

(No. 134.)

"BEIRA" (S.S.).

The Merchant Shipping Act, 1894.

IN the matter of an Inquiry before Commander WARREN FREDERICK CABORNE, C.B., R.N.R., Inspector for the Board of Trade, into the nature and causes of the accident to and damage sustained by the British s.s. "BEIRA," of London, when off the Prince's Channel lightship, Thames Estuary, on the 25th day of February, 1908, whereby loss of life ensued.

*Report.*

Sir,

I have the honour to inform you that in virtue of my appointment from the Board of Trade, dated the 2nd day of April, 1908, I held an inquiry into the above casualty at Caxton Hall, Caxton Street, in the City of Westminster, on the 9th day of April, 1908.

Mr. George C. Vaux conducted the proceedings on behalf of the Solicitor to the Board of Trade (Mr. R. Ellis Cunliffe), and Mr. A. D. Bateson, Barrister-at-Law, represented the owners of the vessel.

The "Beira" (formerly the "Turkistan"), official number 98208, was a British steamship, built of steel at Linthouse, Glasgow, in 1894, by Messrs. A. Stephens & Sons, and was registered at the port of London.

She was schooner-rigged and of the following dimensions, namely:—Length, 345 feet; main breadth, 47 feet; and depth in hold from tonnage deck to ceiling at midships, 26.7 feet; her gross tonnage being 4,056.02 tons and her registered tonnage 2,570.94 tons.

She was said to have been specially designed for the conveyance of coal and general cargoes, had two decks (the main deck being of iron and the lower deck of steel), six steel water-tight bulkheads running right up to the main deck, four cargo holds (each fitted with two cowl-headed ventilators placed one at either end), and six ballast tanks (including the after-peak tank) having a total capacity of 921 tons.

She was propelled by triple-expansion engines of 600 nominal horse-power, and was fitted with three steel boilers having a working pressure of 160 lbs. to the square inch, the machinery and the boilers having been constructed by the builders of the ship.

She carried six boats (four of them being life-boats), with their proper equipment, the other life-saving appliances required by the Statute, and the requisite distress signals.

Lastly, she was surveyed at Newport, where she underwent some repairs in the Commercial Dry Dock, in February last, was in good order and condition, and was owned by the Bucknall Steamship Lines, Limited, of 23, Leadenhall Street, in the City of London, Mr. Edward Lloyd, of the same address, being designated the person to whom the management of the vessel was entrusted by and on behalf of her owners by advice received on the 17th day of January, 1906.

Having completed the before-mentioned repairs, the "Beira," on the 20th of February, 1908, proceeded to a loading berth at Newport and commenced to take in bunker coal and cargo.

After 11 a.m. of the following day, work appears to have been suspended for want of coal, but it was resumed early on the morning of the 22nd of February, the loading being completed about 5 p.m. of the same date.

The cargo consisted of 1,492 tons of Nixon's Navigation coal, which had been purchased by Messrs. Worms and Company, of Cardiff, for transit to Zanzibar, and was shipped by Messrs. Jones, Heard, and Company (agents for Nixon's Navigation Company,

Limited, at Newport), under the superintendence of Mr. James Dixon, their foreman and inspector.

Of the above amount, 888 tons 14 cwts. were stowed in No. 2 lower hold, which was completely filled, the remaining 603 tons 6 cwts. being placed, on the last day, in No. 3 lower hold.

When No. 2 lower hold had been completed, the between-deck hatches were put on, sealed, and covered with tarpaulins, and No. 2 between-decks were then quite filled with bunker coal.

On the other hand, when the coal had been loaded into No. 3 lower hold, there was a vacant space of about 8 feet in height under the hatchway, but considerably more towards the ends, the estimated room equalling 300 tons, and the between-deck hatches were not shipped. In No. 3 between-decks were some 80 tons of boards, bamboos, other dunnage, cargo mats, &c.

Nos. 1 and 4 holds were empty so far as cargo was concerned.

At 8 p.m. of the 22nd of February, all the main-deck hatches were put on and battened down in readiness for the ship going to sea. However, she was detained in port for the night owing to stress of weather.

It may be remarked that some rain fell during the shipment of the cargo, and especially on the 22nd of February.

