LONDON MIDLAND AND SCOTTISH RAILWAY.

Ministry of Transport,
4. Whitehall Gardens,
London, S.W.1.
7th May, 1935.

SIR,

I have the honour to report for the information of the Minister of Transpor in compliance with the Order of the 28th February, the result of my Inquiry into the circumstances of the accident which occurred at about 11.32 a.m. on the 25th February, near Ashton-under-Hill Station on the London Midland and Scottish Railway.

The 9.51 a.m. passenger train from Birmingham (New Street) to Ashchurch, via Barnt Green and Evesham, was travelling at considerable speed between Hinton and Ashton-under-Hill Stations when the whole train became derailed. I regret to state that the driver A. Woolley was killed; the fireman and guard were also injured, the former seriously. There were only two other occupants of the train, a passenger and the local Permanent Way Inspector, G. W. Waite, neither of whom was injured.

The train comprised two bogie coaches only, weighing 56 tons; it was drawn by tank engine No. 2023, Class 3 (or "2000" class) superheater, 0-6-4 type, running chimney first, and weighing in working order 76 tons 11 cwts. The engine was fitted with the steam brake, vacuum controlled, operating blocks on the coupled wheels and on all wheels of the coaches.

The engine spread the track, dropped between the rails, and after travelling 161 yards from the point of derailment, came to rest on its right-hand side, across the track and the cess. It was extensively damaged, due to sliding on its side, and a rail pierced the cab near the front right-hand spectacle plate, passing through by the corresponding rear spectacle; this rail caused considerable damage to steam pipes and brake fittings, and the fatal injuries of driver Woolley were partly due to scalds brought about by the consequent escape of steam.

The screw couplings held, and the two coaches remained more or less upright and in line; the adjacent up line was fouled. Considerable damage was caused to the steel underframes and running gear of both vehicles, but the damage to bodywork was not extensive. There was no telescoping, but buffer locking took place; both coaches were of modern construction, having steel underframes carrying wooden bodies covered with steel panelling, and fitted with shock-absorbing buffers.

A displaced rail rode up over the leading bogie axle of the front coach and over the bogie bolster, penetrating the floor of the third compartment from the front, the end finally protruding through the outside panelling at a distance of 18 feet 6 inches from the leading end of the coach.

The permanent way was destroyed over the whole distance from the point of derailment, one rail, for instance, being bent in a figure of eight.

The weather was fine at the time, but records indicate that in the vicinity there had been occasional rain throughout the previous week, viz. 0.69 inches between the 19th and 23rd inclusive.

Description.

1. The attached plan shows the site of this accident, the position assumed by the engine and rolling stock, the damage to the track, and other relevant information.

The section of line concerned lies south of Evesham on the branch which leaves the West of England main line at Barnt Green, and runs in a southerly direction through Evesham, rejoining the main line again at Ashchurch. Between Barnt Green and Evesham, the line is single, and thence to Ashchurch it is double.

The train was booked to run non-stop between Bengeworth and Beckford Stations, so that the following distances and gradient characteristics are relevant :—

	Mileage.	*Intermediate mileage.*	*Gradients.*
Bengeworth	75 m. 26 c.		
Hinton	77 m. 3 c.	1 m. 57 c.	Generally rising 1 in 400 to 200.
Summit of Gradient ...	77 m. 71 c.	0 m. 68 c.	
Point of Derailment ...	78 m. 50 c.	0 m. 59 c.	Generally falling 1 in 300 to 200.
Ashton-under-Hill ...	78 m. 74 c.	0 m. 24 c.	
Beckford	80 m. 72 c.	1 m. 78 c.	

Curvature is easy throughout this section of line, and the derailment took place at the beginning of a right-hand curve of 120 chains radius, with 1½ inches superelevation.

2. The permanent way was laid in 1889 and was therefore 46 years old. The rails, 30 feet in length, originally weighed 85 lbs. per yard, the present weight being about 80 lbs. The chairs, in which the rails were secured by outside oak keys, were of old Midland pattern and weighed 46 lbs. each, designed originally for fixing to the sleepers by two spike and two oak trenails, two large holes being provided for the trenails, spaced diagonally. The 4-bolt fishplates weighed 32lb. per pair.

There were 11 sleepers per rail length, of creosoted pine, 9 feet × 10 inches × 5 inches, those laid originally being heart side up. The ballast consisted of a mixture of stone and shingle for about 6 inches below the sleeper bed; the stone appeared to be of a somewhat flaky nature. There was ash ballast in the six-foot way; formation was gravel, and drainage generally appeared to be good.

The single line from Barnt Green to Evesham was categorised as "second class" and the section of double line from Evesham to Ashchurch as "third class" (vide definitions later).

For about 1,000 yards in rear of the point of derailment, line and level generally appeared to be good and consistent with the standard to be expected on a branch of this character. Gauge varied on the average from $\frac{1}{16}$ in. slack to $\frac{1}{16}$ in. tight, and near the site from $\frac{1}{4}$ in. slack to $\frac{1}{16}$ in. tight in one rail length; there was little side wear.

