Report of the investigation

of a carbon monoxide poisoning on

fv *Mariama K* (FR242)

in Douarnenez, France

on 10 June 2000

One fatality

Marine Accident Investigation Branch
First Floor, Carlton House
Carlton Place
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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.

CONTENTS

GLOSSARY OF ABBREVIATIONS

BST	-	British summer time
°C	-	Degrees centigrade
cc	-	cubic centimetre
kg	-	kilogram
kW	-	kilowatt
m	-	metre
MCA	-	Maritime and Coastguard Agency
MGN(F)	-	Marine Guidance Notice to Fishermen
mm	-	millimetre
ppm	-	parts per million
ρ	-	rho (density)
RSW	-	Refrigerated sea water
SAR	-	Search and rescue
UN	-	United Nations
UTC	-	Universal co-ordinated time
WC	-	Water closet

SYNOPSIS

This accident occurred in Douarnenez, France on 10 June 2000, and was reported by e-mail to the Chief Inspector of Marine Accidents by French maritime authorities on 13 June. Following the collection of further information, MAIB formally opened this investigation on 22 June.

Mariama K is a 29.76m long, UK-registered steel fishing vessel, built in 1976. Following a period working off West Africa, she returned to Europe and spent several weeks in Douarnenez, France.

While making preparations for her departure from Douarnenez, a portable petrol-engined pump was used to pump out the engine room bilges. The engine of this pump exhausted directly into the engine room.

Shortly after 1900 local French time on 10 June, the vessel's engineer was found unconscious in the engine room, slumped over the (still running) portable pump. The crew and local emergency services tried to resuscitate him, but all attempts failed and he was later declared dead. The cause of death was given as carbon monoxide (CO) poisoning.

While lifting the engineer out of the engine room, members of the emergency services and two other crewmen were also seriously affected by CO.

The Maritime and Coastguard Agency (MCA) is recommended to:

Offer advice to UK fishing vessel owners on the likely management implications of operating well outside of the European regime for vessel repair, and also to offer advice to owners, skippers and crew on the safe operation of portable pumps powered by petrol or diesel engines.

- Admiralty Chart 4014 reproduced by permission of the Controller of HMSO and the UK Hydrographic Office.

SECTION 1 - FACTUAL INFORMATION

1.1 PARTICULARS OF VESSEL AND ACCIDENT

Name	:	*Mariama K*
Type	:	Fishing vessel
Fishing letters and number	:	FR242
Port of registry	:	Fraserburgh
Length	:	29.76m
Engine power	:	522kW
Construction material	:	Steel
Date built	:	1976
Builders	:	Wood & Davidson (Peterhead)
Owners	:	Iasgair Ltd 127 Shore Street Fraserburgh AB43 9BP
Place	:	Douarnenez, France
Loss of life and injuries	:	One life lost, six others affected to varying degrees by fumes

All times are quoted as French local time (BST + 1hour). Times marked * are times that the crew of the vessel provided, and have therefore been adjusted to French local time.

See comments in Section 2.1.

Mariama K

1.2 NARRATIVE

During the summer of 1999 *Mariama K* sailed to West Africa from the UK. On board were a skipper, mate and two other crewmen. She arrived in Conakry, Guinea, on 4 August. The plan was to fish in local waters. Once there, five West Africans were taken on as deckhands.

Fishing operations were restricted by local requirements.

A decision was made to return to European waters during the spring of 2000. Shortly before departure, problems were experienced with the vessel's bilge pumps. To control what was thought to be leakage from the stern or rudder gland, a portable petrol-engined pump was purchased locally.

Four of the five locally engaged crewmen were put ashore before departure. The fifth remained on board for the voyage to Europe.

Calling at Gambia, Morocco and Tenerife en-route, the vessel arrived in Douarnenez, France, on 14 May.

During the passage, the portable pump was used three or four times daily to pump out engine room bilges, often for five to ten minutes on each occasion. Initially the pump was located on the working deck. However, its performance was limited in this position, so it was moved to the engine room to reduce the suction lift.

After arrival in Douarnenez, most of *Mariama K* 's crew disembarked, leaving only the West African crewman on board. He had instructions to look after the vessel and carry out some cleaning.

The crewman used the portable pump to clear bilges when required. He also carried out some cleaning, sometimes with cleaning materials supplied by the vessel's local agent.

Three weeks after the vessel arrived in Douarnenez, the mate and the engineer returned. Their objective was to assess the repairs needed, and oversee this work. The repairs included the defective engine room bilge pumps and hydraulic systems.

Owing to lack of facilities and estimated costs at Douarnenez, the vessel was taken to Falmouth, UK, for repairs.

In preparation, the vessel refuelled and transferred from shore to ship's electrical power supply on Friday 9 June. All three men then spent the night ashore in Quimper, and returned to *Mariama K* after lunch the following day.

The crewman later went ashore for a haircut. The skipper was in the wheelhouse and the third engineer was in the engine room transferring fuel and pumping bilges. The portable pump started between 1700* and 1730* and was seen to be pumping.

The engineer was last seen at about 1745*, busy, hot and sweaty.

The third crewman returned from ashore at about 1830*. Between 15 to 20 minutes later he went to the engine room, where he found the engineer slumped unconscious over the portable pump, with his right arm on the exhaust. The pump was still running.

He stopped the pump and attempted to revive the engineer by splashing water on his face, but without success. The crewman then reported to the skipper that the engineer was asleep slumped over the portable pump and had burned his arm.