At 9.40 a.m. of the 23rd of February, 1908, the "Beira" sailed from Newport for London, where she was to take in cargo for the Cape ports and Zanzibar, her draught in the comparatively fresh water of the Alexandra Dock being 18 feet 11 inches forward and 16 feet 6 inches aft, her crew consisting of 59 hands all told, of whom 49 were lascars, and she being under the command of Mr. Francis Ovenden Potts, who held a certificate of competency as master numbered 027894.

At noon the weather was cloudy and there was a strong westerly breeze and a choppy sea, and by midnight the wind had increased to a strong N.N.W. gale, causing a high beam sea, which made the vessel strain and labour heavily. She was also said to have shipped a good deal of water over all fore and aft.

Similar weather appears to have been experienced during the remainder of the passage up Channel, necessitating the hatches being kept covered.

At 8 a.m. of the 25th of February the ship passed Dungeness.

At noon of the same day there was a strong N.N.W. wind and a moderate sea.

At about 2.15 p.m., the vessel then being off the Prince's Channel lightship, the chief officer (who had previously received instructions from the master to have the holds cleared up and prepared for the reception of cargo) ordered the serang to remove some of the main-deck hatches of No. 3 hold. Two of the hatches were taken off, and the serang, the first tindal, and a lascar went below into the between-decks.

About three minutes afterwards, according to the chief officer, and about five minutes afterwards, according to two lascars, a tremendous explosion occurred, the remaining hatches being blown overboard.

The three men who were in the between-decks, were hauled up by means of ropes, and were found to have been severely burned; accordingly, they were treated with Carron oil and swathed in bandages.

Two other lascars, who were about to descend into the hold, were slightly burnt; the chief officer said that his own hair was singed by the out-burst of flame from the hatchway; and it was mentioned that one of the engineers was also slightly singed.

It was then seen that a fire had broken out below, and measures were taken to extinguish it, but without success.

At 2.45 p.m., the ship anchored off the Girdler light-vessel for a short time, and then proceeded, eventually bringing up in Gravesend Reach at 6.50 p.m.

After considerable difficulty, the fire was put out about 9.30 a.m. of the following day, with assistance rendered by the steam tug "Guiana" and by the Gravesend Fire Brigade.

The three seriously injured men were sent ashore to the Gravesend Hospital, where they all ultimately died.

No. 3 hold or compartment in which the explosion took place was situated immediately abaft the engine-room, and was ventilated by means of two iron cowl-headed ventilators (15 inches in diameter to the between-decks and 12 inches in diameter to the lower hold) of a pattern approved by the Board of Trade (Sketch 3, of Surveys 13), respectively placed one at the forward end and the other at the after end, the forward one being about 4 feet from the forward bulkhead, and about 16 feet 6 inches on the port side of the centre line of the ship, while the after one was about 1 foot from the after bulkhead, and about 5 feet 6 inches on the starboard side of the centre line of the ship.

These ventilators stood 6 feet 6 inches high, measuring from the main deck to the upper portion of the cowl.

It was stated that, throughout the passage, the cowl ventilators had been kept carefully trimmed—one to each hold being turned towards the wind in order to act as a downcast, while the other one was turned from the direction of the wind in order to form an up-take.

It is true, that one lascar witness deposed that he had seen the mouths of both ventilators turned towards the wind at the same time; but the balance of the evidence was in the contrary direction.

Although there were canvas covers provided for all the ventilators, it was distinctly stated that they were never put on during the voyage from Newport.

The main-deck and between-deck hatchways of No. 3 hold measured 24 feet by 16 feet.

It may be added that the ship had previously carried coal cargoes without any accident occurring.

From Gravesend the "Beira" proceeded to the South West India Dock, where a survey was held, and the extent of the damage ascertained. It was found that the ship had sustained considerable injury from the fire (none being traced to the explosion itself), the principal damage being situate near the mainmast. The upper or main deck had buckled right across the ship, several beams and shell-plates had also buckled, and the after bulkhead of No. 3 hold was badly damaged.

It may now be convenient to return for a moment to events which took place prior to the departure of the ship from Newport.