Considerable "spot" sleepering had been carried out, but there was much evidence of softness and decay in the chair seats of the original sleepers, and in places the chairs had cut in to a depth of $\frac{3}{8}$ in. The spikes in these sleepers were not sufficiently loose to be pulled out by hand, but their two oak trenails were mostly decayed and had no holding power whatever. The spikes were of old Midland pattern, 6 in. long under the head, tapering in diameter from 1 in. to $\frac{7}{8}$ in.

Where decay had taken place under the chairs and the sleeper had not been renewed, refastening in some cases had been carried out, and the sleepers had either been shifted a few inches sideways or the chairs had been moved slightly along the rail. Fresh spike holes had been bored in each case.

Where the old sleepers had been renewed, the fastenings consisted of a varied combination of spikes, coach-screws, and trenails. In some cases spikes or coach-screws were used in the original trenail holes of the chair in conjunction with oak ferrules. A detailed analysis is given later of the numbers of the original and changed chairs and of the character of the fastenings over the two miles of the down line in rear of, and including, the point of derailment.

I examined some of the sleepers which had been taken out immediately in rear of the point of derailment. Except under the chair seats, the timber appeared to be sound and was generally up to the full thickness of 5 in. Under the chair seats, however, and round the spike holes, it was soft and decayed, so that the holding power of the fastenings had become much reduced. Examination of the under sides of the damaged rails showed remarkably little chair galling after 46 years in traffic.

3. *Tank Engine No.* 2023.—This (2,000) class of engine has a length over buffers of 40 feet 4½ inches and a total length of wheel base of 29 feet (see diagram

on Drawing). The spacing between the leading and driving axles is 8 feet, between the driving and trailing coupled axles 8 feet 6 inches, and between the bogie centres 6 feet. The diameter of the coupled wheels over treads is 5 feet 7 inches and of the bogie wheels 3 feet 1 inch. The designed fully-loaded weights carried by the leading, driving and trailing coupled axles is 18 tons 11 cwts., 18 tons 18 cwts., and 18 tons 2 cwts. respectively; the weight on the 4-wheeled bogie being 21 tons. The engine carries in the two side tanks and rear tank 2,250 gallons of water, and in the bunker 3½ tons of coal. The centre of gravity of the engine fully loaded is stated to be 5 feet 4 inches above rail level. At the time of derailment it is understood to have been 5 feet 2½ inches. The longitudinal position of the centre of gravity of the engine fully loaded was 4 feet 11¼ inches behind the centre of the driving wheels. The centre of gravity of the side tanks when full is 6 feet 0¼ inch above rail level.

The leading coupled wheels are fitted with a modified form of Cartazzi axle box (with inclines 1 in 8) which allows a total movement, including axle box play, of 1⅜ inches (⅝ inch each way). The driving and trailing coupled wheels each have ¼ inch total side play. The individual axles of the trailing bogie each have ¼ inch total side play, and the bogie as a whole has a total side movement each way of 2⅞ inches, with an initial controlling force of ⅝ of a ton increasing to 2¾ tons at full travel. The bogie side control spring is of full elliptic type, each half having 8 plates. The engine is designed to traverse six-chain curves.

The main springing is arranged as follows:—On the leading coupled wheels there are two vertical coil springs to each box. On the driving and trailing coupled wheels there are laminated springs, consisting of 14 plates 5 inches broad by ½ inch thick. These are kept in position at the centre by a buckle with a ½ inch diameter riveted centre pin, and prevented from side movement by nibbing and slotting at each end of the plates. On the bogie, laminated springing consisted of 11 plates 5 inches broad by ⅝ inch thick, similarly secured.

The 40 engines of this type were built in 1907 and were rebuilt with superheater boilers in 1926; they have two inside cylinders with 18½ inch by 26 inch stroke (inclination 1 in 8½). The working pressure is 175 lbs. to the square inch, the right-hand crank leading. Engine No. 2023 was last under general repair in April, 1933, mileage since then having been 55,354. Total mileage to the date of the accident was 683,706.

Report and Evidence.

4. There were 15 of these engines at Bournville Shed, which supplied power for this branch, and they were called upon as required to work over the road between Evesham and Ashchurch; in fact, two up and two down passenger trains were worked by this type of engine daily.

The train in question had been working on its present timing for some years; it left Evesham at 11.22 a.m., stopping at Bengeworth, the next station, from which it departed at 11.27 a.m. Thence it was booked to pass Hinton and Ashton-under-Hill Stations, arriving at Beckford at 11.35 a.m., and at Ashchurch at 11.42 a.m. The time of the accident was estimated as 11.32 a.m.

The intermediate block posts between Evesham and Ashchurch are Bengeworth, Hinton, and Beckford; but these boxes are only open for specific periods, and at the time of the accident the block was from Evesham to Ashchurch.

The distance from Bengeworth to Beckford Stations, between which the train was booked to run without stopping, is 5 miles 1,110 yards, and the schedule of 8 minutes between these points represents an average speed of 42·15 m.p.h. It was considered that the accelerative powers of the engine, with the light load of two coaches, would allow of time being maintained with a maximum speed at the point of derailment of 45 to 50 m.p.h.; but there was no restriction and therefore no reason why driver Woolley should not have been running at higher speed. In fact, the only restriction in force on the branch was 15 m.p.h., between mile posts 73¾ and 74½ at Evesham, on account of curvature.

