

LONDON AND NORTH EASTERN RAILWAY

MINISTRY OF WAR TRANSPORT,
Berkeley Square House,
London, W.1.

19th September, 1944.

Sir,

I have the honour to report for the information of the Minister of War Transport, in accordance with the Order dated 2nd June 1944, the result of my Inquiry into the explosion which occurred at about 1.45 a.m. on that day at Soham, a wayside station on the Ely - Newmarket branch line, in the Southern Area of the London and North Eastern Railway. I was assisted throughout my Inquiry by Captain N. Fawcett, Inspector of Explosives, Home Office. Representatives of the Explosive Transport and Storage Committee and of the War Office Movement and Ammunition Inspection staffs attended the opening of my Inquiry on 16th June; also representatives of the U.S. Strategic Air Force (Chief Ordnance Officer) and U.S. Transportation Corps.

The 11.40 p.m. freight train from Whitmoor to Ipswich, comprising 51 open wagons loaded with U.S. aircraft bombs and components, hauled by Engine No. W.D.7337, was approaching Soham Station on the single line in the Up direction when the driver, B. Gimbert, observed that the leading wagon was on fire. He made a gradual stop and instructed the fireman, J. V. Nightall, to uncouple the burning wagon from the rest of the train with a view to taking it forward through the station into open country. After Nightall had uncoupled the wagon and rejoined the engine, Gimbert restarted and had travelled about 140 yards when the contents of the wagon, approximately 10 tons of unfuzed bombs, exploded with great violence about one third of the way along the station platforms. The two engine-men were well aware of the nature of their load, and there is no doubt that their prompt and courageous action in isolating the leading wagon prevented the whole train load of bombs (approximately 400 tons), from exploding with very serious destruction of life and property.

I regret to state that Fireman Nightall was killed instantly in the engine cab, and the signalman, F. C. Bridges, who was on the opposite platform, died of his injuries later in the day. Driver Gimbert had a remarkable escape and was taken to hospital with severe and extensive wounds and shock. The 5 others detained in hospital with severe injuries included the stationmaster, H. C. Oliver, who was asleep in the station house when it was wrecked; also sub-ganger W. Muller, of the local permanent-way gang, who had been aroused by Signalman Bridges and was dressing in his house, about 100 yards from the site of the explosion. Twenty-two others, including the guard of the train, H. C. Clarke, and the stationmaster's family, suffered from shock or minor injuries.

There is evidence that the detonation of some 5 tons of high explosive filling was complete, and a crater of 66 ft. diameter and 15 ft. depth was formed, embracing both the platforms for their full width; both the running lines were destroyed for a length of 120 ft. No traces of the wagon concerned were found except a buffer and socket casting; the remains of the underframe, wheels and axles, were probably driven downward into the crater and subsequently filled over, the need for rapid restoration of the line precluding the excavation which would have been necessary for a detailed search. The tender was blown into a twisted mass of steel; its wreckage remained coupled to the engine, which was derailed all wheels to the six-foot side. The engine itself received no serious structural damage, which was mainly confined to the cab and other light platework, boiler and cylinder lagging, etc. The rear portion of the train was unaffected, apart from slight damage by splinters to the 4 leading wagons. All the passenger station buildings were wrecked, including the signal box mid-way along the Down platform; the locking frame was almost intact, though road and wire connections were destroyed, and all communications were severed. There was also severe damage to the walls and roof of the goods shed, 130 yards from the explosion, and to wagons in the yard. Fortunately, no train was approaching from the opposite direction.

There was widespread damage in the small market town, which lies on the East or Up side of the line; 15 houses were wrecked and 36 others were rendered temporarily uninhabitable, all within 350 yards of the explosion. The gas-works, 140 yards from the station, received a good deal of damage, including the two gas-holders, and the supply to Soham and to the neighbouring town of Fortham was cut off for a time; gas which caught fire was soon extinguished. There was also superficial damage of one kind or another to over 700 houses, shops and other premises within a radius of about 900 yards. The church (700 yards) was unharmed.

Within a very short time after the explosion all the necessary resources of the Civil Defence Services were deployed, and the County Police were in attendance; valuable services were also rendered by voluntary organizations, including the Y.M.C.A. and W.V.S., and by the local Home Guard. R.A.F. personnel from Snailwell and Mildenhall, who arrived within half-an-hour, assisted with first-aid, and there was very little delay in removing the more seriously injured to hospital. Altogether, the relief work in all its branches was carried out with promptness and efficiency, including the billeting, feeding and general care of those who were rendered homeless. Emergency repairs to houses were begun at 4.0 p.m. on the day of the accident by the Ministry of Works Flying Squad.

The Cambridge breakdown crane arrived at 5.10 a.m. and there was no great difficulty in re-railing the engine and removing the wreckage of the tender. The earliest possible restoration of the line, which was carrying heavy freight traffic at the time, was of considerable importance, and by arrangement with Lt. Col. C.P. Parker, R.E., R.C.E.3, the Company obtained the assistance of about 100 U.S. Engineer Troops with two bulldozers to fill the crater and make good the formation. This party arrived at 10.50 a.m. about 1½ hours after the Company's ballast train, and worked throughout the day. The two lines through the station were re-opened to traffic at 8.20 p.m. after a lapse of only 18½ hours, for which much credit is due to all concerned. The station was opened for the light passenger traffic on the following day, 3rd June, with temporary booking etc. facilities. Emergency signalling was in force for a further 4 days.

It was a fine dark night, with no moon, fairly warm, with a very light variable wind, generally south-westerly. The weather had been exceptionally dry for some weeks.