Both men returned to the engine room. There was no smell or visible smoke. They again tried unsuccessfully to revive the engineer. Realising they needed help to move the engineer, the skipper left the engine room but had some difficulty climbing the ladder. At this stage the crewman was noticed to be behaving oddly. He also had difficulty in getting out of the engine room.

From a bar ashore the skipper made a call to the emergency services.

At about the time of this call, a local fire crew were directed to investigate a report of a man falling into the fish hold of a fishing vessel and breaking his collarbone. This fire crew boarded the *Mariama K* at 1924, and were joined shortly after by police officers.

The fire crew found the engineer slumped over the portable pump in a cramped region of the engine room. They lifted him over the auxiliary engine, and placed him on the central walkway floor plates between the auxiliary and main engines. There they attempted to resuscitate him.

A doctor arrived at about 1935 and entered the engine room to find the firemen attempting to resuscitate the engineer.

Considering it impossible to perform proper resuscitation in that position, they decided to remove the engineer from the engine room. This manoeuvre, requiring the engineer to be lifted up the engine room’s vertical ladder, proved difficult due to the limited space and the size of the casualty.

During this operation, the rescuers displayed the first signs of carbon monoxide poisoning.

The casualty was placed in the fore and aft passage by the engine room door at main deck level. He could not be revived.

Because the senior fire officer suspected the presence of fumes, all personnel were evacuated to the open deck.

At this stage the crewman lost consciousness and required oxygen treatment. The skipper was vomiting and complaining of a headache. Together with a police officer and fireman, these two men were sent to hospital for observation.

A fire brigade officer tested the atmosphere in the engine room at 2145. Carbon monoxide concentration of 370 parts per million (ppm) was recorded. At this time the chemical handling team of the fire brigade started the ventilation fan to make the space safe for entry.

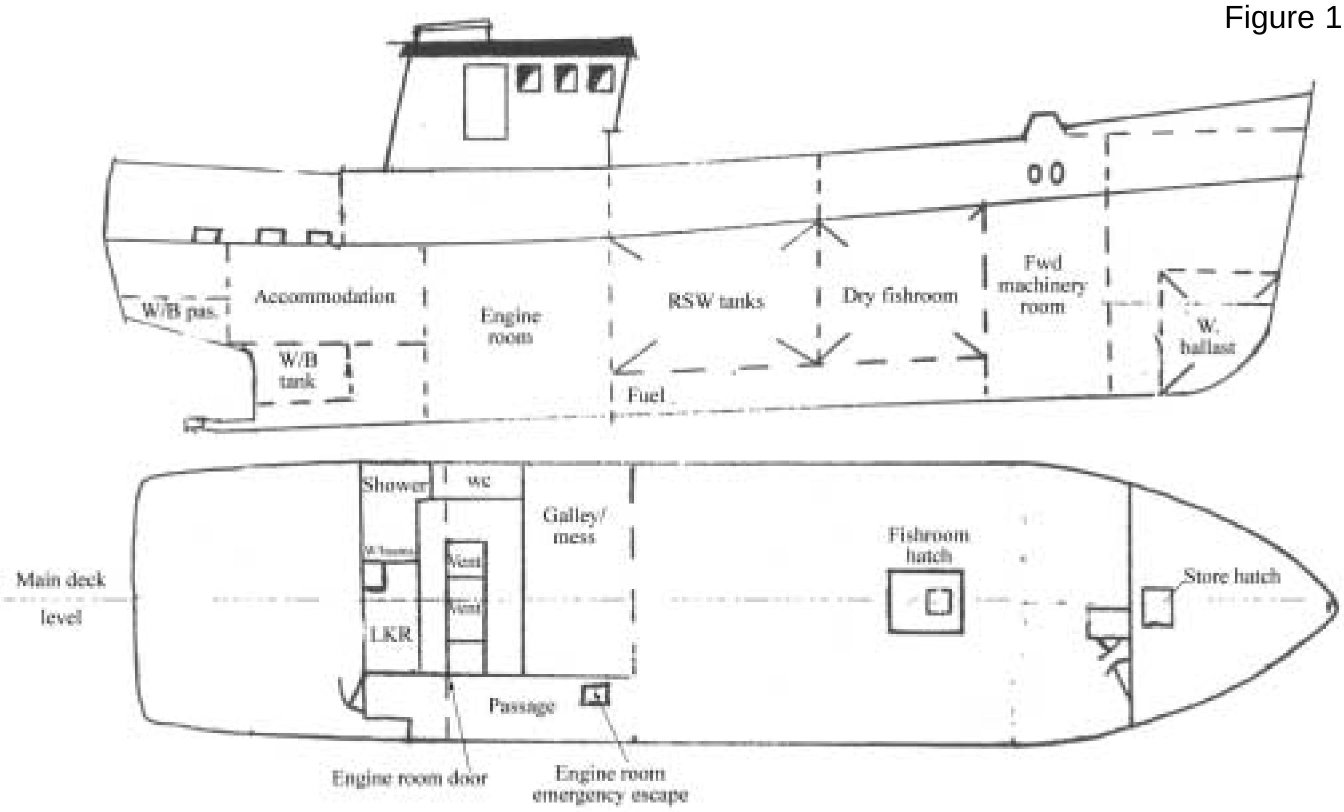
Ventilation was considered complete at 2320 when CO readings were reported as zero.

1.3 GENERAL ARRANGEMENT

Mariama K is a steel-hulled two-deck fishing vessel with wheelhouse three-quarters aft. Beneath the wheelhouse, at working or lower deck level, are the galley, WC, shower and storage spaces.

