB	311, 616†	0.79 to 1.53	B14

Properties and characteristics

1 Coals may emit methane, a flammable gas. A methane/air mixture containing between 5% and 16% methane constitutes an explosive atmosphere which can be ignited by sparks or naked flame, e.g. electrical or frictional sparks, a match or lighted cigarette. Methane is lighter than air and may, therefore, accumulate in the upper region of the cargo space or other enclosed spaces. If the cargo space boundaries are not tight, methane can seep through into spaces adjacent to the cargo space.

2 Coals may be subject to oxidation, leading to depletion of oxygen and an increase in carbon dioxide in the cargo space (see also section 3 and appendix F).

3 Some coals may be liable to self-heating that could lead to spontaneous combustion in the cargo space. Flammable and toxic gases, including carbon monoxide, may be produced. Carbon monoxide is an odourless gas, slightly lighter than air, and has flammable limits in air of 12% to 75% by volume. It is toxic by inhalation, with an affinity for blood haemoglobin over 200 times that of oxygen.

4 Some coals may be liable to react with water and produce acids which may cause corrosion. Flammable and toxic gases, including hydrogen, may be produced. Hydrogen is an odourless gas, much lighter than air, and has flammable limits in air of 4% to 75% by volume.

Segregation and stowage requirements

1 Boundaries of cargo spaces where materials are carried should be resistant to fire and liquids.

2 Coals should be "separated from" goods of classes 1 (▷except◁ division 1.4), 2, 3, 4, and 5 in packaged form (see IMDG Code) and "separated from" solid bulk materials of classes 4 and 5.1.

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* For comprehensive information on transport of any material listed, refer to sections 1–10 of this Code.

† Refer to paragraph 6.1.1 (Asphyxia) of the MFAG.

COAL *(continued)*

3 Stowage of goods of class 5.1 in packaged form or solid bulk materials of class 5.1 above or below a coal cargo should be prohibited.

4 Coals should be "separated longitudinally by an intervening complete compartment or hold from" goods of class 1 other than division 1.4.

Note: For the interpretation of the segregation terms see paragraph 9.3.3.

General requirements for all coals

1 Prior to loading, the shipper or his appointed agent should provide in writing to the master the characteristics of the cargo and the recommended safe handling procedures for loading and transport of the cargo. As a minimum, the cargo's contract specifications for moisture content, sulphur content and size should be stated, and especially whether the cargo may be liable to emit methane or self-heat.

2 The master should be satisfied that he has received such information prior to accepting the cargo. If the shipper has advised that the cargo is liable to emit methane or self-heat, the master should additionally refer to the "Special precautions".

3 Before and during loading, and while the material remains on board, the master should observe the following:

.1 All cargo spaces and bilge wells should be clean and dry. Any residue of waste material or previous cargo should be removed, including removable cargo battens, before loading.

.2 All electrical cables and components situated in cargo spaces and adjacent spaces should be free from defects. Such cables and electrical components should be safe for use in an explosive atmosphere or positively isolated.

.3 The ship should ▷be suitably fitted and◁ carry on board appropriate instruments for measuring the following without requiring entry in the cargo space:

.3.1 concentration of methane in the atmosphere;

.3.2 concentration of oxygen in the atmosphere;

.3.3 concentration of carbon monoxide in the atmosphere; ▷and◁

.3.4 pH value of cargo hold bilge samples▷.◁

These instruments should be regularly serviced and calibrated. Ship personnel should be trained in the use of such instruments. ▷Details of gas measurement procedures are given in appendix G.◁

COAL *(continued)*

▷.4 It is recommended that means be provided for measuring the temperature of the cargo in the range 0°C to 100°C. Such arrangements should enable the temperature of the coal to be measured while being loaded and during the voyage without requiring entry into the cargo space.◁

▷.5◁ The ship should carry on board the self-contained breathing apparatus required by SOLAS regulation II-2/17. The self-contained breathing apparatus should be worn only by personnel trained in its use (see also section 3 and appendix F).

▷.6◁ Smoking and the use of naked flames should not be permitted in the cargo areas and adjacent spaces and appropriate warning notices should be posted in conspicuous places. Burning, cutting, chipping, welding or other sources of ignition should not be permitted in the vicinity of cargo spaces or in other adjacent spaces, unless the space has been properly ventilated and the methane gas measurements indicate it is safe to do so.

▷.7◁ The master should ensure that the coal cargo is not stowed adjacent to hot areas.

▷.8◁ Prior to departure, the master should be satisfied that the surface of the material has been trimmed reasonably level to the boundaries of the cargo space to avoid the formation of gas pockets and to prevent air from permeating the body of the coal. Casings leading into the cargo space should be adequately sealed. The shipper should ensure that the master receives the necessary co-operation from the loading terminal (see also section 5).

▷.9◁ The atmosphere in the space above the cargo in each cargo space should be regularly monitored for the presence of methane, oxygen and carbon monoxide. ▷Details of gas monitoring procedures are given in appendix G.◁ Records of these readings should be maintained. The frequency of the testing should depend upon the information provided by the shipper and the information obtained through the analysis of the atmosphere in the cargo space. ▷◁

▷.10 Unless expressly directed otherwise, all holds should be surface ventilated for the first 24 hours after departure from the loading port. During this period, one measurement should be taken from one sample point per hold.