There appears to be little doubt that the fire was accidental, and that it originated inside the wagon.

I. GENERAL DESCRIPTION OF TRAIN AND RULES

1. The train load formed part of a consignment of 500-lbs and 250-lbs aircraft bombs and components for the U.S. Air Force from Immingham Dock to White Colne. The traffic was loaded ex ship on 31st May, and left the Immingham "empty" sidings at 2.55 a.m. on 1st June in a full train load of 61 open wagons. Approximately 7 hours were occupied in travelling the 89 miles to March Yard (subsidiary to the main marshalling yard at Whitmoor), which was reached at about 9.45 a.m. on the 1st June.

On arrival, the usual train examination was carried out by the Carriage & Wagon staff, and the 10 leading wagons were detached, to be worked forward by convenient services, leaving 51 wagons and van in No. 1 Siding, Coal Yard. These remained in the yard for 14½ hours unaltered in formation until they left at 12.15 a.m. on 2nd June as the 11.40 p.m. (1st June) train, Whitmoor to Ipswich.

2. The engine was W.D.7337 of the 2-8-0 "British Austerity" heavy goods type, the most powerful in use on this section of the line, with a tractive effort at 85% boiler pressure of 34,215 lbs. and weighing 126 tons in working order with tender. The maximum load for this class of engine over the route concerned (on account of gradients beyond Soham) is 52 minerals. The 51 wagons concerned were rated as 44 minerals (bombs) and 7 goods (components), so that the load was within the maximum laid down. There are no gradients of any consequence between March and Soham, and the train was easily timed over this section (see below). The overall length of the train, including the engine and rear van, was approximately 390 yards.

3. From March the double line runs in a general South Westerly direction for $13\frac{1}{2}$ miles to Ely North Junction, where it turns South West for approximately 2 miles through Eley station and yard to Ely Dock Junction. At the latter, the line to Newmarket and Ipswich via Soham diverges, again to the South East. For the $4\frac{1}{2}$ miles from Ely Dock Junction to Soham the line is single, worked on the key token system, with an intermediate token station at Barway Siding. Beyond Soham the line is double. The following table gives the relevant distances and the booked point to point timings of the train between the signal boxes named:-

		<u>Miles</u>	<u>Miles</u>	<u>Booked Timing</u> (Minutes)	<u>M.P.H.</u>	
Double Line	{ March South Jnc. Ely North Jnc.	0 $13\frac{1}{2}$	}	13 $\frac{1}{2}$	36	22.5
Several Lines	Ely Station North	-				
Single Line	{ Ely Dock Jnc. Barway Siding Soham	15 $\frac{1}{2}$ 18 20 $\frac{1}{2}$	}	2 $\frac{1}{2}$	7	21.4
				20 $\frac{1}{2}$	58	21.2

There are only two overline bridges on the whole route, about 2 miles and 1 mile respectively short of Ely North Junction; both are occupation bridges leading to farms, and one is disused and fenced off.

4. Approaching Soham Station as the train was running, the line is on an easy right handed curve and practically level. All the Soham signals were clear for the train, which was stopped by Driver Gimbert with the engine 970 yards past the Up distant signal and 90 yards short of the platform ramps; as already stated, he had taken the leading wagon 140 yards forward when the explosion took place. Open country begins immediately beyond the station.

II. EVIDENCE REGARDING THE ONSET OF THE FIRE.

5. The main witness was Driver Gimbert, though the fire was also seen by the Guard, H.G. Clarke, from his van and by Sub-ganger W. Fuller from his house nearby. None of these three men was fit to give evidence until 18th July, nearly seven weeks after the accident, although I had a brief interview with Gimbert in hospital on 5th June, and he made a statement, also in hospital, to the Company's officers on 12th June.

6. In spite of the severe shock he had received, Driver Gimbert's account of his experiences was clear and connected. It was to the effect that he was approaching Soham Station, under clear signals at a speed of 15-20 m.p.h., with the engine steaming lightly on the level line. A few yards after passing the Up distant signal, he noticed some steam coming from the left-hand injector and looked out of the cab side window, when his attention was attracted by the sight of flames in the leading wagon. (A test with a similar engine and wagon showed that he could have seen about 9 - 12 ins. into the left-hand rear corner of the wagon over the rear corner of the tender). He described the flames as of ordinary yellow colour and was quite certain that there were no flames outside the wagon; at this stage they were about 18 inches high and had not reached the wagon top. He said, however, that "the flames appeared to be getting all over the bottom of the wagon and seemed to be spreading very rapidly, which seemed to suggest that something very inflammable was alight". He then sounded the engine whistle to warn the guard and, "knowing what the wagon contained", stopped the train gently by a light application of the steam brake (operating on the coupled and tender wheels). Directly the train stopped Gimbert instructed Fireman Nightall to get down and uncouple the leading wagon. He told him to take a coal hammer with him in case the coupling was too hot to handle as, by this time, the flames were well over the top of the wagon; in fact, Gimbert had some doubt as to whether Nightall would be able to uncouple the leading wagon, and thought

he might have to take two wagons forward.

Gimbert, who did not leave the footplate himself, said that Nightall was hardly away for a minute. As soon as the latter had rejoined the engine he started forward smartly, and slowed down to a crawl through the station to tell Signaller Bridges what he was doing and warn the latter to stop opposing traffic, as he was aware that a mail train was nearly due. (In actual fact, no opposing train had been accepted, and the signaller at the next box ahead was warned by the sound of the explosion and the breakdown of the block communications). Gimbert had just crossed to the right-hand (fireman's) side of the footplate to speak to Bridges, who had come out of his box on to the platform, when the explosion took place. He saw Bridges by the light of the fire, which by this time was lighting up the whole station. He remembered noticing that Bridges had a fire bucket beside him on the platform.