Below working deck level the hull is divided into five main compartments. From forward to aft, these are: forward store, forward machinery space, fishroom/refrigerated sea water (RSW) space; engine room; cabin **(see Figure 1)**.

Figure 1



Mariama K - General Arrangement

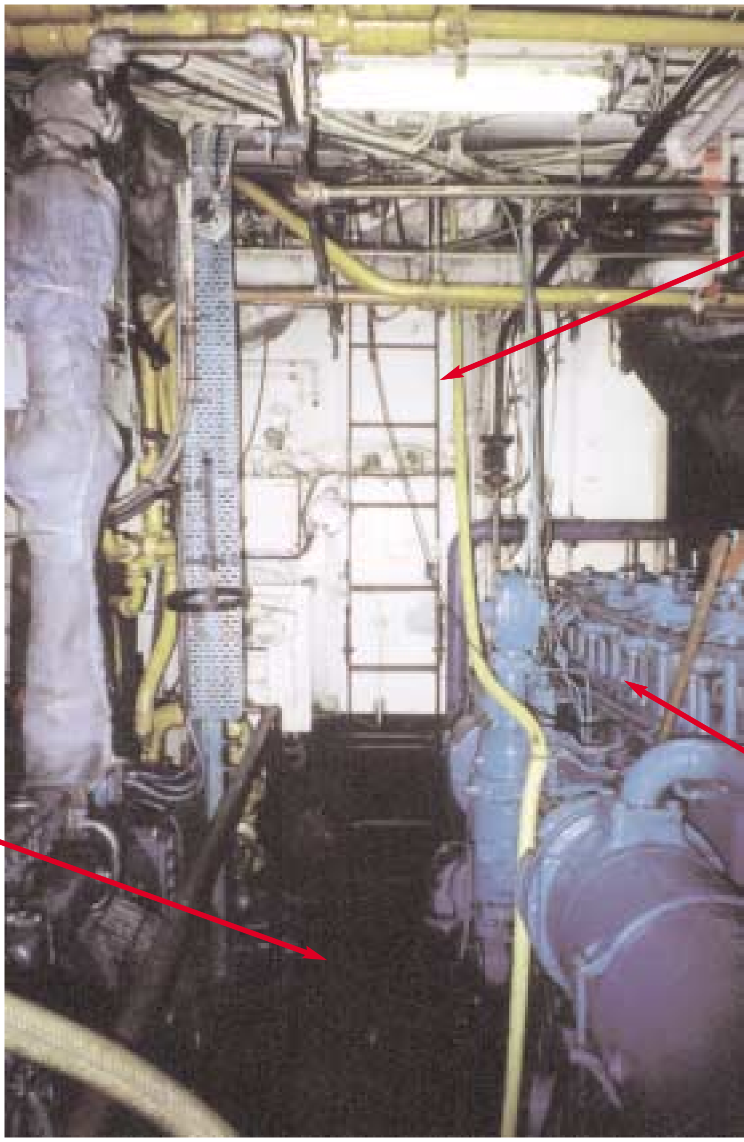
At main deck level, on the starboard side of the galley, is a fore and aft working passage. From here is the engine room main access door and, set in the deck of the gangway, the engine room's emergency escape hatch.

The main engine room door leads into a vertical trunk, with a ladder leading down to a fore and aft walkway to the starboard side of the main engine. On the starboard side of this walkway is an auxiliary engine with another narrow length of walkway at its starboard side **(see Figure 2)**.

At the forward end of the narrow walkway by this auxiliary engine is a ladder leading up to the engine room emergency escape hatch at main deck level.

The portable pump used to pump bilges was positioned at the forward end of this narrow walkway, beneath the emergency escape hatch.

Figure 2



1.4 CREW AND CERTIFICATION

The port of Douarnenez, France, is within the Limited Area as defined in the Fishing Vessels (Certification of Deck Officers and Engineer Officers) Regulations 1984 as amended. These regulations set out the requirements as regards the certificates of competency to be carried by persons on board a UK fishing vessel. The requirements are related to the vessel's registered length, engine power and area of operation.

Mariama K has a registered length of 29.76m and engine power of 522kW. When the vessel proceeds to sea, within the Limited Area, these regulations require the vessel to carry certificated persons as follows:

One person holding a Class 2 Fishing Vessel Certificate (Deck Officer)

One person holding a Class 3 Fishing Vessel Certificate (Deck Officer)

No person with an engineering certificate is required.

A UK Second Hand Full & Special Fishing Vessel Certificate (Deck Officer) was held by one of the three crew on board, and another held a Class 2 Fishing Vessel Engineers Certificate of Service, issued by Department of the Marine, Eire. The third person had no relevant qualifications.

Although the vessel required no certificated engineer, for ease of reference the three people on board at the time of the accident will, in this report, be referred to as skipper, engineer and crewman.

1.5 THE PERIOD IN WEST AFRICA

During her stay of 7 to 8 months in West Africa, *Mariama K* achieved very little fishing. This was partly due to difficulties with the local authorities who, for several weeks, denied the crew access to the vessel.

In addition, security and unauthorised removal of equipment, including a self-contained breathing apparatus, proved to be a problem.

Repair of equipment, particularly of bilge pumps and hydraulic equipment, was also difficult because of the poor local availability of suitable spares.

Shortly before the vessel's departure from West Africa, a portable petrol engined pump was purchased locally to replace the vessel's defective bilge pumps.

