

LONDON MIDLAND & SCOTTISH RAILWAY

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

July, 1945.

Sir,

I have the honour to report for the information of the Minister of War Transport, in accordance with the Order dated 24th March, 1945, the result of my Inquiry into the explosion which occurred at about 10.17 p.m. on 22nd March, 1945, at Bootle (Cumberland), between Workington and Barrow, on the London, Midland & Scottish Railway. I was assisted at my Inquiry by Captain N. Fawcett, Inspector of Explosives, Home Office; the Explosive Storage and Transport Committee were represented by the Secretary, Major P. Taggart, R.A., and the Admiralty by Mr. P. J. Rafferty, Naval Armament Supply Officer, Broughton Moor.

The 7.10 p.m. through freight train from Workington to Bankfield (Liverpool), of which the leading 7 wagons were loaded with depth charges, was passing through Bootle station on the Up line at about 20-25 m.p.h. when the enginemen noticed that one of the leading wagons was on fire. The driver, H. Goodall, stopped the train and the fireman, H.N. Stubbs, who had alighted before it stopped, uncoupled behind the burning wagon, which was of the high-sided open type, marshalled 6th from the engine. Stubbs then rejoined the engine and the 6 wagons were drawn forward for about 80 yards; he alighted again while the engine was still in motion, and after he had uncoupled in front of the burning wagon, the leading 5 wagons were taken forward for a further 80 yards.

Two or three minutes later, the load of 52 depth charges exploded with great violence. I regret to report that Driver Goodall was killed; his body was found by the line side about 70 yards in rear of the crater, which suggests that he had gone back either to see what he could do himself, or to seek assistance to extinguish the fire. This was the only casualty, apart from the guard, T. Wilkinson, who suffered from shock. Fireman Stubbs was about 200 yards away when the explosion took place; he had gone forward to protect the opposing line and had already put down one detonator. He was thrown from one side of the line to the other, but quickly recovered and continuing forward placed 3 more detonators on the rails. There is little doubt that the prompt action of the enginemen in isolating the burning wagon, without regard to personal risk, prevented a far more serious explosion.

The fire was also observed by the Bootle signalman as the train passed his box. He sent the "Stop and Examine" signal and telephoned to Silecroft, the next box ahead, and an approaching passenger train was stopped there.

The explosion took place in shallow cutting in open country, about 770 yards forward of the small wayside station in the Up direction. The detonation of some  $9\frac{1}{4}$  short tons of high explosive filling appears to have been complete, and an oval crater was formed in the stiff blue clay formation, 105 ft long and 45-60 ft wide; the maximum depth was 50 ft. The dimensions of the crater, especially its depth, were remarkable considering that the "charge" was not in contact with the ground. About 60 yards of double line was destroyed, and 6 spans of the lineside telegraph route. There was considerable damage, mainly superficial, to the hut buildings of H.M.S. Macaw, an Admiralty shore establishment 300-400 yards from the explosion. A good deal of glass was broken in Bootle Station, also in the villages of Bootle and Hycemoor, 1,500 yards and 1,100 yards distant respectively.

Practically no traces were found of the wagon concerned, though a small unburnt piece of its sheet was recovered. None of the remaining wagons nor the engines were derailed, and damage to the front portion of the train

was confined to the two wagons nearest the explosion; their body work was wrecked, and a piece about 3" long was blown from one of the tyres.. Blast effect on the 51 vehicles of the rear portion was more far reaching, there was damage in varying degree to 11 of them as far as, and including the 34th, which was about 220 yards from the explosion. Seven depth charges were penetrated by fragments.

All except two of the damaged vehicles were made fit to run with comparatively little trouble. The crater was filled by using a bulldozer to push back the debris, much of which was in large solid lumps scattered in the surrounding fields; a few wagon loads of ashes were used for the top layer. A single line was opened for traffic at 7.0 p.m. on 24th March, and normal working was resumed, under speed restriction, at 5.40 p.m. on 25th March, after a lapse of 68 hours. This was a creditable achievement, as it involved the handling of 2,000 - 3,000 cubic yards of material before the track could be restored.