The deceased driver, A. W. Woolley, was stationed at Bournville and was aged 61. He had 41 years' service, all at Bournville, and had acted as a driver for the last 15 years. He had an exemplary record.

5. Guard I. Cuttriss had known this road for 25 years, and had worked with this train regularly since its present timing had been introduced after the War, though this was the first trip he had made following a lapse of some 12 months

The train had been running for 3 or 4 years with its present composition of two or three coaches and a tank engine of the 2,000 class.

Cuttriss spoke to driver A. Woolley and fireman G. Lyndon at Birmingham at the commencement of the journey, and all went well until approaching the distant signal at Ashton-under-Hill. The first thing Cuttriss noticed was an emergency brake application, but his coach was not then off the road, although there was considerable oscillation. He was thrown from end to end of the brake compartment, which was situated at the trailing end of the second coach; after recovering his senses, he went forward and assisted fireman Lyndon and Permanent Way Inspector Waite to release driver Woolley.

He thought that at the time of derailment the train was travelling at its usual speed at this place, which he estimated as between 40 and 50 m.p.h. He was well acquainted with Woolley and considered him a good engineman and consistent time-keeper. He himself had never had occasion to complain about the road and he had never heard Woolley so complain.

Guard G. E. Jenkins, who had worked with this train for the previous 10 months, also knew Woolley very well, as a conscientious and steady man. He said that the train was rather sharply booked between Bengeworth and Beckford, but there was no difficulty in keeping time. His estimation of its maximum speed between these points was uncertain, but he thought it might be as much as 50 m.p.h. He had never noticed any unusual oscillation and had not heard of any complaints in this respect.

Fireman G. Lyndon was not sufficiently recovered to give evidence till the 15th March. He had 14 years' service, practically all of which had been spent at Bournville on passenger suburban work; he had known the Barnt Green-Evesham section since he started and the Evesham-Ashchurch section during the last 12 months.

The day of the accident, Monday, 25th February, was the first time he had worked over the road for 7 weeks. He had accompanied driver Woolley during the previous week, except on the Friday and Saturday when Woolley had, at his own request, travelled over the Evesham-Ashchurch section, and over the line to Tamworth, in order to refresh his knowledge of these sections. During that week Lyndon had not observed anything unusual about Woolley's driving; he knew him to speak to in the shed, and he appeared to be fit for duty. Woolley had made no comment with regard either to the working of the train or his knowledge of the road.

On leaving Birmingham, the engine was running chimney first; it behaved satisfactorily up to Evesham, attaining a speed of 40 m.p.h. in places, and the various stops were made normally. Lyndon had fired on these engines all his service, and said that "*if you got anything like speed out of them they commence to be rough, viz., a hunting motion, not a rolling motion*". In places they were unsteadier than in others, and drivers knew that and applied the brake as necessary. There was nothing abnormal about this engine, and it was running as others of this class do.

Leaving Evesham, Woolley obeyed the speed restriction of 15 m.p.h., and the stop at Bengeworth was made normally. When leaving there Woolley remarked "*We are booked pretty sharp from Bengeworth to Beckford*"; but Lyndon "*did not get the impression that he was in a hurry; in fact he acted just as the other drivers do*".

Lyndon's account was that when approaching Ashton-under-Hill, the usual oscillation commenced, and Woolley eased the regulator; that was after passing the summit. Neither of them spoke, and they were looking forward; after travelling a little further, more than usual swaying was set up and it seemed to get worse suddenly, the motion being so quick that there was no time to do anything before the derailment occurred. He stated that "*the next thing I knew was that the engine started to heave up at the front end and the driver was applying the brakes, and after that I can remember the engine falling on its side*".

Lyndon estimated that speed at the time was 50 m.p.h., and while he thought that Woolley applied the brake when the oscillation suddenly increased and before the engine heaved up, he could not say for certain whether he fully closed the regulator when the derailment occurred. He had no doubt that speed at the time was faster than on the journey to Evesham; but he thought it was not abnormal for this section of line with this type of engine and light train.

6. Driver W. Jackson, with 34 years' service in this capacity, had known this train for over two years, and had been driving engines of the 2,000 class ever since their introduction. He had no trouble in keeping time with this train, running at a maximum speed of about 45 m.p.h. between Hinton and Ashton-under-Hill. He had occasionally reached 50 m.p.h. at this place, but never, he thought, 60 m.p.h.

Jackson said that these engines "*roll somewhat in places and I think they feel the road easily, but I have never in my experience had to report them for rolling. With regard to this particular piece of road, I have never had any cause to complain and I have always eased down as we got over the bank, and I have never experienced any rolling on this line except from about 300 yards on the Evesham side of Ashton to the Ashchurch end of the platform; but such rolling has not been serious enough to report and I think the oscillation would have been worse at higher speed, but having time in hand my practice is to keep speed down*."

Jackson stated that when Woolley rode with him over this line during the week previous to the accident, he had told him that a little rolling was to be expected at this place, but on that occasion this did not occur, as time was well in hand and he "*eased down*". He said that there had always been comments in this respect about this road from the other seven drivers in his link, and rolling occurred only on branch lines.