Gimbert estimated that it took him about 3 minutes to bring the train to a stand after he first noticed the fire, and that a further 3-4 minutes elapsed before the explosion, or 6-7 minutes in all. This estimate appears to be reasonable, having regard to the theoretical time (3-4 minutes) required to stop in 900 yards, from 15-20 m.p.h. and to the subsequent events. Gimbert also was quite sure that he saw nothing unusual when he last looked back along the train after slowing to exchange tokens at Barway Siding, about 6 minutes before he noticed the fire.

7. The guard, H.G. Clarke, received his first intimation that anything was wrong as the train slackened speed when his van was about a train length in rear of the distant signal; on looking forward across the right-handed curve he saw that the leading wagon was on fire and assisted Gimbert to stop by a light application of his hand brake. He said that when the train came to a stand the flames, which were of ordinary yellow colour, were coming straight up from inside the wagon "in a tremendous blaze"; he was quite sure that there were no flames outside it. Almost immediately afterwards he heard the sound of uncoupling and saw the engine and leading wagon move ahead. When the explosion took place he was on his way forward and was thrown down and temporarily stunned.

Apparently he lay for some time before he came to, when he re-lit the van lamps which had been blown out by the explosion, and walked to the front of the train. On learning what had happened he walked back the $2\frac{1}{2}$ miles to Barway Siding signal box, putting down detonators on the way. According to the Barway signaller, Clarke arrived at the box at about 3.30 a.m. "in a very dazed condition". He is 59 years of age, and suffered from severe shock; his action to protect the train was creditable.

8. Sub-ganger W. Fuller's house is close to the passenger station on the Up (East) side of the line, i.e., on the near side as the train was approaching. One of the windows of his bedroom has a good view of approaching Up trains, and when the train concerned came to a stand before reaching his house the leading wagon was about 230 yards away. Fuller was aroused by shouts for assistance from Signaller Bridges, who had evidently seen the fire as the train was approaching, and the train had already stopped when Fuller first saw it through the window as he dressed. He heard the coupling drop and watched the burning wagon as it was taken forward until it was obscured by the station buildings just before the explosion, which destroyed his house and buried him and his wife and daughter in the debris.

Fuller said that he a very good view of the fire while the wagon was stationary. He thought the flames were coming more strongly from the leading offside corner of the wagon than elsewhere, and said that they were two or three feet above the wagon top; he confirmed the statements of Gimbert and Clarke that there were no flames outside the wagon. He differed from them, however, in his description of the colour of the flames which he said were partly yellow and partly blue, the ordinary yellow colour predominating.

Having regard to the information which I had received on the 26th June, 3 weeks before I heard Fuller's evidence, that this wagon had conveyed a previous load of natural sulphur in bulk (see Section VI), Captain Fawcett and I questioned Fuller closely as to his reference to blue flames, particularly as nothing of the kind had been noticed by Driver Gimbert. Fuller, however, remained quite unshaken that he had seen strong tinges of blue, and described their colour as that of the flame of a gas ring; moreover, he strongly denied

any knowledge that the wagon had been loaded with sulphur on a previous journey. He also said that he noticed a peculiar smell which he described as "something like the gas works on fire"; he added that this was before the explosion, and his own words in this connection were "there was a certain amount of smell to the flame, or something was burning somewhere to cause the smell".

III. EVIDENCE REGARDING THE RUNNING OF THE TRAIN.

9. The train left March at 12.15 a.m., and passed Ely North Junction at 1.5 a.m. after a brief stop at the outer home signal there, representing an average speed of approximately 16 m.p.h. for the $13\frac{1}{2}$ miles. From Ely North Junction the 2 miles through Ely station and yard to Ely Dock Junction were covered in 9-10 minutes; on arrival at Ely Dock Junction the train was held in the Up reception line for 10 minutes awaiting the arrival of an opposing train on the single line from Barway Siding and Soham. It restarted at 1.24 a.m. from the home signal, some 200 yards in rear of Ely Dock Junction box, where the token for the section to Barway Siding was picked up. Seven minutes, as booked, were occupied in running the $2\frac{1}{2}$ miles (21 m.p.h. start to pass) to Barway Siding, where tokens were exchanged.

10. Ely Dock Junction box is on the off side of a train going towards Barway Siding, and there is one intervening track. Signalman G. Francis was standing at the door, facing the train as it approached his box after restarting from the Up Reception line home signal. He remained in this position watching the train until about three-quarters of it had passed; he then went inside to attend to the block bells, returning to the landing outside the door in time to view the tail lamp. Francis was "quite confident that there was no indication of fire on the train or friction of wagon wheels in any way". He added that the train made an easy start from the home signal and gathered speed quite normally, passing the box at about 10 m.p.h. So far as he could see, the engine wheels did not slip, nor were any sparks thrown from the chimney. The signalmen at the two boxes in rear of Ely Dock Junction, viz., Ely Station North and Ely North Junction, also stated that there appeared to be nothing amiss with the train.

11. The Barway Siding Signalman, C.D. King, recorded that the train passed his box at 1.31 a.m. This box is only a few feet from the Up line on the near side, and King first saw the headlights of the approaching train through the signal box window when it was about $\frac{1}{2}$ -mile away; he then went on to the landing at the top of the steps at the Soham end of the box and watched the whole of the train go by at, he said, about 15 m.p.h. He saw one of the enginemen exchange the tokens (by means of the lineside apparatus) and noticed that the regulator was reopened as soon as this had been done. He said that he was in a position to see into all the wagons and was sure that there were no signs of fire or smoke in any of them, nor any evidence of a heated axlebox; nor did he notice any unusual smell. After King had seen the tail lamp he collected the token, went back into the box, and sent the "Train out of Section" signal to Ely Dock Junction.