It was a fine night with the moon in the first quarter; there was a moderate wind from the South, against the direction of the train. The preceding four weeks had been unusually dry, only .73 inches of rain having been recorded locally during this period.

The fire was probably due to ignition of the wagon sheet by a spark from the engine chimney.

DESCRIPTION OF TRAIN AND ROUTE

1. After leaving Workington yard for the South, the train called at Corkickle yard, Whitehaven, where it received its final formation after some shunting. Thence it was routed south and east, along the Cumberland coast line to the junction with the Western Section main line at Carnforth, where further shunting was to be performed. The following are relevant distances:-

	<u>Miles</u>	<u>Miles</u>
Workington yard	0	
Single line	8	8
	14½	6½
	18	3½
	22	4
Double line	25½	3½
	28½	3
	81	

Gradients as far as Bootle are not severe; there is a rise of two miles at 1 in 366 between Sellafield and Drigg, and 2½ miles rising at 1 in 407, 1 in 327 and 1 in 365 between Eskmeals and Bootle.

2. The line is straight through Bootle station and for some distance beyond, and the following are local distances related to the site of the explosion:-

Bootle signal box, at north end of platforms	854 yards North
South end of platforms	713 yards North
Brake Van of train	470 " "
Front end of rear portion	about 80 " "

Rear end of front portion

about 80 yards South

Engine

" 130 " "

3. The 7 wagons which were leading at the time were loaded with depth charges on the same morning, 22nd March, in the private sidings of Camerton Admiralty depot, about 3 miles inland from Workington on the line to Cookermouth and Keswick. They were taken to Workington yard by the 2.30 p.m. trip, and the 7.10 p.m. train was made up there during the afternoon. It left the yard punctually with a few wagons of ordinary merchandise between the 7 explosive loads and the engine.

The train was remarshalled at Corkickle, where 31 wagons were detached and 28 attached; it left there for the south at 8.50 p.m. 47 minutes late, in the following formation:-

Engine No.3579

7 wagons - depth charges, ex Camerton for Liverpool.

2 wagons - non-explosive Admiralty Stores, ex Camerton for Liverpool

7 wagons - ordinary merchandise, for destination south of Carnforth.

1 empty wagon for repairs

2 bogie coaches for repairs

38 empty wagons

20 ton van

The total load of approximately 500 tons was within that laid down over this route for the class of engine, which was of moderate-sized 0-6-0 type, Class 3F, weighing  $84\frac{1}{2}$  tons in working order with tender. The total length of the train was approximately 440 yards.

4. The demolished wagon was private owner's No.9386 of the standard 12-ton mineral type, fitted with side, end, and bottom doors. It was built in 1928 with underframe of hard wood and body of  $2\frac{3}{8}$  ins. and  $2\frac{1}{2}$  ins soft wood planking; the axle boxes were oil-lubricated. Inside body dimensions were:-

Length 16 ft  $1\frac{1}{2}$  ins.

Width 7 ft  $7\frac{1}{4}$  ins

Height 4 ft  $4\frac{1}{2}$  ins.

5. According to a copy of the wagon waybill, the load was 52 depth charges, Mark VII, each weighing 450 lbs. The case of this type of depth charge is a cylindrical steel drum with dished ends, welded from  $\frac{1}{8}$  in: steel plate; the external diameter is 1 ft  $7\frac{1}{2}$  ins. and the length 2 ft  $3\frac{1}{2}$  ins. There is an axial steel tube,  $3\frac{1}{2}$  in. diameter, welded into the ends to house the hydraulic "pistol" and exploder, which are transported separately. During transport, as on this occasion, the ends of the empty central tube are closed by wooden caps. The casing is filled with the high explosive charge through two diametrically opposed openings in one end, each 5 ins. diameter; these openings are closed by plugs, each of which consists substantially of two steel discs which are drawn together by a nut and bolt, squeezing a thick rubber ring between them against the bore of the opening. The main filling in this particular consignment was 360 lbs of Amatol (9.36 short tons in all).