1.6 THE PORTABLE PUMP

The complete portable pump unit is designated as a Honda WP30X. The engine is a Honda 4-stroke, overhead valve petrol engine of 163cc capacity. This is directly coupled to a centrifugal self-priming pump having a discharge capacity of 900 litre per minute at a total head of 5m. Its limiting suction head lift is 9.5m.

Pump and engine are mounted in a tubular space frame having overall dimensions of 505mm x 376mm x 490mm and total mass of 28kg.

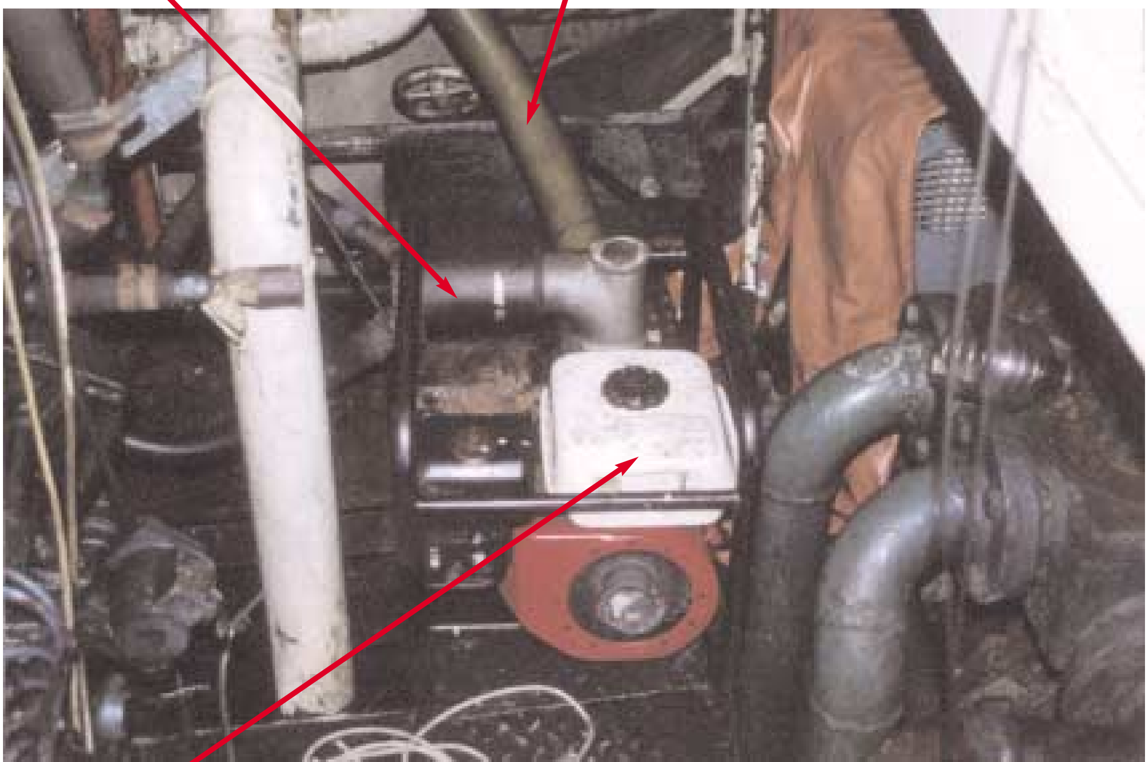
1.7 BILGE PUMPING PROCEDURES

During the voyage to Europe, the engine room bilges were routinely pumped out using the portable pump. Initially this was placed on the working deck, with a suction hose leading into the engine room bilges. The pump did not perform well in this arrangement, so it was decided to reduce the suction lift by lowering the pump into the engine room **(see Figure 3)**. This configuration performed satisfactorily.

Discharge connection

Suction hose

Figure 3



Portable pump

Typically the pump was run for five to ten minutes three or four times per day.

The portable pump, positioned at the starboard side of the main engine, was used to pump the bilge water into a slush well on the starboard side of the working deck. Two hoses, passing from the pump through the engine room's emergency escape hatch, connected the pump to the slush well. An electric pump, permanently installed in the slush well, then transferred the bilge water overboard.

Running time on 10 June was between 1 and 1½ hours. Pumping rate was restricted, probably by some partial obstruction of the pump, resulting in an estimated flow rate of about one third of maximum. Despite this poor performance, it was decided to leave the pump running in this state. This made it necessary to extend the running time required to clear the bilges.

1.8 WATER INGRESS

Water leakage through the rudder stock gland had been a problem for several weeks before the accident. As this leakage drained into the engine room, these bilges needed to be emptied regularly.

When the vessel returned to the UK, the rudder stock gland was easily tightened sufficiently to stop the leakage. However, it is not known whether the leakage resumed when the rudder was again in operation under seagoing conditions.

1.9 THE STAY IN DOUARNENEZ

On arrival in Douarnenez it was expected that the vessel would be sold to new owners. All but one crewman then returned to the UK.

The crewman was left with instructions to remain with the vessel as a watchman. His duties included pumping out bilges, cleaning, tidying and general care of the vessel.

Mariama K's local agents supplied her with a 25kg drum of Sodium Hydroxide-based cleaning fluid United Nations (UN) No 1824. He used this to clean some particularly dirty areas, including parts of the engine room. Also supplied were some personal protective clothing such as rubber gloves and aprons. The agent gave the crewman some instruction on the importance of using this equipment when handling the cleaning fluid, United Nations (UN) No 1824.