7. Porter F. Green of Bengeworth stated that the train left at 11.27 a.m. by the station clock: he had no conversation with the trainmen. Green said that no passenger trains ran through Bengeworth without stopping, but that fitted goods (banana) trains, of 30 to 35 wagons, ran through at 45 to 50 m.p.h.

Mr. R. E. Sharland, the Bengeworth Station Master, referred to conversation with guard Cuttriss as to checking of the latter's watch. Sharland thought that the train arrived a little early; he held it a minute and it departed dead on time. He estimated that the speed of the fitted freight (banana) trains, which ran through at night, did not exceed 30 to 40 m.p.h.

Porter E. W. Ricketts, aged 25 years, and of two years' service, all at Ashton-under-Hill, stated that he usually saw this train pass though the station. It was the only passenger train which did not stop and he estimated that it was usually travelling at 50 m.p.h., but he did not consider himself a good judge of speed.

Mr. W. R. J. West, the Beckford Station Master, was also in control of Ashton-under-Hill, and had been at Beckford for three years. He had not, however, seen this train pass through Ashton-under-Hill, and could give no estimate of its usual speed there; every train stops at Beckford, except three up and two down goods trains, which he thought attained a speed of 40 m.p.h. through the station. He had heard of no complaints about the road, and had no suspicion that this was in defective condition. He knew the gangers in the neighbourhood and they had never complained about the speed of trains.

8. Ganger Heath, aged 49, had been in charge of the Hinton to Ashton-under-Hill length, No. 118, from mileage 77 to 79½, for 11 years. His gang consisted of two men besides himself: it had been reduced from four to three men in 1929, the length remaining the same. He was working about 700 yards on the Hinton side of the site (nearer the summit) and could give no account of how the accident happened; he estimated, however, that the speed of the train was about 50 m.p.h. when it passed him, and the swaying of the engine was noticeable.

He had not complained about the speed of this train, but an engine of the same class had widened the gauge a month or so previously to the extent of ¼ inch to ¾ inch; he replaced the sleepers concerned, and in other cases he moved them and respiked the chairs. He did this whenever he noticed the chairs were pushed out, perhaps once a week. He had renewed three sleepers near the site only a week previous to the accident.

He had not reported the matter in writing, but he had talked to Permanent Way Inspector Waite about it, and had drawn the latter's attention to the necessity for respiking; his work had not been criticised. He was aware of the large number of decayed trenails in his length, and when a sleeper was replaced he made a practice of putting a third spike with a ferrule in the trenail hole. He said that he had not renewed all the decayed trenails because the worst sleepers

were being replaced first, and during the previous two months 200 had been dealt with.

He had walked over the down road on the morning of the accident, and on the previous day, finding no defects; his opinion appeared to be that two spikes were sufficient on a straight road of this character, and he was supported by Permanent Way Inspector Waite. He thought that the presence of three might have prevented the spreading by this engine; but the position with regard to trenail replacement apparently was that this work had not been pursued for two or three years due to lack of supply and obsolescence.

9. Permanent Way Inspector G. W. Waite, aged 60, has 46 years' service, and has served in his present capacity for the last 15 years. He had been in charge of this section for about five years; it extended from Ashchurch northward to Stoke Works on the main line and to Coughton on the branch, 21 and 22 route miles respectively of running line. He was also responsible for Worcester Yard.

He had been taking stock at Evesham, and was returning to Ashchurch by this train in the second compartment of the second coach. Briefly, his account of the accident was that, after passing the distant signal for Ashton-under-Hill and when travelling at 50 to 60 m.p.h., the coach commenced to oscillate more than usual. The derailment followed immediately, and he was thrown across the compartment under the seat. He was uninjured, and after helping to extricate driver Woolley and going to the station, he returned to the site and examined the road.

He came to the conclusion that the engine was travelling too fast; the rails had been pushed out, wide to gauge, first on one side and then on the other, a little to start with, but gradually increasing to at least 3¼ inches at the point of derailment (vide the detailed plan), the engine having finally dropped inside the 4-foot way without marking the rail. Even where four serviceable sleepers had recently been put in, the gauge had spread by as much as 1¾ inches. Beyond the point of derailment for 161 yards the track was entirely destroyed, more particularly the left-hand rail with its chairs being pushed off the sleepers.

Waite had last walked through this section of line on the 19th of February, nine days previously; he found the track "*very fair, with no signs of spreading*". He had tested the gauge in several places and found it true. He considered the "*top*" as good as some main lines, and though he realised that the road was "*getting weak*"—in recent months he had given instructions for further "*spot*" sleepering, as material was available—he was of opinion, like ganger Heath, that where trenails had decayed in the old sleepers, the remaining two spikes gave sufficient strength on the straights and easy curves.

In fact, notwithstanding the decayed condition of the old sleepers under the chair seats, and the deficiency of trenails, Waite thought that the track generally was fit for unlimited speed, except, he stated, in respect of the 2,000 class of tank engines, the operation of which he had discussed with his gangers, and "*we think they knock the road about more than others, but I never thought it necessary to report the matter, as in my opinion, it was not serious enough*". As the result of this accident, however, Waite considered that a speed restriction of 40 m.p.h. was necessary, and he proposed to have all decayed trenails replaced forthwith.