If after 24 hours the methane concentrations are at an acceptably low level, the ventilators should be closed. If not, they should remain open until acceptably low levels are obtained. In either event, measurements should be continued on a daily basis.

COAL *(continued)*

▷ If significant concentrations of methane subsequently occur in unventilated holds, the appropriate special precautions as described in section 2.2.1 should apply.◁

▷.11◁ The master should ensure, as far as possible, that any gases which may be emitted from the materials do not accumulate in adjacent enclosed spaces.

▷.12◁ The master should ensure that enclosed working spaces, e.g. storerooms, carpenter's shop, passage ways, tunnels, etc., are regularly monitored for the presence of methane, oxygen and carbon monoxide. Such spaces should be adequately ventilated.

▷.13◁ Regular hold bilge testing should be systematically carried out. If the pH monitoring indicates that a corrosion risk exists, the master should ensure that all ▷◁ bilges are kept dry during the voyage in order to avoid possible accumulation of acids on tank tops and in the bilge system.

▷.14◁ If the behaviour of the cargo during the voyage differs from that specified in the cargo declaration, the master should report such differences to the shipper. Such reports will enable the shipper to maintain records on the behaviour of the coal cargoes, so that the information provided to the master can be reviewed in the light of transport experience.

▷.15◁ The Administration may approve alternative requirements to those recommended in this schedule.

Special precautions

1 *Coals emitting methane*

If the shipper has advised that the cargo is liable to emit methane or analysis of the atmosphere in the cargo space indicates the presence of methane ▷in excess of 20% of the lower explosion limit (LEL)◁, the following additional precautions should be taken:

.1 Adequate surface ventilation should be maintained. On no account should air be directed into the body of the coal as air could promote self-heating.

.2 Care should be taken to vent any accumulated gases prior to removal of the hatch covers or other openings for any reason, including unloading. Cargo hatches and other openings should be opened carefully to avoid creating sparks. Smoking and the use of naked flame should be prohibited.

COAL *(continued)*

.3 Personnel should not be permitted to enter the cargo space or enclosed adjacent spaces unless the space has been ventilated and the atmosphere tested and found to be gas-free and to have sufficient oxygen to support life. If this is not possible, emergency entry into the space should be undertaken only by trained personnel wearing self-contained breathing apparatus, under the supervision of a responsible officer. In addition, special precautions to ensure that no source of ignition is carried into the space should be observed (see also section 3 and appendix F).

.4 The master should ensure that enclosed working spaces, e.g. storerooms, carpenter's shops, passage ways, tunnels, etc., are regularly monitored for the presence of methane. Such spaces should be adequately ventilated and, in the case of mechanical ventilation, only equipment safe for use in an explosive atmosphere should be used. Testing is especially important prior to permitting personnel to enter such spaces or energizing equipment within those spaces.

2 *Self-heating coals*

.1 If the shipper has advised that the cargo is liable to self-heat, the master ▷should◁ seek confirmation that the precautions intended to be taken and the procedures intended for monitoring the cargo during the voyage are adequate.

.2 If the cargo is liable to self-heat or analysis of the atmosphere in the cargo space indicates an increasing concentration of carbon monoxide▷ ◁, then the following additional precautions should be taken:

.2.1 The hatches should be closed immediately after completion of loading in each cargo space. The hatch covers can also be additionally sealed with a suitable sealing tape. Surface ventilation should be limited to the ▷absolute minimum time◁ necessary to remove ▷methane◁ which may have accumulated. Forced ventilation should not be used. On no account should air be directed into the body of the coal as air could promote self-heating.

.2.2 Personnel should not be allowed to enter the cargo space, unless they are wearing self-contained breathing apparatus and access is critical to the safety of the ship or safety of life. The self-contained breathing apparatus should be worn only by personnel trained in its use (see also section 3 and appendix F).

.2.3 When required by the competent authority, the ▷carbon monoxide concentration◁ in each cargo space should be measured at regular time intervals to detect self-heating.

COAL *(continued)*

▷.2.4 If at the time of loading, when the hatches are open, the temperature of the coal exceeds 55°C, expert advice should be obtained.◁

▷.2.5◁ If ▷◁ the carbon monoxide level is increasing ▷steadily◁, a potential ▷self-heating◁ may be developing. The cargo space should be completely closed down and all ventilation ceased. The master should seek expert advice immediately▷◁. Water should not be used for cooling the material or fighting coal cargo fires at sea, but may be used for cooling the boundaries of the cargo space.

▷.2.6 Information to be passed to owners

The most comprehensive record of measurements will always be the log used to record daily results. The coal cargo monitoring log for the voyage should be faxed, or the appropriate content should be telexed to the vessel's owners.

The following minimum information is essential if an accurate assessment of the situation is to be achieved.

(a) identity of the holds involved; monitoring results covering carbon monoxide, methane and oxygen concentrations;

(b) if available, temperature of coal, location and method used to obtain results;

(c) time gas samples taken (monitoring routine);

(d) time ventilators opened/closed;

(e) quantity of coal in hold(s) involved;

(f) type of coal as per shipper's declaration, and any special precautions indicated on declaration;

(g) date loaded, and ETA at intended discharge port (which should be specified); and

(h) comments or observations from the ship's master.◁