King said that he looked out again towards Soham a little later and noticed a "pinkish glow" on the steam or smoke from the engine; he estimated that by this time the train was about "one-third of the way towards Soham", i.e. about $\frac{1}{3}$ -mile from his box, and soon afterwards it was lost to his view round a curve. He thought nothing of this at the time and attributed it to the glow from the firebox (the side sheets would have to be thrown back to exchange the tokens). Shortly afterwards, he heard the explosion and noted the time as 1.43 a.m., 12 minutes after the train had passed his box. He tried to attract the attention of the Soham signalman, both on the block instrument and on the telephone, but failed to get any reply.

12. Driver Gimbert and Guard Clarke described the journey as perfectly normal in every way until they reached Soham. Clarke remained for the greater part of the time on the rear verandah of his van and noticed no smell of burning or of a hot axlebox while the train was travelling, nor when he walked some way forward during the 10 minutes wait at Ely Dock Junction. Enquiries show that 7 goods trains, 2 passenger trains, and 2 mail trains passed in the opposite direction while the train was running between March and Ely Dock Junction.

Clarke reported for duty at March at about 9.30 p.m. while it was still daylight and examined both sides of the train after placing his lit in the van and lighting the lamps. He said that the train consisted of 51 "sheeted" wagons

and that the sheets of the leading wagon and of two or three others were not tied over the wagon sides but were placed inside over the load. He actually climbed on to the leading wagon, by way of the brake lever, and looked inside to make sure there was a sheet; this was the only wagon he looked into from the top as he was able to see the other "inside" sheets through the gaps at the sides of the doors. During the whole 14½ hours the train was in March yard there were members of the shunting staff engaged around it, especially at the leading end, and none of them noticed anything unusual.

13. Carriage and Wagon Examiner G. Stevens, who has considerable experience, watched the whole train of 61 wagons arrive at March at 9.45 a.m. on 1st June, and saw the first 10 wagons detached as already described. He then took approximately ½-hour to examine both sides of the train, feeling all the axle boxes with the back of his hand, tapping wheels and looking underneath and all round the wagons, in accordance with the usual practice. Stevens found no defects in any of the wagons; no axle boxes were showing any tendency to heat, and from the dates recorded on the solebars, none of the wagons was overdue for oiling; he said that oiling was usually well up to date with trains from Immingham.

Examiner L. Ellis also noticed nothing wrong as he walked up one side of the train and down the other (on his way to and from other work) about 4 hours before it left March. Evidence was also given by Examiner G. Middleton that all was in order before the train left Immingham.

All these three men had often seen overheated axle boxes, both oil and grease lubricated, during the course of their work but had never known a wagon to be set on fire from this cause.

IV. DETAILED DESCRIPTION OF TRAIN AND LOAD.

14. A check of the remaining 50 wagons of the train shortly after the accident disclosed that all except two were Railway owned, and all were fitted with oil-lubricated axleboxes. Their contents from front to rear were as follows:-

		<u>Total</u>
1st	500-lb bombs unfuzed	1
2nd	Empty (A)	1
3rd	Detonators and primers	1
4th-6th	Fuzes	3
7th	Wire release gear	1
8th-10th	Fuzes	3
11th	Detonators and primers	1
12th-45th	250-lb bombs unfuzed	34
46th-50th	Bomb tail fins	5
	Grand Total	<u>50</u>

(A) Owing to inspection and re-arrangement of loads after the accident.

15. Records show that the demolished leading wagon was S.R. 12-ton open goods No. 29416. It was built in 1926 with the body of soft wood planking and all-steel underframe; the axleboxes were of the modern divided type, oil-lubricated. There were the usual side doors and the inside body dimensions were:-

Length	17 ft. 1½ ins.	
Width	7 ft. 6½ "	
Height	4 ft. 7⅞ "	(8 planks).

16. According to a copy of the wagon waybill, the contents were 44 500-lbs general purposes aircraft bombs of United States manufacture, weighing approximately 9 tons 16 cwts. The official nomenclature of this type is "Bomb, G.P. 500-lbs D.N. -M.64". As prepared for transport, unfuzed and without the tail fins, it is approximately 4 ft.0-ins long and 13½ ins. in diameter.

The head is ogival and the base, which is partially streamlined, is closed by a steel screw plug. The steel case, of minimum thickness .3 ins., is manufactured from a forging or seamless steel tubing. The main filling consists of 50-50 amatol, with tetryl exploders, the nose and base of the bomb being filled with E.M.T.; the total explosive content is 262 lbs (5.14 tons for 44 bombs). During transport each bomb is protected by two encircling detachable collars of steel or papier maché.

The usual way of loading this type of 500-lb. bomb is to place them nose to nose across the wagon in two layers, two staggered rows of 11 to a layer; it was stated that 44 bombs arranged in this way usually made a good fit in an open wagon of the above dimensions without the need for packing or scotching.

17. On 3rd June, the day after the accident, I made a superficial examination of the train which was standing in unchanged order in a refuge siding at Ely. I looked into a few of the wagons, and all of them were examined on the following day at the final unloading point by District Inspector N. Timm.