Waite stated that this was his first experience of serious and extensive damage caused by these tank engines; but he had had several complaints previously about their effect on the section of down line between Evesham and Beckford, though the gangers concerned had always put matters right before he saw the damage referred to.

On the other hand, he had never taken steps to ride on an engine of this class, though he had frequently travelled in trains being hauled by them, and he suggested that they imparted more oscillation to the vehicles than other engines. Further, he had never had cause to complain about the road, nor as to excessive speed, and he thought that the normal maximum speed of passenger trains was 40 to 50 m.p.h.

Waite judged that half the original 46 years' old sleepers were still in the road, the other half having been "*spot*" renewed. Since 1930 he had replaced 1,046 in five track miles, or rather less than 10 per cent.; but during the previous month or so 200 had been dealt with between Hinton and Ashton-under-Hill;

" we felt that the sleepers were becoming more decayed, and that is why I gave instructions, and as the material was available, to commence the work ".

Though he admitted that moisture accelerated the decay, he did not consider that the prevailing wet weather had anything to do with the accident, as the road bed was dry. His opinion generally was that the derailment came about due to swaying of this tank engine, occasioned by its excessive speed, and that the accident could not in consequence be attributed primarily to insufficiency of lateral strength of the track itself.

With regard to the standard of maintenance, Waite referred to reduction in the strength of gangs three or four years ago; he said that gangers had complained on several occasions, and he thought that this and other gangs on the branch were of insufficient strength. He had not, however, reported this, and generally it appeared that Waite considered that the road had had all the attention that was necessary; but that auxiliary work, such as fencing and ditching, had to be neglected at times to permit of this. On the other hand, he considered the line between Evesham and Ashchurch as below the average in the amount of " *agricultural* " work which was required.

10. Chief Permanent Way Inspector F. W. Evans had been in charge of the Walsall district for five years, and was responsible for some 680 track miles of first, second, and third class lines. He is 54 years of age and has 34 years' service. The last time he had been over this section of line was when, with Permanent Way Inspector Waite, he accompanied Mr. Grimoldby, the District Engineer, for the relaying inspection in September last. His statement was as follows :—

" I thought then that this was a fair road but it was getting towards the end of its time and it should be put in for relaying, and it was put in for relaying accordingly (in 1936). *There are a lot of decayed trenails but there are two spikes, and the two spikes should hold any road with reasonable traffic up to* 45 *m.p.h., at any rate on the straight, and on very easy curves as we inspected to-day; but on curvatures of* 40 *chains and over we should have more fastenings. I gave instructions in September to Inspector Waite that we should change a few sleepers, as required, to keep them going until the road was renewed, and when each sleeper was renewed I expected two spikes and, if necessary, a third with a ferrule.*

I got to the site of this derailment at 4.15 *in the afternoon and I think the derailment was caused by the engine swaying from side to side at high speed, knocking the rails out of gauge first on one side and then on the other. I have seen it before, but not so bad, I saw it in the same place in August* 1929. *On that occasion we put the road back and put the sleepers through, I should think between* 40 *or* 50 *in that neighbourhood. These were changed at that time. After that I considered the road would last several years.*

I do not think the accident has come about through weakness of fittings. I consider it has been caused by the engine in question travelling at excessive speed and badly swaying. I gather the way that this train is timed the maximum speed was probably 60 *m.p.h. at this point. I could not say whether it has been altered since* 1929.

With regard to the action to be taken now; I consider that an additional spike should be added where the trenails have decayed pending complete renewal in 1936, *but, of course, on our standard material, we only put two screws in our chairs on second and third class lines. Pending the completion of that I should keep the speed restriction on that we have got now, viz.* 25 *m.p.h., but I should like to see a permanent restriction on the branch altogether, viz. from Barnt Green to Ashchurch and to Malvern of* 40 *m.p.h., in view of the fact that it is a third class line, notwithstanding the addition of these spikes. I propose to make recommendations accordingly. . . .*

I have come to this conclusion not only as a result of this accident but because I was not aware of the high speeds that were being run, and at the same time the material is getting weak."

Mr. Evans had never travelled over this road on an engine, as he only went on the footplate on first class lines. His last experience in this respect on the 2,000 class was between Birmingham and Nuneaton at 35 to 40 m.p.h. two years previously. He stated that he found " *these engines roll very badly when going over* 40 *m.p.h. with a light load* ".