1.10 VENTILATION

The engine room has a forced ventilation system powered by an electric fan. This system was not in operation on the afternoon of the accident.

As the air consumed by the main and auxiliary engines is drawn from the engine room, when they are running the consequent air movement provides ventilation.

Without the ventilation fan, main engine or the auxiliary engine running, there was no forced circulation of air through the engine room.

1.11 PROPERTIES OF CARBON MONOXIDE (CO)

At normal atmospheric conditions, CO is a colourless, flammable and odourless gas having a density slightly less than air. It can be inhaled without giving any warning to the victim, with the first sign of severe poisoning being loss of consciousness. Further inhalation of high concentrations will readily lead to death.

Exposure to an airborne concentration of 400ppm for 1 to 2 hours gives symptoms of serious headache, fatigue, nausea and dizziness. This exposure is life-threatening after three hours.

At a concentration of 3200ppm death can occur within 1 hour. At 6400ppm, death within 25 to 30 minutes; 12800ppm, death after 1 to 3 minutes exposure.

The major effects of CO on humans are caused by a reduction in the oxygen-carrying capacity of the blood due to its ability to combine with blood in preference to oxygen. CO combines with the oxygen-carrying haemoglobin in the blood to form carboxyhaemoglobin.

Concentrations of carboxyhaemoglobin in the blood in excess of 50% to 60% are fatal.

1.12 BLOOD ANALYSIS

After the engineer’s body was taken to Douarnenez Hospital, a blood sample was taken and tested.

The test result figure for concentration of carboxyhaemoglobin in the blood sample was 68%. The hospital physician concluded from these results that carbon monoxide poisoning was the cause of death.

1.13 INSPECTION OF VESSEL

The MAIB was unable to obtain a translation of the report written by the French police, or the medical reports, until several months after the accident. They were, therefore, not available when she was inspected by the MAIB upon her return to Falmouth, UK, in July 2000.

Although the general circumstances of the accident, as recounted by skipper and crewman, firmly suggested that exhaust fumes from the portable pump overcame the engineer, during the inspection efforts were made to collect data that might support another explanation.

After finding the unconscious engineer, both skipper and crewman felt the effects of an inhospitable atmosphere while in the engine room. They had entered no other enclosed space on the vessel. Further, the engine room ventilation fan had not been running, so precluding the possibility that fumes had been ingested from without. Therefore the examination centred on the engine room and its contents.

The engine room contained fuel oil, lubricating oil and, in the fuel tank of the portable pump, petrol. Apart from petrol, none of these substances could be expected to produce a vapour at ambient temperature. Apart from being highly explosive, petrol vapour has a strong and easily recognisable odour. No petrol odour was present, nor were there any signs of petrol leakage from the pump's fuel tank.

A container of sodium hydroxide solution (caustic soda), was also stowed in the engine room. This substance had been supplied for the crewman to carry out some cleaning tasks in Douarnenez. The container was marked with the substance's UN number of UN1824, together with a label setting out its hazards. It is corrosive to certain common metals, reacts violently with acids, and reacts with ammonium salts evolving ammonia gas.

The last time the crewman had used this sodium hydroxide was about one week before the accident.

Although there are hazards associated with sodium hydroxide, health and safety data indicates that at an ambient temperature of 20°C, evaporation is negligible. Similar sources also indicate that inhalation produces a cough, a burning sensation and laboured breathing. Neither the skipper, nor the crewman, reported having these symptoms during the incident.

These properties of sodium hydroxide caused it to be dismissed as a cause, or a contributory cause, of this accident.

No other substance capable of producing a noxious vapour was found in the engine room. However, the portable petrol-powered pump, at the starboard forward end of the engine room was examined.

Apart from noting that the engine of this pump exhausted into the engine room, details of manufacturer, its type and capacity were recorded. These have been stated in Section 1.6. Also noted was the poor condition of several parts of the engine, in particular the governor linkage and sparking plug were very heavily corroded **(see Figure 4)**. Although the governor linkage was free to move by hand, it was not established whether its range of movement was to specification. The engine and pump were not test run as part of this inspection.

This investigation then awaited the medical reports from the French authorities. As the initial reports suggested, these confirmed that the engineer had died from CO poisoning.

Figure 4

SECTION 2 - ANALYSIS

2.1 TIMING

Times of arrival of the local emergency services are accurately documented in their records. These show that the first unit was on scene at 1925, and was joined about ten minutes later by the doctor.

However, the times quoted by the skipper and crewman suggest that these events occurred at least one hour earlier. These times are indicated by * in Section 1.2, Narrative. For example, the skipper and crewman recall finding the engineer unconscious at about 1750.

In the absence of an unaccountable delay between finding the unconscious engineer and calling the emergency services, this discrepancy can only be explained if *Mariama K* and, therefore her skipper and crewman, were using a time other than local French time.

On the date of this accident UK time was set on BST, or one hour ahead of UTC, and one hour behind local French time.

The vessel had spent several months in Conakry, West Africa, before her voyage to Douarnenez where she was in the care of the West African crewman. Local time in Conakry is UTC throughout the year, with no seasonal changes for daylight saving etc. It is possible that the crewman had maintained his own watch, and possibly also the vessel's clocks, on Conakry time, UTC. Had that been so, the time of first finding the unconscious engineer, 1750, corresponds to French time of 1950. From the local emergency services records this was clearly not so.

Three days before the accident, the skipper and engineer had travelled from the UK. Further, within a few hours *Mariama K* was due to leave France to sail to the UK. These factors suggest the vessel's time might have been on BST, 1 hour behind local French time.