On the 20th February, the master called at the office of Messrs. Worms and Company, at Cardiff, with reference to some charts, and, while there, asked what class of coal Nixon's Navigation was, and whether ordinary ventilation would be sufficient. In reply, he was told by the shipping clerk that the coal was the best, that it had a good reputation, and was generally safe, and that the foreman inspector of Nixon's Navigation Company could give him any further information. However, the master appears to have been satisfied and did not pursue his inquiries. At the same time, he seems to have been fully aware of the danger which so constantly exists of the explosion of gas given off by coal, and, before leaving Newport, gave orders to the chief officer that naked lights were not to be taken into the holds.

At Cardiff, Nixon's Navigation Company make a practice of supplying the ships that they may load with cautionary and ventilation notices respecting their coal, but, for some reason, that is never done at Newport, where they are only represented by agents. However, as one of those notices was not supplied to the "Beira," I can hardly take their subject-matter into consideration.

Mr. James Dixon, foreman and inspector at Newport, in a written statement said: "In every case, however, either I or my foreman have told the master or officers to take every precaution with regard to ventilation;" and Mr. Alfred Bale, the foreman coal-trimmer, stated that he had cautioned the chief officer of the "Beira." But inasmuch as the statement of the first-named person (to the reading of which Mr. Bateson raised no objection) was not made upon oath, and that owing to his absence through ill-health (a medical certificate was attached to his returned summons) he could not be cross-examined upon that or any verbal statement; and

again, as in the second instance, the witness could not identify the officer to whom he said he had given warning, I am not able to place any value on their statements.

Before proceeding to deal with the cause of the casualty which formed the subject of this investigation, it may be advisable to devote some little attention to the nature and properties of the gas which exudes from coal.

This is the more necessary, as the information that is to follow, although well-known to scientists and others, is mainly to be found in blue-books and scientific papers not readily accessible to those connected with shipping. It may also be said that most of the main points apply more or less to the present case.

The gas in question, known as light carburetted hydrogen ( $\text{CH}_4$ ), or marsh gas, has a specific gravity of 0.557 as compared with 1.000 for atmospheric air (taken as the standard), is odourless, colourless, and tasteless, and so is not capable of detection by the ordinary senses.

The late Sir Frederick Abel, so far back as 1875, said in a lecture which he gave at the Royal Institution: "If marsh gas, or light carburetted hydrogen, which exists imprisoned in coal beds and escapes into the atmosphere in the pit-working, either gradually or sometimes under considerable pressure, becomes mixed with the air to such an extent that there are about eighteen volumes of the latter to one of the gas, the mixture burns with a pale blue flame, which will surround that of a candle contained in such an atmosphere; the appearance of such a 'corpse light' round the flame of the pitman's candle or lamp-flame is a warning, too generally unheeded, of the presence of fire-damp in quantities likely to be dangerous; for if the proportion of marsh gas increases much beyond that above specified, an explosive atmosphere will be formed, the violent character of which increases as the proportion of fire-damp approaches that of one volume to ten of air."

"Marsh gas requires for its ignition to be brought into contact with a body raised to a white heat; fire-damp, or a mixture of marsh gas and air, is therefore not inflamed by a spark or red-hot wire, but will explode if brought into contact with flame. The fact that this contact must be of some little duration to insure the ignition of the fire-damp was applied by Stephenson in the construction of his safety-lamp;

In a joint paper by Sir F. Abel and Dr. Percy, prepared for the information of the Royal Commission on the Spontaneous Combustion of Coal in Ships (1876), the following passages occur: "The gases which are occluded (or confined in a more or less condensed condition) in coal, vary considerably in quantity and composition in different kinds of coal, and they also gradually undergo various changes in composition by exposure or keeping of the coal."

"Their chief inflammable constituent is marsh gas, and it is to the admixture of this gas with a considerable volume of air that explosions are due in freights or stores."

"In pits where explosions are likely to occur, the gas escapes either with more or less rapidity and force from fissures ('blowers'), or gradually from the freshly exposed surfaces of coal seams. When coal from such pits is brought to the surface it continues slowly to evolve inflammable gas for some time afterwards especially if the coal be in large masses or stored in compact heaps."

"If facility is not afforded for the ready escape or removal into the open air of the inflammable gas emitted from the coal composing a cargo or contained in bunkers on board ship, the spaces between the masses of coal, or any partially confined spaces not occupied by the coal but in close proximity to or communication with it, will in time become filled with a mixture of the gas with the air in those spaces, which, unless the former be present in very small proportions, would explode on the approach of a flame to it, and with a violence depending upon the proportion which the air bears to the inflammable gas which has become diffused through it."