11. Mr. G. A. Grimoldby, the District Engineer, had been in charge of the district for the last seven years. He said that the "*spot*" sleepering on this branch had apparently been going on for the last 15 to 20 years, and the road had not been re-sleepered throughout. The following is a tabular summary of a statement prepared by him showing the renewals effected in the down line, and the different chair fastenings, between M.P. 77¾ and 78¾, viz. over the mile in rear of, and including, the site of the derailment:—

	Number.	*Per cent. of Total.*
(1) *Original Sleepers.*		
(*a*) With two spikes per chair and old decayed trenails or trenails lacking.	221	11
(*b*) With two spikes and one or two new trenails per chair	418	22
Total original sleepers	639	33
(2) *Changed Sleepers.*		
(*a*) With three spikes per chair ...	522	27
(*b*) With two spikes only per chair ...	119	6
(*c*) With four coach-screws *or* two spikes and one trenail *or* two coach-screws and one or two trenails	656	34
Total changed sleepers	1,297	67

Mr. Grimoldby estimated that of the 1,046 sleepers which had been changed during the last five years, in the five track miles between M.P. 77 and 79½, about 75 per cent. had been put in the down line, representing, say, 16 per cent. of the total number in this 2½ mile section. With regard to past and future renewals for the Evesham-Ashchurch section, he informed me that of the 11 miles on the down line, 1,498 yards, 7.7 per cent., had been renewed in 1931-33. 1 mile 1,144 yards, 15 per cent., had been approved for 1935, and 2 miles 616 yards, 22 per cent., of which about 2 miles cover the site of the derailment, were proposed for renewal in 1936.

He referred to the previous case of spreading in August 1929 which occurred on the down road a little nearer Ashton-under-Hill; this was caused by the passage of the same class of engine, No. 2024, on the same train, and the gauge had widened zig-zag to a maximum of 1 inch (according to Chief Permanent Way Inspector Evans, it was 1¼ inches). He gave orders for the repair of the road on this occasion and the damaged sleepers were replaced, as already described, no speed restriction being imposed because the engine concerned was said to have been taken off. There was, however, no confirmatory information with regard to this, and the fact is that these engines have been consistently running in this service since they were put on in June 1929.

Mr. Grimoldby also said that since the occurrence in August 1929, no further trouble of this kind had been reported to him. With regard to the state of the road and conditions of operation, he said that he was not aware that the decayed trenails were not being replaced by spikes; he inspected the road last September and "*saw these decayed trenails, and, at that time, believing that the traffic and speed were only light, considered that the two fastenings were sufficient. Had he been aware of the class of engine and the booked speed at which it had to run, he would either have imposed a speed restriction, or relaid the road*". He thought that trains were stopping at every station and running at slow speeds; otherwise he would have "*questioned the position*". He was not aware that there were trains not stopping at Hinton and Ashton-under-Hill.

With reference to the maximum speed of operation and to the classification of lines for the purpose of assessing the standard of maintenance, I was informed

that the classification formerly used by the L. & N.W.R. had been adopted as a standard for the L.M.S.R., the basis being as follows :—

First Class.

All Main Trunk Passenger Lines.

Passenger Lines other than above, over which Express Services are run regularly.

Important Through Goods Lines subject to Express Goods Traffic.

Goods Lines subject to fast and heavy traffic.

All Electrified Lines.

Second Class.

Passenger Lines (other than Main Trunk Passenger lines) subject to speeds over 45 miles per hour.

Through Goods Lines subject to fast traffic, i.e. exceeding 45 miles per hour, but not heavy.

Third Class.

Branch Passenger Lines over which speed does not generally exceed 45 miles per hour, and traffic is fairly light.

All Goods Lines and Loops subject to Slow or Station to Station Traffic.

12. The shed examination of engine No. 2023 prior to the accident had proved satisfactory; corresponding examination of the stock at Birmingham on the morning in question also revealed no defect, and all wheels were in excellent condition.

Assisted by the Company's officers, I made a detailed examination on the 15th March of the engine wheels, axle boxes, springs, bogie, etc. Tyres and flanges (standard depth of $1\frac{1}{8}$ inches) were very little worn; the maximum out-of-truth did not exceed $\frac{1}{16}$ inch (driving coupled wheels) and this was considered to have resulted from the derailment. The total side play on all the wheels, including that of the Cartazzi slides on the leading axle, from one side to the other, was as follows :—

	Designed Standard.	*Actual.*	*Difference.*
Leading coupled	$1\frac{3}{8}$" total	$1\frac{1}{16}$" total	$\frac{5}{16}$" less than standard.
Driving coupled	$\frac{1}{4}$" "	$\frac{5}{16}$" "	$\frac{1}{16}$" more than standard.
Trailing coupled	$\frac{1}{4}$" "	$\frac{7}{16}$" "	$\frac{3}{16}$" "
Leading bogie	$\frac{1}{4}$" "	$\frac{13}{32}$" "	$\frac{5}{32}$" "
Trailing bogie	$\frac{1}{4}$" "	$\frac{9}{16}$" "	$\frac{5}{16}$" "

The increases from standard will be noted, mileage since the last general repair being 55,000. The reduction from standard by $\frac{5}{16}$ inch in respect of the leading coupled axle was brought about at some time by the thickening of the white metal pads (normally $\frac{1}{8}$ inch) on the outside face of the axle boxes.

The total side play on the leading coupled axle, due to play of the journal in the brass and of the axle box in the guides, was $\frac{9}{16}$ inch, leaving the Cartazzi movement alone restricted to a total of $\frac{1}{2}$ inch instead of 1 inch as designed. Thus there was on the leading axle $\frac{9}{16}$ inch free uncontrolled side play plus $\frac{1}{2}$ inch Cartazzi controlled side play, compared with design of $\frac{3}{8}$ inch free, plus 1 inch controlled.