The 52 depth charges were loaded in three groups. At each end of the wagon, there was a group of 20 on their ends, 5 across and 4 along, and in the middle a group of 10 on their sides, 5 rows of 2 charges laid lengthwise; the odd 2 charges were laid lengthwise on top of the middle group. The load so disposed was a good fit in the wagon and no packing was used.

6. The sheet was tied over the wagon and with the 4 ft  $4\frac{1}{2}$  ins. side, and the low load, was unsupported in the middle (see later). It was of the red war-time pattern, of cotton fabric with waterproof dressing of linseed oil and bauxite residue pigment. Owing to shortage of supplies, less linseed oil is used than with the black pre-war sheet, in which the carbon black pigment gave better penetration of the fabric by the dressing, on which the sheet depends for its fire-resisting as well as its waterproof qualities. The recovered fragment showed that the sheet was well worn, with the fabric exposed in places.

7. The 7 wagons of depth charges were labelled with the war-time Government Explosives label. This is of the same size as the label for ordinary traffic, viz. 7" x 4" and is distinguished from it by a conspicuous hollow red rectangle and the words "Shunt with great care". For security reasons it was substituted in May 1941 for the more distinctive 9" x 6" peace-time Explosive label, which was of similar general design and bore in addition the word "Explosives" in heavy block type.

8. The special war-time Government Regulations for the conveyance of explosives (reprinted October 1943) lay down that unfuzed depth charges (Explosives in Group VII) may be loaded in open wagons "well sheeted with good sheets". With regard to marshalling, the standard Rule 240, Clause (10) requires that not more than 5 vehicles containing explosives must be conveyed by any one train at any one time, and further that vehicles containing explosives must be marshalled as near the middle of the train as possible. Early in the war, however, the conveyance of up to 60 wagon loads of explosives in any one train was authorised by the Government Regulations; the R.E.C. Instructions implementing these Regulations cancelled the provision of Rule 240, Clause (10), including the reference to marshalling in the middle of the train, which the decision to permit conveyance of explosives in full train loads rendered inoperative.

#### REPORT

9. After leaving Corkickle at 8.50 p.m. the train ran without stopping to Nethertown, arriving there at 9.14 p.m., representing an average speed of about 16 m.p.h. for the  $6\frac{1}{2}$  miles. It was held for 15 minutes at Netherton to cross a freight train from Barrow on the single line, leaving there at 9.29 p.m. There was no further stop during the run to Bootle, the 14 miles from Nethertown having occupied 41 minutes, or approximately 20 m.p.h. Between Nethertown and Bootle the train passed a north-bound passenger train on the double line just south of Sellafield, also a north-bound freight train between Drigg and Eskmeals.

10. Fireman Stubbs and Guard Wilkinson described the journey as perfectly normal in every way until they reached Bootle. No great effort was required from the engine, which was steaming well; the coal was not of the first quality, and there was some clinker in the fire, but Stubbs had no occasion to use the pricker. Wilkinson referred to the shunting at Corkickle and was aware that the wagons next the engine on leaving there contained Government traffic, but he did not seem to have appreciated that the red rectangle on their labels meant that they were loaded with explosives. So far as he was aware there was no restriction on placing wagons loaded with explosives next to the engine, and he stated that the Government traffic was placed in front of the train to facilitate shunting at Carnforth.

11. The fire was first noticed at 10.10 p.m. by the Bootle signalman, J. Southward, at about the same time as it became apparent to the enginemen. The signalman at Drigg,  $6\frac{1}{2}$  miles back, saw nothing wrong, although he watched the train closely as it passed him 15 minutes earlier. Eskmeals station and signal box were closed.

Signalman Southward watched the train approach from the door at the north end of the box, and it was not until the wagon was a few yards from him that he saw a white glow against the inside; there was some smoke, but no flames at this stage, and he could see nothing of the sheet. He noticed no unusual smell. About 100 yards further on flames burst up suddenly from the top of the wagon, of which the following is his own description:-

"I saw flames rising over the top of the wagon and they would be about 10 or 12 feet above the wagon side, as much as that; it seemed to be ablaze all inside, or in other words one level big flame inside the wagon, but there was no flame outside the wagon, and I could see the darkness of the wagon side".