There were sheets to all the wagons and except in two instances, where they were laid inside, the sheets were properly secured over the wagon top. This was in accordance with Guard Clarke's statement, and I accept his assurance that there was also a sheet inside the leading wagon, No. 29416, over the load of bombs. The "red" war-time standard wagon sheet is of cotton base fabric, treated with a mixture of linseed oil and bauxite residues (mainly iron-oxide). Experiments carried out by the Armament Research Department show that this type of sheet, while not completely non-inflammable, has particularly good fire resisting properties.

18. I noted at my examination on 3rd June that in one wagon, L.M.S. No. 358568, about one third of the way down the train, there was a loose pile of about 2 cwts. of short ends (6 ins. or less) of soft wood timber scantlings, such as might be used as small scotches for individual bombs. The pile was on the centre line, between and on top of two rows of 250-lb. bombs, and apparently had been put in after the wagon had been loaded. This wagon was properly sheeted. Inspector Timm also noticed this pile of short ends, and expressed the opinion that timber of this kind was useless for scotching, unlike the log timber (hard wood) which he found at the end of this and other wagons to prevent a partial load of bombs from shifting lengthwise. He also reported that in L.M.S. No. 123352, about half-way along the train, there was approximately 3 ins. of loose straw on the floor under a load of 250-lb. bombs. With these exceptions, and two other wagons in which he found a few pieces of broken fish boxes and odd lengths of deal, Inspector Timm was satisfied that the wagons were "clean" and properly loaded. No explanation was forthcoming from the loading staff at Lamingham (see later) to account for the unsatisfactory condition of L.M.S. wagons Nos. 358568 and 123352. Nor could it be expected that the loading of S.R. wagon No. 29416, which caught fire should be remembered specially.

19. The "Special Instructions relating to the Conveyance of Explosives etc". (R.E.C. "White Pamphlet" 1939 - reprinted 1944) lay down that unfuzed aircraft bombs (Explosives in Group VII) may be loaded in open wagons "well sheeted with good sheets" in any case, and that bomb fuzes (Group VI) and detonators (Group X) may be loaded in open wagons so sheeted, if covered wagons are not available. The following is the relevant extract (p.12) with regard to sheeting and cleaning of wagons:

"All vehicles must be swept clean before loading and all open wagons must have sheets properly stretched over them and securely fastened with the sheet ties."

It is also laid down that explosives of different groups should be segregated in separate wagons, and this appears to have been done.

The Company's own Regulations are also strict as to the need for sheets to be properly secured over the wagon, and that wagons should be cleaned of straw or other inflammable material before loading. The following is an extract from a letter which was addressed by the Superintendent, Southern Area, to the Port Master, Grimsby Docks, on 26th January, 1944:-

/ "Attention

"Attention has been drawn to cases which have come to the notice where bombs in open wagons have been wrapped round with wagon sheets. This practice is quite irregular and involves an element of danger by the risk of sparks falling inside wagons. There is also the possibility of a gust of wind getting underneath the sheet, dislodging both bombs and cover.

It is essential to ensure that open wagons containing bombs, etc., have sheets properly stretched over the vehicles and securely fastened by the sheet ties."

V. EVIDENCE REGARDING LOADING AT LLEINCHALL.

20. I was informed by Mr. G.R. Abbott, the Dock Superintendent that, in the discharge of bombs from ship, each bomb is carried independently in a sling suspended from a crossbar, which is handled to and from the wagon by crane. All scotches used for securing loads of bombs in wagons are obtained from the ship, where they are used as packing; the thinnest timber used for this purpose is about 1 $\frac{1}{2}$ - 2 ins. Scotches and log timber packing are brought ashore in trays, also by crane, and landed direct to quay whence the loaders draw such pieces as they may require.

21. Wagon No. 29416 was loaded under the supervision of Checker H.W. Frow. The only other wagon which he loaded out of the 61 which left for March was No. 36270; the latter was one of the 10 detached at March and therefore was not in the train at the time of the accident. It was Frow's duty to check traffic from ship to wagons, and he worked with a gang of 4 loaders. It was also his duty to see that wagons were "clean" before loading; the sweeping out of empty wagons was not done by his gang but by 2 men detailed specially to each berth for this purpose. Sheeting was not his responsibility.

Frow, who appeared to be a reliable witness, stated that he had had considerable experience of the loading of aircraft bombs. He was on the 7.0 a.m. to 7.0 p.m. turn of duty on 31st May; the discharge of bombs commenced at about 10.0, a.m. and he assumed from his record that wagon No. 29416 had been loaded about 12 noon. He was emphatic that it was his "automatic" practice to inspect personally every wagon before it was loaded, looking into the wagon from one of the ladders provided; he was therefore certain that Wagon No. 29416 was despatched with no straw in it or inflammable refuse of any kind. He had often seen empty wagons come into the berth with straw, shavings, and all kinds of refuse in them, but they were invariably cleaned out before loading.

Frow's record confirmed that the wagon was loaded with 44 500-lb. bombs. He said that it was his responsibility to decide the arrangement of the load in the wagon and whether scotching was necessary. He could not remember whether he told the loaders to use scotches in this wagon, but he thought that this was unlikely as 44 500-lb. bombs loaded as described in paragraph 16 above would make a good fit. By scotches he meant comparatively large pieces of log timber, about 6 ins. in diameter, wedged in at the wagon ends. He added that he had sometimes seen oil-soaked empty wagons come into the docks, but he said that in no circumstances would bombs be loaded in them.

Loader A. Riggall, one of Frow's gang, had no special recollection of Wagon No. 29416, but he generally confirmed the latter's evidence that 44 500-lb. bombs generally made a "nice load" without the need for timber scotching. He said that as a rule Frow would look into the wagon before the bombs were put into it but that there might be exceptions when Frow was in the shed writing up his records.