"As the application of flame (or of a body raised to a high red-heat) is indispensable to the ignition of mixtures of air with the inflammable gas evolved

from coal, it is obvious that it may spontaneously from the approach of a light, or where it is stored, or where it penetrates.

"If coal, from some cause, is placed on board a ship from the pit, there is a possibility of the formation of an explosive atmosphere in the bunkers, or spaces between the masses of coal, every possible means should be taken to prevent recourse to for facilities for the escape of coal into the open air."

"But as the gas is so inflammable as to render it violent, it is necessary to take every special means of ventilation to prevent the risk of explosion of the air over the coal, and so as to accelerate the escape of the inflammable gas."

In 1882, an Act of Parliament was passed, the number of interest being the explosion of coal.

Speaking about the explosion of coal, the Royal Institution in July 1882, said: "The gas given off, and with some surface continues to the ordinary atmosphere, and with a rapid increase in temperature, the coal be at once started, the hold of a ship is nearly always to be exploded with a force of ten square inch."

"Marsh gas, when mixed with air, and burns quietly, producing as the products of combustion carbon dioxide and water, and sometimes its own volume, and explodes with a force of ten square inch."

"Ten volumes of marsh gas gives a mixture, although the proportion of air is either side of the mixture are explosive, and it is very rare that a mixture of marsh gas to three parts of air is explosive, and it is the maximum quantity of marsh gas to ten parts of air that passed the explosion mixture containing air is obtained when it is very rarely necessary to give a mixture of marsh gas to three parts of air that very varying."

"Another cause of explosion is the presence of coal dust, less than that which it gives an explosive atmosphere in the area of explosion."

Other authorities going are sufficient to show that a slightly enlarged barometric pressure in mines or on board of coal dust.

When the pressure of the atmosphere remains more or less uniform in the mine or the cells, the spheric pressure of the gas becomes more dangerous, and the barometric pressure is steep.

That fine coal dust is a danger will be understood that fine particles in suspension in the air, when brought into contact with one disastrous explosion.

from coal, it is obvious that *explosions* cannot occur spontaneously from this cause on board ship, but must be brought about by the accidental or incautious approach of a light to localities where the coal is stored, or where the explosive mixture is likely to penetrate.

"If coal, from seams which are charged with marsh gas, is placed on board ship shortly after being raised from the pit, there is obviously great liability to the formation of an explosive atmosphere in the hold or bunkers, or spaces communicating with them, and every possible means should in such cases be had recourse to for facilitating the escape of gas from the coal into the open air.

"But as the gas requires a large admixture of air to render it violently explosive, . . . . . the only useful application which might be made of any special means of ventilation with a view to diminish the risk of explosions would be to pass a current of air over the coal and immediately into the open air, so as to accelerate the escape and removal of the inflammable gas."

In 1882, an Admiralty Committee carried out a number of interesting experiments in connexion with the explosion of coal gas.

Speaking about coal gas at the Royal United Service Institution in July, 1890, Professor Vivian B. Lewes said: "The gas occluded in the coal is slowly given off, and with some coals a slow discharge from its surface continues for some time after its exposure to the ordinary atmospheric pressure, becoming more rapid with a fall in the barometer or with any great increase in temperature; so that if a freshly-won coal be at once stored in an enclosed space, such as the hold of a ship, a certain proportion of marsh gas is nearly always to be found present in the air.

"Marsh gas, when pure, is perfectly non-explosive and burns quietly with a faint luminous flame, producing as the products of its combustion carbon-dioxide and water vapour, but when mixed with ten times its own volume of air and a light applied it explodes with a force equal to about 210 lbs. on the square inch.

"Ten volumes of air mixed with one volume of marsh gas gives theoretically the most explosive mixture, although practice points to a slightly smaller proportion of air (9.4), but there is a margin on either side of this proportion within which all mixtures are explosive; when there is one volume of marsh gas to thirteen of air the mixture is slightly explosive, and its explosive power increases with increase in the quantity of marsh gas present until the maximum effect is reached with one volume of marsh gas to ten of air, and as soon as this point is passed the explosive power again diminishes until a mixture containing one part of marsh gas to five of air is obtained when it again becomes non-explosive. It very rarely happens that the exact proportions necessary to give the maximum effect are present, so that very varying results occur.