Directly he noticed the fire Southward put the Up starting signal to danger and, as has been mentioned, warned the next box ahead to stop opposing traffic. He estimated that the explosion took place about 5 or 6 minutes after the train had passed him, and 3 or 4 minutes before the main explosion he heard two light reports, separated by about 10 seconds, which he compared to the sound of a double-barrelled shot gun; this was after the wagon had broken into flame. He noticed a few sparks from the engine chimney as it approached which he said was quite usual with trains on the rising gradient from Eskmeals.

Porter G. Bradshaw was on the platform at the foot of the signal box steps. He saw a glow as the train approached, which he thought was coming from the firehole door, until the wagon was about 20 yards away. He reached the top of the steps as it went by and noticed that there were low flames all over the bottom of the wagon. Otherwise he confirmed Southward's evidence.

12. Fireman Stubbs looked back once or twice after passing Eskmeals and saw nothing unusual; he again looked back as the engine was passing the Bootle platforms and saw the reflection of the fire on the station buildings, Just before the train stopped, he jumped off and uncoupled in rear of the burning wagon and pinned down two brakes on the rear portion. On this occasion he experienced no difficulty from the heat though the flames were blowing backwards over his head from the top of the wagon, and almost touching the next in rear; he described their colour as "brighter than burning wood".

When he uncoupled the second time, in front of the wagon, the combustion had become very violent; flames were spurting from the bottom of the wagon through a hole in the front planking just above the drawhook, and he had to bend down underneath it to uncouple. He spoke of "a blueish white sheet of flame", also "flames fizzing like a gas-jet"; and referred to a minor explosion, like a firework, just after he had uncoupled, when something shot out of the wagon and fell behind him. The wagon sides, however, were not burning, and he saw no signs of a hot axle-box.

After the front portion of the train had been drawn clear, Stubbs ran forward to protect the opposing line as already described, and subsequently took the engine forward to Silecroft. According to his statement, neither he nor Driver Goodall were aware that there were explosives in the train, and the guard had made no mention of this when he informed them of the load on leaving Workington.

13. Evidence as to the loading was given by Mr. J. F. Burgess, Assistant Foreman of Stores at Camerton Depot, and by W.B. Kirkby, in charge of the contractor's gang who loaded Wagon No. 9386 with depth charges, together with two others (one privately owned) on the morning of the 22nd March. Kirkby stated that he inspected the wagons and had them swept out before they were loaded. He also referred to the sheeting of the two privately owned wagons, which was his responsibility; he described it as "hollow sheeting" with a space of 2 ft 0 ins to 2 ft 6 ins. between the sheet and the load, and an overlap of about a foot on the wagon side. He added that it was more difficult to get sheets pulled tight on privately owned mineral wagons as they were not fitted with sheet hooks.

Mr. Burgess referred to the strict discipline enforced in the depot with regard to the cleaning of wagons before loading, and he and Mr. Rafferty expressed confidence in Kirkby's reliability in this respect. Mr. Burgess appreciated that the loading of depth charges in wagons with end and/or bottom doors was contrary to the regulations, but only short notice for empties was possible, and the depot had to use such wagons as the Railway Company could supply. Grease-lubricated wagons, however, were invariably rejected.

The wagons were labelled by the Camerton station staff. The junior porter, J. Simon, checked them as they came out of the depot and was certain that No.9386 was properly sheeted, and there was an entry to this effect in his wagon book, which I verified. The stationmaster, Mr. Fraser, said that he had never had any occasion to complain of unsatisfactory sheeting by the depot staff during the whole of the war.

14. The 2.30 p.m. trip of wagons from Camerton was examined on arrival at Workington by the carriage and wagon staff; none of the axles were showing any tendency to heat, and only one had to be replenished with oil (not of wagon No.9386). The train was also examined at Corkickle and nothing was found out of order.