Crew recollections on this matter are unclear. However, the one hour difference between UK and French time approximately corresponds to the differences between official French records and the initial recollections of skipper and crewman. In the absence of any other plausible explanation for the difference in times given in Section 1.2, Narrative, it is assumed that this was the case.

This assumption means that all the times marked * in the Section 1.2, Narrative, have had 1 hour added to bring them to local French time

2.2 PORTABLE PUMPS

Portable pumps, driven by diesel or petrol engines, are carried by a number of UK fishing vessels. These are in excess of statutory safety requirements, but skippers and owners see them as valuable backups to permanently installed bilge, deck wash, and general service pumps.

The popularity of these portable pumps has increased over the past decade. This is probably due to the valuable role played by similar pumps, supplied by the coastguard, and carried to vessels suffering from flooding problems. Availability, and keen pricing of mass produced units have also played their role.

The typical emergency application for a portable pump is to remove floodwater from an engine room or fish room. For these purposes the pump is normally placed on an open deck, and a semi-rigid suction pipe is passed into the flooded space. The pump, and more importantly its engine, is in a well-ventilated space where an accumulation of exhaust gases would not be possible. This is the recommended mode of operation.

Using these pumps within a confined space, such as an engine room, is not a recommended practice. In view of the growing popularity of these units in the fishing industry, The MCA is recommended to issue a Marine Guidance Note to the fishing industry (MGN (F)), referring to this accident as suitable material to emphasise the potential dangers of their use.

2.3 PUMPING TIMES

Difficulties with the vessel's bilge pumps, and the need to regularly clear the bilges, resulted in the portable pump on *Mariama K* becoming a substitute for a bilge pump. Indeed, it was the only mechanical method available for pumping engine room bilges. As such it became semi-permanently situated at the forward starboard corner of the engine room, together with its associated suction and discharge hoses.

During the vessel's passage to Europe from West Africa, the portable pump was routinely used to empty the engine room bilges three or four times per day. Each operation required the pump to run between 5 and 10 minutes.

When used by the caretaker crewman in Douarnenez, the pump was used for 10 to 15 minutes each time. Operating alone, the crewman normally stood on deck watching the overboard discharge, and was well away from any exhaust gases.

On 10 June, with the vessel in Douarnenez, this pump was running for between one and 1 and 1½ hours; significantly longer than on any previous occasion when used at sea. As a result, far more exhaust gas was generated.

2.4 ENGINE ROOM VENTILATION

During the afternoon of 10 June neither the main engine, the auxiliary engine, or the engine room ventilation fan had been started. Without these running, the engine room on *Mariama K* relied entirely on passive ventilation. The two major openings in the engine room casing were the main entrance door and the emergency escape. Both were open at the time of the accident.

The inadequacy of passive ventilation has been demonstrated in numerous accidental CO induced deaths in domestic garages. Even with garage doors and windows open, sufficient CO concentrations have accumulated to cause death.

There are slight differences in geometry between a domestic garage and the engine room of *Mariama K.* Doors and windows of domestic garages are openings in the side boundaries; the main doorway and emergency escape of *Mariama K* were in the top boundary of the engine room. However, the difference in density between air and CO is small, with CO being slightly less dense than air dense than air ($\rho_{CO} \approx 0.986\rho_{air}$). Convective effects are, therefore, likely to have been small and contributed little to the circulation of air into, and within, the engine room.

Conversely, when at sea with the main engine running, there would have been a significant airflow through the engine room. This, coupled with the comparatively short duration of each pumping session while at sea, would have ensured that there was no serious accumulation of CO.

Although not recommended practice, using the pump in the engine room when the vessel was at sea caused no significant accumulation of gases because of the ventilation induced by the running main engine and ventilation fan. Further, the pump was run for no longer than 5 to 10 minutes, so limiting the quantity of CO generated. However, there are other matters of concern associated with this practice.

2.5 OTHER SAFETY MATTERS

Danger of downflooding

Whether it was positioned inside or outside the engine room, using the portable pump to clear the engine room bilges meant that at least one length of portable pipeline had to pass across the engine room's boundary.

Positioned at the forward starboard corner of the engine room, the pump's discharge lines were passed up through the emergency escape hatch. If positioned on deck, to achieve adequate ventilation for exhaust gases, a portable suction line would have to be passed into the engine room, probably through the same hatch.

Either arrangement requires a hose to pass through an opening that would normally be weathertight and gas tight. These arrangements have implications for safety, particularly when the pump is used when the vessel is at sea.

Maintaining weathertight hatches and doors open when at sea may diminish the survivability of a vessel. Fishing vessels are known to have been lost because of this practice; some with an associated loss of lives.

Fire detection and extinction

The engine room of any vessel has a significant fire risk. In recognition of this some boundaries are insulated, and the space monitored by a fire detection system. A gas smothering fire-extinguishing system is also fitted. The engine room of *Mariama K* was protected in this way.

A correctly functioning gas smothering system requires boundaries to be gas tight. The containment of smoke, flames and heat within a fire-affected space also requires the boundaries to be gas tight. Having emergency escape hatches, and even the main access door, open at sea clearly destroys the gas tightness of the space.

If the crew discovered an engine room fire, they may be prompted to close the offending hatch, just as they would close ventilation dampers. Fires which have occurred on board fishing vessels have demonstrated that this is not always possible, particularly where hoses prevent doors from closing and first need to be cleared.