22. Dock Supervisor W.H. Young was responsible for the general supervision of the discharge of ships and loading of wagons at this and two other quays; he spoke of Checker Frow as an experienced and reliable man. Mr. Young confirmed the usual method of loading 44 500-lb. bombs, and added that it was not unusual to use small wooden scotches for individual bombs, especially if the protective collars were damaged.

23. With regard to the pile of short snatches which were found in wagon No. 358568, Mr. Abbott suggested that they might have been put in as packing for the partial load, which consisted of 35 250-lb. bombs 30 of them stowed in rows of 15, noses inward on the floor of the wagon, with the remaining 5 placed lengthwise between the two rows. Mr. Abbott also made careful enquiries regarding the straw which was found in Wagon No. 123352 but with no satisfactory result.

VI. PREVIOUS JOURNEYS AND LOADS OF WAGON NO. 29416.

24. These were traced back for a month by a careful and laborious search of station records. It is of some significance that the wagon was loaded on 4th May from Victoria Docks to Luton with a consignment of natural yellow sulphur in bulk. At Luton it was dealt with at a private siding and was released empty on 14th May. Thence it was worked empty to the Sunderland District, in accordance with the general flow of empty wagons at the time, arriving there on 21st May. On 22nd May, it was loaded at Sunderland with a cased vehicle consigned to Grimsby (Alexandra Dock) where it arrived on 25th May. It was unloaded on 30th May and was worked empty to Immingham, arriving there at 11.45 p.m. on that day.

25. There is considerable traffic to Luton of imported sulphur in bulk, for the manufacture of sulphuric acid; the average is about 500 tons a month in lots of 500-1,000 tons at irregular intervals. Captain Fawcett and I accompanied by Mr. E.R. Rhodes, the Company's Assistant Chief Chemist, examined four open wagons shortly after they had been released empty by the firm concerned. All four were in much the same condition; the floors were covered with a thin layer of small lumps, grains, and dust; as would be expected, this residue was thicker where the ends and sides met the floor, and in the corners. One wagon was swept out in our presence with a stiff broom and some 56 lbs. of sulphur were recovered in this way. Even after fairly thorough sweeping there were considerable quantities of sulphur dust and small lumps lodged in the corners and crevices and in the irregularities of the floor planking, which in one case was broken right through, leaving a triangular hole with approximately 6 inch sides.

It appears reasonable to assume that the state of these wagons was representative of that of No. 29416 when it was despatched empty from Luton on the 14th May. There is no record of its subsequent cleaning, although, of course, it should have been swept out at Immingham, if indeed this had not been done before it was loaded at Sunderland. Checker Trow's evidence was given on 16th June, some time before the previous journeys of wagon No. 29416 had been traced. As it was clear that he had no recollection of this particular wagon, there appeared to be no object in questioning him later as to whether he had noticed any remains of its earlier load of sulphur.

26. The sulphur residue in the empty wagons at Luton appeared to be rather damp and several attempts to ignite it on the wagon floor by means of a glowing cigarette end failed; a flaming match met with more success and a small blue flame, which persisted for a minute or two with little spread, was fairly easily blown out. Nevertheless, finely divided sulphur can, under favourable conditions, be ignited at a considerably lower temperature than that of an ordinary flame. Moreover Mr. Rhodes informed me that it is not unknown for small fires to be started in bulk wagon loads of sulphur by sparks from the engine if it has not been possible to sheet them. Such fires, however, rarely become serious, and are easily extinguished by water; also it is sometimes the practice to spray sulphur loads with a hose as a precautionary measure if sheets are not available. The presence of sulphur in wagon No. 29416 (which seems likely) may, therefore, have had some bearing on the accident, and this is referred to later in Section VIII - Conclusion.

VII. SUBSEQUENT EXPERIMENTS.

27. Experiments were carried out by Mr. N. Newsome, Carriage and Wagon Works Manager, Stratford, in order (1) to reproduce the effect of a heated axlebox, so far as practicable with a stationary wagon, and (2) to illustrate the initiation and spread of a fire inside the wagon under various conditions. A copy of Mr. Newsome's memorandum is attached as Appendix I.

These trials, which were undertaken before it was known that wagon No. 29416 had previously been loaded with sulphur, cannot of course be regarded as conclusive, as there can be no assurance that any or all of the conditions present at the time were reproduced. They do, however, indicate, especially 2 (d), a surprisingly rapid spread of the fire to the wagon body planking (even without appreciable draught) from the ignition of a comparatively small quantity of inflammable material such as straw.

28. Experiment (1), though it could not be truly representative of running conditions, suggests that an overheated axle, even if the oil caught fire, would be unlikely to set fire to the wagon body, especially with a steel underframe, and Mr. Newsome had known no such case in his experience. Moreover, all the evidence was to the effect that the fire was entirely inside wagon No. 29416.

Apart however from this, and the evidence of the signalman, the statement of Carriage and Wagon Examiner Stevens may be accepted that all the axles of the train were cooled and oiled to date when it arrived at March. The subsequent slow run between March and Soham, with two stops at Ely, would hardly predispose to overheating of oil lubricated axles.

VIII. CONCLUSION.

29. I am advised by Mr. L.J. Burt, of M.I.5. War Office, who made exhaustive enquiries in co-operation with the Company's Police, that it is unlikely that the fire was the result of sabotage. Nor do I consider that there is any reasonable probability that it was caused by overheated axle. It may, therefore, be concluded that the fire was accidental and that it originated inside the wagon. In the opinion of Captain Fawcett and the Service experts present at the Inquiry, a fire of the volume and intensity described burning for 6 or 7 minutes, would be likely to bring about the detonation of aircraft bombs of this type by local heating.