15. On the morning after the accident, the remaining 6 wagons of depth charges (one covered and 5 open) were inspected by Goods Department Inspector G. D. Musgrave, accompanied by Mr. Burgess. Inspector Musgrave reported that all the loads had been satisfactorily stowed, without any wood packing, and that there was no inflammable refuse in any of the wagons. The 5 open wagons appeared to have been properly sheeted, though it was difficult to judge as the sheets had been pushed into the wagons and damaged by the falling debris.

#### GASCOIGNE WOOD, 18th APRIL

16. In daylight, a somewhat similar fire and explosion occurred in a freight train at Gascoigne Wood yard, near Selby, in the North Eastern Area of the L.N.E.R. after several days of warm and dry weather. No Inquiry was held, but the Company's report and subsequent correspondence disclosed that the train comprised 12 open sheeted wagons next the engine loaded with unfuzed 500 lb. aircraft bombs, followed by 37 empties. It was running into the yard through a facing connection when the driver (also a signalman) noticed that the 8th wagon was on fire. The driver, who was aware that the wagons next the engine were loaded with bombs, stopped the train, uncoupled in front of the burning wagon, and drew 7 wagons forward.

A few minutes later there was a violent explosion which formed a crater about 90 ft diameter and 50 ft deep and caused widespread damage to track, buildings and rolling stock in the yard. The fireman of another engine was killed. A subsequent count indicated that 98 out of 132 bombs in the 8th, 9th and 10th wagons had detonated, representing some 13 short tons of T.N.T. filling. The 7 wagons which had been drawn forward were undamaged, and none of the bombs in the 11th and 12th wagons exploded.

All the loaded wagons were fitted with oil-lubricated axle boxes. According to the guard's statement, which there is no reason to doubt, the sheets of the 8th, 9th and 10th wagons (which were demolished) were tied over one side in the ordinary way, and were tucked inside, over the bombs, on the other. These three wagons had been loaded at Cardiff Docks and subsequent inspection disclosed that the 6th wagon, also from Cardiff, contained about 14 lbs of refuse, some of it straw.

#### CONCLUSION

17. Although the gradients of the Cumberland Coast route are not such as to require engines to be worked heavily, the Company's records show that it is by no means immune from line side fires, the majority of which are caused by engine sparks, both in summer and in winter. The weather had been unusually dry for some weeks before the accident and, having regard to the position in the train of wagon No.9386, i.e. 6th from the engine, I consider that the most probable cause of the fire was a spark from the engine chimney lodging in and igniting the sheet, the fabric of which had become exposed through ordinary wear and tear. It also seems likely that the fire at Gascoigne Wood on the 18th April, where the 8th wagon was involved, was due to the same cause; weather conditions were very similar, as also in the case at Soham on the L.N.E.R. in June last year, into which formal Inquiry was held and where the fire was in the leading wagon of a full train load of aircraft bombs.

In all these three cases it is difficult to account for the rapidity with which the fire developed after all was thought to be in order, though

it is possible that smouldering of the sheet or even of the wagon woodwork might have passed unnoticed for considerable time, until the running draught, increased at Bootle by a contrary wind, fanned the embers into flame. From Fireman Stubbs' description of his experiences, it is evident that the amatol filling itself caught fire some minutes before the explosion, probably as the plugs of the depth charges were blown out by internal pressure under the heat; I have no doubt that the two light reports which were heard by Signaller Southward can be explained in this way, also the projection of the object from the burning wagon when Fireman Stubbs uncoupled the second time. With a fire of the intensity described, detonation of the explosive filling could have been expected after a very few minutes.

18. The discipline at Camerton Depot with regard to the loading of wagons generally and their sheeting appears to have been strict, and I accept the statements of the staff there that Wagon No. 9386 was free from inflammable refuse. I am also satisfied that it was properly sheeted over the top, though with a high sided wagon and a load of this kind it is impossible to avoid a hollow in the sheet which might facilitate the lodgment of glowing cinders. On the other hand, at Gascoigne Wood the sheeting of the wagon concerned, and of the two next in rear of it does not appear to have been in accordance with the regulation; this contravention was particularly regrettable in view of the special reminder which was issued to the staff after the explosion at Soham, where the whole sheet had been laid inside the wagon.