"Another cause which tends to increase the danger of explosion is that if the air is charged with fine coal dust, less than 1 per cent. of marsh gas mixed with it gives an explosive mixture, and also extends the area of explosion."

Other authorities might be quoted, but the foregoing are sufficient for all practical purposes.

However, there are two points that I should like to slightly enlarge upon, namely, the relation between barometric pressure and the risk of coal gas explosions in mines or on board ship, and the explosive nature of coal dust.

When the mercury stands high, the weight or pressure of the atmosphere causes the marsh gas to remain more or less imprisoned within the seams of a mine or the cells or pores of coal. When the atmospheric pressure decreases, and the mercury falls, the gas becomes more free to exude, and probably the most dangerous time is after a long period of high barometric pressure, particularly if the falling gradient is steep.

That fine coal dust in the air should be a source of danger will be readily recognized when it is understood that fine particles of ordinary flour dust, held in suspension in the atmosphere, have, when brought into contact with fire, been the cause of more than one disastrous explosion in flour mills.

The Nixon's Navigation coal shipped on board the "Beira" was obtained from the company's Mountain Ash Collieries, in the Aberdare Valley, which have several seams, and the shafts to which are from 858 to 1,398 feet deep. Mr. F. A. Gray, His Majesty's Inspector of Mines for the Cardiff District (within the area of which the above-named collieries are situated), described it as being a high quality steam coal, taken from seams which produce fire-damp freely, but not exceptionally so, as all seams in the neighbouring collieries are very similar. He also stated that the precaution was taken of introducing large quantities of fresh air into the mines; and that safety-lamps were used there exclusively.

The consignment in question was raised to the surface on the 20th and 21st of February, and shipped on the 21st and 22nd of February, it being screened at the colliery and double-screened at the time of shipment; and it is almost needless to say that this newly wrought coal would be liable to give off gas in considerable quantities.

The foreman trimmer asserted that only safety-lamps were used while trimming in No. 2 hold, and that no lights were used in No. 3 hold; but candles were certainly utilized for this purpose in the latter, the chief officer, upon the requisition of the men actually working, having supplied some, while a partially-burnt bundle of three or four candles was found by the marine-superintendent, Mr. F. H. Wise, on the top of the coal on the port side after the arrival of the ship in London.

Some time prior to the casualty, when giving the chief officer directions about the holds, the master had again specially warned him against permitting naked lights to be taken below. Before, or when taking off the hatches, the serang asked to be allowed to have a lamp (and it may be here remarked that with marsh gas an ordinary globe or other similar covered lamp is, in the long run, hardly if any less dangerous than a naked light), but the chief officer refused his request, and I am satisfied from the chief officer's own evidence and that of two lascars (both of whom were slightly injured by the explosion), that no lamp, covered or otherwise, was taken into the between-decks.

However, it is by no means clear that the serang, and those with him, understood the reason for the refusal, or in any way appreciated the danger that is to be apprehended from an accumulation of coal gas.

In this instance, there were conditions present favourable to a catastrophe, inasmuch as the coal, which was of a character calculated to give off a large amount of gas, was newly wrought, that the hatches had been battened down for nearly three days, and that the barometer was falling. However, I do not attach any importance to the latter point, as I gather from the log-book that the gradient was very slight.

It may be mentioned that the temperature of the holds, which was between the maximum and minimum of the external air, indicated very little variation during the passage.

As the men had only been below for a period estimated at from three to five minutes, and as there is no proof that during that time they had commenced to sweep up, the question as to whether fine coal dust was present in the atmosphere hardly arises.

It has been shown by the eminent chemists whom I have cited, that a mixture of marsh gas and air will not explode spontaneously, and that a spark (and in this case, owing to the respective directions of the ship's head and the wind, none could have reached the hatchway from either the main or galley funnels) would not have the necessary intensity to bring about ignition.

When, therefore, in addition, I have completely satisfied myself that no naked nor covered light was taken below, there remains only one possible solution of the problem, and that is, that the explosion was caused either by the intentional or accidental lighting of a lucifer match by those in the between-decks.