All bearing springs and bogie side control springs were tested for deflection and gave results which did not vary appreciably from design. All plates were found to be in good condition except for a small and unimportant surface crack near the middle of the sixth plate of the right driving spring.

13. On the 15th March, accompanied by Colonel Rudgard, Divisional Superintendent of Motive Power, Major Wilson and I travelled on the footplate of an engine of this class, No. 2011, when working an up stopping passenger train, from Burton to Leicester, a distance of 31 miles.

This engine had worked about 25,000 miles since its last general repair in June 1934, less than half that of No. 2023. The train concerned comprised three bogie coaches, booked to leave Burton at 3.33 p.m., to stop for one minute at each of the intermediate stations, Gresley, Moira, Ashby, Swannington, Coalville, Bardon Hill, Bagworth, Desford, Kirkby Muxloe, and to arrive at Leicester at 4.38 p.m. Gradients generally rise to Bagworth, and thence fall to

Leicester; *average* speed, start to stop, between stations was about 30 m.p.h.; except over the 4½ miles on the falling gradient between Bagworth and Desford where it was 45 m.p.h., and between Desford and Kirkby Muxloe, 2¾ miles, where it was 41.2 m.p.h.

Severe side-to-side nosing movement was experienced between Burton and Gresley over ash ballasted road for a distance of about half a mile; this occurred at approximately 40 m.p.h., with the engine working hard up the gradient. The period of oscillation was about one second. After this, until Coalville was reached, the movement was initiated several times on attaining speed above 30 m.p.h., but it was damped before again becoming excessive. Speed appreciably higher than 40 m.p.h. was not attained between Burton and Bardon Hill, and, if anything, the engine rode more steadily on curves than on the straight.

Between Bardon Hill and Bagworth, when steaming up the gradient at 40 to 45 m.p.h., there was again violent swaying, particularly on the curve approaching the latter place; this persisted for a considerable distance where the road appeared to be in fair condition (better than at Ashton-under-Hill) but ballasted with ash. Between Bagworth and Desford, on ballasted road in good condition, while there were periods of considerable oscillation, the engine generally rode steadily without steam on the falling gradient, at speeds varying from 50 to 55 m.p.h. Thence to Leicester there was occasionally appreciable movement, accentuated with the engine under steam, although at no time was it severe, and on relaid road the engine rode steadily, speed not exceeding 48 m.p.h.

The trip clearly illustrated how sympathetic this engine was to track defects, and riding on the footplate obviously afforded a rapid means of examining the road. On two occasions oscillation developed which, in my opinion, might have rapidly increased to a dangerous extent had speed been a little higher or the track less well maintained. Driver A. E. Passley informed me that unless speed was carefully regulated the movement was liable to be worse at certain places on the down road. As reported separately, this engine became derailed at Moira five days later, on the 20th March, when operating a down passenger train at about 60 m.p.h.

Conclusion.

14. There is no doubt that similar rapid development of violent oscillation in engine No. 2023 also brought about the accident in question. The effect is clearly shown on the plan. Derailment resulted from the spreading of the road, owing to the lateral weakness of chair fastenings, which were unable to resist the side to side thrust at the comparatively high speed of 50 to 55 m.p.h.

While this engine evidently exerted an abnormal punishing effect at such speed, there is also no doubt that the track had been allowed to deteriorate to the extent that it retained only sufficient margin of safety to carry even normal traffic at 40 to 45 m.p.h.; hence the speed restriction which it was subsequently decided to impose.

15. The evidence was conflicting as to the speed of the train; but the schedule average over the 5 miles 1110 yards between Bengeworth and Beckford was 42·15 m.p.h., and the Company's officers suggested that, in view of the accelerative capacity of the engine with this light load, higher maximum speed than 45 to 50 m.p.h. was unnecessary, notwithstanding the generally adverse gradients for the first 2½ miles.

It is, however, possible that, in the absence of any restriction, and having regard to the lack of recent experience of the road, driver Woolley was exceeding the lower speed, although he had been warned during the previous week by driver Jackson of the possibility of oscillation at this point. Fireman Lyndon even estimated that it was 50 m.p.h., and in view of the distance which the train travelled after derailment, ploughing its way through the track up to its axles, and of the fact that the engine fell on its side, I doubt whether it was less than 55 m.p.h. The fact that the oscillations roughly covered an average of nearly 88 ft. (see the plan) and occupied about 1 second also indicates speed of this order.

The records of gauge and line, commencing some 1,100 yards in rear of the site of derailment up to point A, showed a maximum variation in gauge from correct to ½ inch slack over one rail length, and in level over two rail lengths (on the straight) from plus ¼ inch on the right-hand rail to plus ⅜ inch on the

left-hand rail. The first signs of widening of the gauge, as the result of the passage of this train, were noted at point A, about 380 yards in rear of the site, but between there and point B there was little evidence of this, as the fastenings appear to have been sufficiently stable, 33 sleepers, or 36 per cent., in this length having been recently changed. From point B, however, the pushing out of the chairs of one rail and then of the other, to the extent of ½ inch to 1 inch, appears to have coincided with the side-to-side oscillation of the engine up to point C, 64 yards in rear of the site; thence the widening became rapidly worse until it reached 3¾ inches, fracture of the chair jaws of the left-hand rail indicating where derailment had commenced.