30. The available evidence, however, is not sufficient to justify more than surmise, firstly how the fire originated, and secondly how it reached such intensity in less than 12 minutes after all was thought to be in order. There is no reason to doubt the statements of the various signalmen that there were no visible signs of fire up to 1.31 a.m. when the train passed Barway Siding; yet about 6 minutes later it appears that the sheet was well alight, for Gilbert "saw flames all over the bottom of the wagon", and after a further 6 minutes, just before the explosion at 1.43 a.m., the sheet and probably the wagon woodwork as well were burning fiercely.

Captain Fawcett informs me that any question of spontaneous combustion of the bomb filling may be excluded. It is therefore necessary to consider more ordinary causes, and on the whole it seems most likely that a spark from the engine was primarily responsible, particularly as the leading wagon of the train was concerned. I do not think, however, that either the sheet or the wagon woodwork can have been set alight directly in this way in spite of the exceptionally dry spell of weather; experiments have shown (see paragraph 17 and Appendix I) that it is by no means easy to ignite a wagon sheet, and it is improbable that the working on this level route would lead to glowing cinders of any size being thrown from the chimney of a powerful engine with a moderate load. In the case at Gomshall on the Southern Railway on the following day, 3rd June, where it appears that the woodwork of a covered wagon containing anti-aircraft ammunition was set on fire directly by a cinder from the engine chimney, the conditions were in sharp contrast to those at Soham, with heavy working on long and steep gradients. In the present case, therefore, I think it must be assumed that there was some substance present in the wagon which was particularly sensitive to ignition by a trifling spark from the train engine, (or perhaps from the engine of a passing train) which otherwise would have proved harmless.

31. The presence of straw packing or other such readily inflammable material appears to have been unlikely, as apart from the evidence of Checker Frow, the previous load of this wagon from Sunderland to Grimsby, viz: a single cased vehicle, was not such as to require packing of this kind. There can, however, be little doubt that the wagon must have contained some remains of its earlier sulphur load, even if it had been swept, and it does not seem unreasonable to

suppose that the fire may have been started by the ignition of this dry sulphur residue by a minor spark lodging behind the sheet, which was laid inside and could not give the same protection as one properly secured over the wagon top. Alternatively, a spark may perhaps have been generated by friction between the bombs themselves or between one of them and a particle of flint or other stone embedded in the wagon floor; I understand that it is not impossible to ignite finely powdered sulphur in this way. Sub-ganger Fuller's reference to the blue tinges in the flames and the peculiar smell which he noticed is certainly of interest, though this evidence cannot be regarded as conclusive.

32. Captain Fawcett and Mr. Rhodes agree that the foregoing may at any rate be a reasonable explanation of the origin of the fire, but the manner of its subsequent development is still obscure. When, however, everything is dry, and draught conditions are favourable, as may well have been the case, especially if there were appreciable gaps in the wagon floor, the development of a fire from very small beginnings may take an unpredictable course. It seems quite possible that small sulphur flames may have been gradually spreading, and perhaps the rough wagon woodwork smouldering, for a considerable time before the train reached Barway Siding (or Ely Dock Junction) with no visible signs of fire, even to a watchful signalman. In these circumstances it is not difficult to imagine that, under the running draught, the accumulating heat of such a fire confined underneath the sheet would reach a point when everything suddenly burst into flame.

Also, if there had been any quantity of small soft wood scotches in the wagon, such as were found in another wagon of the train (see IV and V above), these might have accelerated the spread of the fire, although I am quite sure that Checker Frow's evidence was given in good faith. On the other hand he did not specially remember wagon No. 29416 and Loader Riggall suggested that Frow might not have inspected every wagon owing to preoccupation with his clerical duties. I do not, however, suggest that any degree of responsibility for this accident should rest with Checker Frow and his gang, or indeed with any of the Company's staff, and the unsatisfactory condition of two other wagons in the train, both of which were properly sheeted, may have been quite incidental.

33. If the evidence as to the cause of the fire is inconclusive, there is no doubt that the two enginemen acted in accordance with the highest traditions of the Railway Service, and they were successful in preventing an incomparably greater disaster; I am very pleased to record that the George Cross has since been awarded to Driver B. Gimbert, and posthumously to Fireman J.W. Nightall. Gimbert is 41 years of age, with 25 years' service with the Company, and has been a driver for the last 2 years; Nightall was aged 22, with 5 years' service. Signalman F.C. Bridges also lost his life in the performance of his duty. Although there was no direct evidence that he was aware of the dangerous nature of the contents of the burning wagon, it was common knowledge to the staff that ammunition traffic was regularly conveyed by this train, and it is clear that Bridges was making preparations to fight the fire, with the assistance of Sub-ganger Fuller, when the explosion took place.

IX. REMARKS.

34. The fact that this is the first instance during the whole of the war of a serious explosion in a running train, despite the countless loads of ammunition which have passed and are still passing on the British Railways, illustrates the care which is generally taken to ensure that empty wagons are freed from inflammable material. Following the accident a strong reminder was issued, at the instance of the Railway Executive Committee, to the staff of all the Companies, stressing the importance of strict compliance with the Standing Instructions which stipulate that "clean" wagons must be supplied for loading. Reminders to the same effect were also issued to all private dock authorities, etc. and to the Service Departments, following which the War Office and the Air Ministry sent appropriate instructions to their local Movement staffs; action was also taken by the U.S. authorities.