Some evidence was given by a lascar to prove that the men had no matches, but it was quite unconvincing, the more so that two dozen boxes of them were afterwards found among the tindal's effects.

With regard to the theory of accidental kindling, it is possible that one of the coal-trimmers employed

at Newport may have dropped a match in the between-decks, and that this match, lying on the steel deck, was accidentally stepped upon, fired, and brought to a full state of ignition, by one of the three men who were below at the time of the casualty.

However, it is far more probable (taking into consideration that it was the dark season of the year, that the weather was dull and overcast, that only two upper hatches had been removed, that although the vessel was fitted with side-lights the dummies were shipped, and that the men had just descended from the light of the upper deck) that a match was struck for the purpose of momentarily looking round, and in absolute ignorance of the great peril incurred by so doing.

The explosion, which naturally took the line of least resistance, and so blew off the loose hatches, does not appear to have directly injured the structure of the ship, and, therefore, could not have approached the given maximum strength; and that is also proved by the fact that the three men were rescued alive, although fatally injured.

In order to avoid, so far as may be possible, the risk of these explosions, it would seem to be desirable that, whenever carrying coal—and all coal is liable to exude gas in a greater or lesser degree—the hatches (notwithstanding the supposed efficiency of the system of ventilation employed) should not be wholly battened down until just immediately before the vessel proceeds to sea (and not then unless the state of the weather should render such a course necessary), and that the hatches should be again removed upon the earliest possible opportunity; that no one should be permitted to go below until a reasonable period had elapsed from such removal, unless accompanied by an officer to see that no matches were struck; and that, in the event of a light being absolutely requisite, only safety-lamps should be used.

At the conclusion of the evidence, Mr. Vaux, on behalf of the Board of Trade, submitted the following questions for my opinion:—

(I) Was the coal shipped on board the "Beira" at Newport, Mon., in February last, liable to give off inflammable gas? When was it wrought? When was it shipped?

(II) When were the main deck hatches of the hatchway to No. 3 hold put on and secured?

(III) Were No. 3 lower hold and 'tween-decks fitted with ventilators so arranged as to carry away any accumulation of gas given off by the coal? If so, were such ventilators in working order at the time the vessel sailed and during the voyage?

(IV) Was the ventilation of No. 3 hold and 'tween-decks sufficient to prevent any accumulation of coal gas?

(V) Was any lamp or light taken into No. 3 'tween-deck by anyone on the afternoon of the 25th February last?

(VI) What was the cause of the explosion and loss of life?

Mr. Bateson then addressed me on behalf of his clients, Mr. Vaux replied, and the inquiry terminated.

Having carefully considered the evidence, I now reply as follows to the questions of the Board of Trade:—

(I) The coal shipped on board the "Beira" at Newport, Monmouthshire, in February last, was liable to give off inflammable gas. It was wrought on the 20th and 21st days of February, and was shipped on the 21st and 22nd days of February.

(II) The main or upper deck hatches of No. 3 hold were put on and secured about 8 p.m. of the 22nd of February.

(III) No. 3 lower hold and between-decks were fitted with ventilators calculated under ordinary conditions to carry away any accumulation of gas given off by the coal, and they were arranged upon the system approved by the Board of Trade. Such ventilators were in working order at the time the vessel sailed and during the voyage.

(IV) For the reasons set forth in the body of this report, and in view of the explosion that occurred, the ventilation of No. 3 hold and between-decks was not under the then existing circumstances sufficient to prevent an accumulation of coal gas.

(V) No lamp or other light was taken into No. 3 between-decks by anyone on the afternoon of the 25th of February last.

VI. For the detailed reasons given in the body of this report, I am of opinion that the cause of the explosion, and the consequent loss of life, was the ignition of a match, either intentionally or by accident, by one of those who lost their lives, and the probabilities of the case strongly point to the first-named alternative.

I have the honour to be,

Sir,

Your obedient Servant,

W. F. CABORNE,

Inspector.

April 20, 1908.

The Assistant Secretary,  
Marine Department,  
Board of Trade.

*List of those who Lost their Lives.*

Name.	Rating.	Nationality.
Shaik Oosman Sulleyman	Serang ...	Native of East Indies.
Shaik Hassan Abuba ...	1st Tindal	Ditto.
Oomer Eusoof ...	Lascar ...	Ditto.