19. It was unfortunate that the explosive loads in the Bootle case were marshalled next the engine. I understand that no appreciable delay would have resulted either at Carnforth or at any point in the journey if they had been placed nearer the middle of the train, but with Rule 240, Clause (10) in abeyance, I do not think that Guard Wilkinson or the Yard staff at Corkickle can be criticised on this account. Wilkinson's failure to notice that there were loads of explosives on the train, if this really was the case, was remarkable, though the possibility of his recollection having been affected by his experience must be taken into account.

20. As at Soham, the rapidity of decision and action displayed by the enginemen at Bootle and at Gascoigne Wood was most creditable, and was successful in preventing far more serious consequences, either by spreading of the fire or by sympathetic detonation; although Stubbs stated that he was unaware that the burning wagon contained explosives, he must have realised from the violence of the combustion when he uncoupled the second time, that there was imminent danger.

#### REMARKS

21. The relaxation of Rule 240, Clause (10) referred to in paragraph 8 above, was a necessary war-time measure to expedite traffic under conditions of operational urgency and abnormal pressure on the Railways, apart from the fact that the rule was clearly inapplicable with full train loads of explosives, as in the Soham case. At Bootle and Gascoigne Wood, however, the explosive loads formed a comparatively small proportion of the train, and in neither case would any appreciable difficulty or delay have occurred if they had been marshalled further from the engine to minimise the risk of fire from sparks.

The Companies have now issued instructions that where possible odd wagons of explosives, i.e. less than full train loads, should be marshalled near the middle of the train, provided no undue delay is caused, which should reduce the risk of accidents of this type. It is largely a risk of war, and the fact that there have been not more than three wagon fires leading to major explosion in a running train during the whole of the war, suggests that it has not been very serious hitherto. It will not, however, be possible for some time to return to the full peace-time restrictions on the carriage of explosives by rail, but I have no doubt that the position will be kept under review.

22. The general question of sheeting of explosive loads was considered by the Railway Executive Committee following the accidents at Bootle and Gascoigne Wood. It was recommended to the Explosive Storage & Transport

Committee that, in view of the greater fire risk with the war-time pattern of sheet, especially when the fabric is exposed through wear, open wagons loaded with steel-cased weapons such as unfuzed shells, bombs, depth charges, etc., should travel unsheeted, on the understanding that special precautions are taken to ensure that wagons are "clean". This was discussed by the E.S.T.C. at their meeting on 28th June, at which I was present, but it was decided that sheeting should be maintained, as the risk of fire was not considered to outweigh the advantages of sheeting for protection from the weather and security; regard was also had to the re-imposition of the restriction that explosive loads should be marshalled near the middle of the train.

23. The supply and maintenance of wagon sheets generally has been a matter of much difficulty during the war, but it is hoped that as the position improves in respect of materials and labour, a return will be made to the pre-war type, which was superior from all points of view. Also, I understand that experiments are being conducted by the Ministry of Supply, with the co-operation of the London Midland and Scottish Railway, with cartage sheets dressed with polyvinyl chloride, which is a good deal less inflammable than the linseed oil dressings used hitherto. The Company reports that so far these sheets have stood up well and no doubt the experiment will be watched in its bearing upon the possible improvement of wagon sheets.

24. If Driver Goodall had known that the burning wagon was loaded with explosives it seems reasonable to assume that he would have taken steps for his own safety, having done all that he possibly could for the safety of the rest of the train. The Railway Companies have now made provision in the Rules that the guard should inform the enginemen when explosives are being conveyed, as a guide to any emergency action they may have to take, as well as for their own safety. Return has also been made to the use of the more distinctive peace-time "Explosives" label referred to in paragraph 7 above.

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

(Sgd) G.R.S. WILSON

Major

The Director-General,  
Ministry of War Transport.