Smoke and heat in the area might also prevent this action. After leaving West Africa the vessel had no self-contained breathing apparatus. Without this none of the crew could have entered any smoke filled space to close any critical opening. Little would then prevent fire and smoke spreading through the hatchway to the remainder of the vessel.

The use of the portable pump to pump engine room bilges thus compromised the fire containment capability of the vessel's engine room. It also reduced the likely effectiveness of the gas flooding fire-extinguishing system.

Use of petrol as a fuel

Another risk associated with using the pump was its fuel. Petrol produces a flammable vapour at temperatures above about -30°C (flash point). In contrast, the flash point of diesel fuel for the vessel's main engine is at least 60oC. The density of petrol vapour is 2½ to 3 times that of air. With the pump and engine permanently stowed low in the engine room, any leakage of petrol, or its vapour, had the potential to generate pockets of vapour in the lower part of the engine room. With no forced ventilation, as was the case with the vessel shut down in port, this vapour would not be cleared. The associated potential for a serious fire or explosion was significant.

Portable pump as vessel's only bilge pump

The Fishing Vessels (Safety Provisions) Rules 1975 require a fishing vessel longer than 24.4m to have no fewer than two independent powered bilge pumps. *Mariama K* was 29.76m registered length and thus was covered by this requirement.

The only pump able to pump the vessel's bilges during the voyage from Conakry to Douarnenez was the portable pump, purchased shortly before departure. Its regular use was required to control the effect of water ingress via the rudder or stern gland. This pump was in poor condition, as seen on the vessel's return to Falmouth in July 2000. The linkages in the governor were heavily corroded, as well as the spark plug. The spark plug's condition in particular, an item that is very simple to remove, service and replace or renew, suggested a poor maintenance regime.

Despite its poor condition, total reliance was placed on this pump. Its failure might have allowed water in the engine room to rise to the extent where it affected the working of the main engine and important electrical equipment. At sea, the vessel's safety would then have been in question.

To summarise, there were several serious hazards associated with using this pump as the only means of clearing bilge water at sea. In view of the increasing popularity of these pumps in the fishing industry, other vessels may be at risk from their use. Therefore, the MCA is recommended to highlight the dangers to other fishermen in any revision of its Guide to Safe Working Practices for Fishermen, an MGN(F) or similar.

2.6 REPAIR, MAINTENANCE AND MANAGEMENT

Most UK fishing vessels of *Mariama K*'s size spend the bulk of their working lives operating from UK ports and/or in European waters. Supporting infrastructure in the area, such as ship repair facilities, spares sources, equipment manufacturers' agents, and financial facilities is therefore well known to owners and skippers. Consequently there is little excuse for important safety related equipment to be disabled because of the lack of spare parts or technical expertise.

This comparatively comfortable situation changes when a vessel of this size roams far beyond the waters surrounding continental Europe. She may then be operating from ports where, even if ship repair facilities are available, there may be difficulties in obtaining spare parts, owing to the lack of local agents. In addition, political, administrative, legal, currency and social differences may compound these problems. They can only be overcome with a comprehensive vessel management infrastructure, capable of extending to these areas.

One of the consequences of *Mariama K* operating in West Africa for several months, was that she left the area with defective bilge pumps. As a result, shortly before departure the portable pump was purchased and put into service. She also left without the self-contained breathing apparatus of her fireman's outfit. Clearly, her management system was unable to function properly and effectively.

Other owners need to be alerted to the increased management burden which may result when operating a fishing vessel well outside the familiar European regime for repair, spares and technical support. It is recommended that the MCA issues a suitable MGN(F), or similar, to alert fishing vessel owners to these potential problems.

2.7 EMERGENCY PORTABLE PUMPS

Portable pumps have demonstrated their value during many fishing vessel floodings around the UK coast. When supplied and operated by search and rescue (SAR) personnel, they are normally positioned on an open deck, with semi-rigid suction hoses passing into the flooded space. The publicity afforded to these incidents has convinced many fishermen of their value during an emergency.

As a result, they are carried by a number of UK fishing vessels. The accident on board *Mariama K* should serve as a warning that care is required when these pumps are in use. Particular care is required to arrange proper ventilation for the exhaust gases; the most dangerous component of which is invisible. It is recommended that the MCA offers advice to owners, skippers and crew on the safe operation of these units, both petrol and diesel powered.

Following a difficult few months in West Africa, it is clear why the owners, skipper and crew were anxious for the vessel to leave the area. That she did so without proper bilge pumps is probably equally understandable, even though there was a significant risk associated with their substitute, the portable pump.

However, once the vessel was again in a European port, proper repairs to the bilge pumps should have been relatively straightforward. There was no reason to accept the continued risk of placing total reliance on the portable pump. No efforts were made to repair the bilge pumps before preparations were made to sail the vessel from Douarnenez to the UK. This was unwise.

2.8 EMERGENCY ACTION

The immediate actions taken by the crewman and skipper were probably influenced by their failure to recognise that the engine room was badly polluted with CO. They were not alone. Police and fire officers also failed to recognise the presence of the gas until several people began to show the effects of poisoning. There are several causes for the oversight.

Carbon monoxide is notoriously difficult to detect by sight or smell. In the absence of instrumentation, its presence usually has to be inferred from the presence of fuel burning equipment and, possibly, symptoms of occupants - such as headaches.

Both the skipper and the crewman knew that the portable pump had been used recently. Indeed only a few minutes before the accident the crewman had stopped its engine. However, both men had become accustomed to this pump being used in the engine room. Previous use had been without incident, so dulling their perception of the associated hazards.