35. Ordinary methods, however, cannot be expected to rid all traces of a bulk load of sulphur from the irregularities of a wagon floor, though where general traffic is concerned long experience has shown that the risk of a serious fire from this cause may be regarded as negligible. Nevertheless, in this exceptional instance, it does seem possible that the fire may have originated

and developed from the chance ignition of the sulphur residue in Wagon No. 29416, and with ammunition traffic the consequence of a fire may be so disastrous that something more than ordinary precautions would seem to be justified, especially with the present shortage of sheets (see below). The circumstances of this accident certainly suggest that it is undesirable to load dangerous goods such as explosives into wagons which have lately been used for bulk sulphur traffic, and I think it should be considered whether any preventive action can be taken though there are obvious practical difficulties. In any event it would be a step in the right direction if some pressure could be brought to bear on firms unloading sulphur to clean their empty wagons far more thoroughly, by hosing or other means, than those which I saw at Luton.

36. Apart from other precautions, sheeting by itself affords considerable protection against fire, but only if the sheet is properly secured over the wagon top; if laid inside the wagon, as in this case, a sheet may prove to be worse than useless. Sheets, however, have been in short supply for some time, and in order to avoid delay to urgent ammunition consignments it has been agreed by the Explosive Transport and Storage Committee that bombs in Group VII may, in certain circumstances, travel unsheeted in open wagons (see Appendix II for relevant extract from minutes). This appears to be a necessary wartime emergency measure which should entail very little additional risk, provided always that wagons are free from any kind of inflammable refuse, which is much the most important consideration. "Inside" sheeting, which is prohibited by the Regulations, is particularly undesirable with ammunition traffic, and an appropriate general reminder was issued to the staff immediately after the accident.

37. In conclusion, I have to acknowledge the valuable assistance which I have received throughout the course of this investigation from Captain Fawcett, from the Service Departments including the U.S. Air Force, and from all the Company's officers concerned.

I have the honour to be, Sir,
Your obedient Servant,

(SGD.) G.R.S. WILSON.
Major.

The Director General,
Ministry of War Transport.

MEMORANDUM

In order to investigate the possibility of setting fire to a wagon by various means, I have carried out experiments with an old wagon at Stratford Works, and give below particulars of the results obtained.

(1) Fire from a Hot Axlebox.

The axlebox was first heated by means of a blowpipe and the oil ignited. Very little flame came out when the front of the axlebox was closed and this only appeared at the back of the box. As this flame could not possibly set fire to the wagon, the front of the box was opened and a flame fanned by a strong wind immediately appeared and burned for 50 minutes. At no time did the flame reach any of the woodwork of the wagon.

Whilst this test was proceeding a portion of the wagon sheet was suspended over the axlebox so that it was licked by the flames. It remained in this position for 35 minutes and although it became softened by the heat, it did not catch fire.

(2) Fire from inside the wagon.

Further tests were made to ascertain the possibility of fire being started inside the vehicle.

(a) A small pile of forewood and straw about 3 ft. square by 9 inches high was placed in one corner of the wagon and covered with a portion of an old dry sheet; red hot cinders, cigarette ends and lighted matches were thrown on top of the sheet, which was suitably wrinkled to provide pockets, and tucked round the wood and straw, but after one hour none of these had penetrated the sheet or set fire to it. A smouldering piece of timber, however, about 9" long x 2" square caused the sheet to give off a great deal of smoke and charred a hole in it but did not set fire to any of the material underneath.

(b) Whilst experiment (a) was proceeding, a layer of straw about 2 ft. square x 3" thick was placed in the opposite corner of the wagon and ignited by a match, a piece of the sheet was thrown on top of it and in 7 minutes that corner of the wagon was on fire and would have spread to the remainder of the wagon had it not been extinguished.

(c) The fact that straw caused such a fierce fire in such a short time caused me to carry out a further experiment with this material and to do this cigarette ends and small pieces of burning timber were placed through the hole in the sheet charred in experiment (a). These failed to ignite the timber but resulted in a slight smouldering of the straw.

(d) As the experiment in (c) failed to ignite the material after a lapse of about 10 minutes, a lighted match was dropped through a hole in the sheet so that it fell on to the straw. Smoke quickly appeared and in 2½ minutes a good fire had started under the sheet and in 3 minutes the wagon side and end boards had ignited. In 4½ minutes the heat from the burning boards was so intense that it was unbearable to stand within 8 feet of the burning end of the wagon.

It should be noted that experiment (1) was carried out on a windy day the wind blowing at about 20 m.p.h. parallel to the longitudinal centre line of the wagon. The series of experiments under (2) took place on a calm day with practically no wind.

(SGD.) N. REASON.

17th July, 1944.

SECRET.

EXPLOSIVE STORAGE AND TRANSPORT COMMITTEE.

Extract from minutes of 43rd Meeting on 14th June 1944.

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5. SPECIAL REGULATIONS FOR THE CONVEYANCE OF GOVERNMENT EXPLOSIVES DURING THE PRESENT EMERGENCY.

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(b) The Railway Companies and the Air Ministry report a shortage of tarpaulins and ask whether the Regulations calling for the sheeting of open trucks carrying explosives can be modified to avoid holding up consignments, at least so far as aircraft bombs and similar "loose" ammunition are concerned, particularly as aircraft bombs are stored in the open without cover.

Action.

The Committee are averse to the granting of any general relaxation of this kind, as tarpaulins afford weather protection to "loose" ammunition, minimising rust, offer a certain amount of protection against fire and have a certain security value. In view, however, of the evident shortage and the importance of avoiding delays they agree that High Explosive Bombs in Group VII can be conveyed by rail without sheets when these are not available or for short hauls of the order of 20 miles or less even though the tarpaulins may be available. The Railways and Services will be advised accordingly.

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