Fire officers in particular might be expected to have recognised the dangers before any others. However, they had been alerted to an incident where a person was reportedly injured by a fall. This was probably the incident on *Mariama K.* Their understanding of the nature of the incident was probably slightly confused by language difficulties. They attended *Mariama K* expecting to deal with an injured crewman, rather than a polluted atmosphere. This was demonstrated by their entering the engine room without attempting to don breathing apparatus, or even having it to hand. Further, their understanding of the situation was not helped by the fact that the pump had been stopped for some time, with no obvious indication that it had been running.

The fire crew quickly attempted to resuscitate the engineer. Access restrictions posed by the adjacent machinery in the engine room caused them to lift the engineer over the auxiliary engine to lay him on the central floor plates. Again the limited access caused problems in lifting the casualty, and their physical exertions simply accelerated consumption of the polluted atmosphere. A doctor arrived and was able to supervise the casualty's removal from the engine room. These operations highlighted the problems which the skipper and crewman would have encountered had they made any prolonged attempt at rescue and resuscitation.

Signs of poisoning in both police and fire brigade officers became apparent during this operation, probably exacerbated by the physical exertion.

Once the casualty was clear, a fire officer tested the engine room's atmosphere. The result of 370ppm of CO was obtained at least two hours after the portable pump was stopped. During this period, emergency personnel had worked in the space, sometimes performing significant physical exertions. This, coupled with some natural convection of the atmosphere, would have reduced the CO concentration.

The level of CO in the engine room when the pump was stopped is unknown. However, the time which elapsed before a test was made, suggests that the concentration was very much higher at the time the unconscious engineer was found.

It is worth noting that even the fire officers, who presumably learned about the dangers of polluted atmospheres during their training, were unable to sense even these high levels of CO without the aid of instrumentation.

SECTION 3 - CONCLUSIONS

3.1 FINDINGS

1. Local French time on 10 June 2000 was two hours ahead of UTC. [1.1]

2. The time used by those on board *Mariama K* on 10 June 2000 was probably UTC +1 (BST). [2.1]

3. *Mariama K*'s bilge pumps were defective when she left Conakry, West Africa, during the spring of 2000. [1.2]

4. A portable petrol engine pump was purchased before the vessel's departure from Conakry. This was used as a bilge pump. [1.2, 1.5]

5. Using a petrol or diesel-engined portable pump within an engine room is not recommended practice. [2.2]

6. Water leaked into the engine room through the rudder gland or stern gland. [1.2,1.8]

7. During the voyage from Conakry to Douarnenez, and for the stay in Douarnenez, total reliance was placed on the portable pump to control bilge water levels. [2.5]

8. The pump's condition suggested poor levels of maintenance. [2.5]

9. While at sea, failure of the portable pump would have seriously affected the safety of the vessel. [2.5]

10. Use of the portable pump degraded the fire containment and extinguishing capability of the vessel's structure and systems. [2.5]

11. Use of petrol in the engine room had the potential to generate concentrations of explosive vapour. [2.5]

12. The vessel's bilge pumps were not repaired while in Douarnenez. [2.7]

13. In preparation for the vessel leaving Douarnenez on 10 June 2000, the portable pump was used to lower the engine room bilges. [1.2]

14. The portable pump was at the forward starboard corner of the engine room, with hoses connected to its suction and discharge. [1.7, 2.3]

15. The suction hose led directly to the engine room bilge. [1.7]

16. The discharge hoses led through the engine room's emergency escape hatch. [1.7]

17. The gases from the portable pump's engine exhausted into the engine room. [1.2]

18. The pump was running for 1 to 1½ hours during the afternoon of 10 June 2000. [1.2, 1.7, 2.3]

19. The vessel's engineer was in the engine room for part of that period. [1.2]

20. There was no forced or induced ventilation of the engine room. [1.10, 2.4]

21. The vessel's engineer was overcome by the pump's exhaust fumes. [1.12]

22. The vessel's engineer was discovered unconscious, in the engine room, at about 1900 local French time. [1.2, 2.1]

23. Resuscitation efforts by the crewman and skipper were unsuccessful. [1.2]

24. The skipper and crewman summoned emergency services from a telephone ashore. [1.2]

25. Fire and police officers were on scene at 1924. [1.2]

26. These officers made further unsuccessful attempts to resuscitate the engineer. [1.2]

27. A doctor arrived at about 1935. [1.2]

28. Until some people began to show symptoms of poisoning, the emergency services personnel did not suspect high concentrations of CO in the engine room. [2.8]

29. Tests carried out over 2 hours after the portable pump was stopped, showed a CO concentration in the engine room of 370ppm. [1.2]

3.2 CAUSES

This accident was caused by the use of a petrol-engined pump in the enclosed space of the vessel's engine room.

The petrol-engined pump was in use because the vessel's bilge pumps were defective.

Difficulties associated with managing the vessel beyond European waters contributed to the vessel's deficiencies regarding bilge pumps and other safety equipment.

SECTION 4 - RECOMMENDATIONS

The Maritime and Coastguard Agency is recommended to:

1. Offer advice to UK fishing vessel owners on the likely management implications of operating well outside the European vessel support regime.

2. Offer advice to owners, skippers and crew on the safe operation of portable pumps powered by petrol or diesel engines.

The owners of *Mariama K* are recommended to:

3. Introduce a comprehensive vessel management infrastructure capable of extending beyond European waters.

Marine Accident Investigation Branch
April 2001