Assuming that speed was 55 m.p.h., some 13 or 14 seconds must have elapsed between the first noticeable damage and the derailment; but it was not until 3 or 4 seconds before the accident happened that the gauge was widened by more than 1 inch (point C) and in all probability this was the first moment that the movement on the footplate was severe enough to cause alarm, too late to bring about sufficient reduction in speed to save the situation.

The track was classified as third class for maintenance purposes, the basis of this being that traffic was fairly light and speed was not expected generally to exceed 45 m.p.h. It was realised that the road was nearing the end of its life and it had been proposed for renewal; but evidently there had been serious misjudgment as to its lateral stability under comparatively high speed, though the punishing effect of this type of tank engine was notorious, examples being the derailment at Swinderby in 1928, and the damage here in 1929.

This failure to appreciate the risks being run is illustrated by the pursuance of a prolonged policy of "spot" replacement of sleepers even after the occurrence in 1929, by the existence of a large number of decayed trenails and reliance upon only two spikes having inferior hold in decayed timbers, and by omission to impose a stringent speed restriction pending renewal. While Mr. G. A. Grimoldby, the responsible Engineer, according to his evidence, was out of touch with the prevailing conditions of traffic, and had failed, like the rest of the staff, to realise the effect which these engines might have on weak track material, Permanent Way Inspector G. W. Waite had evidently not kept him informed of the true position.

I consider therefore that Waite was primarily responsible for permitting this road to remain without the strength which would have been afforded by new fastenings in the old sleepers, decayed as these sleepers were. Such decay must have been going on for a long time, and he was aware of the opinions and experiences of his gangers with regard to these engines. He failed, however, even to travel on the footplate, and did no more than change a few sleepers when more extensive renewal and strengthening were clearly required. While I am satisfied that this was the outcome of lack of appreciation rather than lack of interest, I cannot but remark that a Permanent Way Inspector accepts grave responsibility in letting deterioration, even of a road of this character, extend to the lengths it did here, without drawing special attention to it and to the prevailing traffic conditions. Unless he does that and frankly recommends the imposition of corresponding speed restriction he fails in his duty.

16. With regard to the operation of this class of tank engine, which was designed and built for mixed traffic, and of which 40 have been working for about 28 years, this derailment and the similar occurrence at Moira on the 20th March, afford further illustrations of the destructive effect of these engines on track material. As is reported separately, it is considered that engine No. 2011, which was concerned in the latter accident, was probably responsible for causing serious damage to new standard 85 lb. material, which had been laid only 12 months previously near Moira.

To appreciate fully the combination of circumstances which led to these accidents, it is necessary to consider some of the characteristics of this engine as a carriage. Its coupled wheels, 5 feet 7 inches in diameter, are larger than is usual for goods engines, and it could therefore attain speed up to 55-60 m.p.h. with reasonable freedom, though having regard to the existence of slide valves and restricted port area, speed of this order represented the limit. Notwithstanding this type of valve, it is noteworthy that in 1926 these engines were rebuilt with a superheater boiler.

To deal with goods traffic, the engine was provided with larger water and coal capacity than is usual for a tank engine of this size and type, viz., 2,250 gallons, or 10 tons, of water, and 3½ tons of coal. The side tanks are extended nearly to the front of the smoke box, and having regard to the distribution of weight of water and coal there is clearly a high moment of inertia about the vertical axis.

The engine was designed to negotiate curves of 6 chs. radius; flexibility in the wheel base was attained in two ways, by side play (¼ inch total) of the six coupled axle boxes in their guides, and by the incorporation of Cartazzi slides in the leading axle boxes, play on the latter account being 1 inch from one side to the other, controlled by lubricated slides of 1 in 8 inclination. These slides were in good condition, and depending on friction and the state of compression of the coil bearing springs, they exerted a minimum lateral controlling force of roughly 2 tons 6 cwts. The white metal pads on the outside faces of these axle boxes were slightly marked by the bosses of the wheel centres, showing that the side play provided had been utilised to the full extent in service.

With regard to the bogie design, in addition to the side movement as a whole of 2⅞ inches each way, total play of ¼ inch was allowed for each axle in respect of the axle boxes in their guides. This had become increased by wear in engine No. 2023, as already noted; the bearing surfaces, being comparatively small, permitted the development of early sloppiness. The controlling force of the bogie check springs rises from ⅝ ton to 2¾ tons, so that the rear end of the engine, with its heavy load of coal and water, is comparatively lightly controlled in the first stages of side-to-side displacement.

As might be expected, the engine can easily negotiate sharp curvature at low speed, but this advantage has to be paid for by unsteadiness at high speed, and, as pointed out in previous reports upon other tank engine derailments, it is very sensitive to defective track conditions, in that comparatively small variations of gauge or line may initiate oscillation which, as I noted on the footplate, was accentuated under steam.

Undamped by a heavy separate tender, the engine has, in fact, a natural frequency of oscillation depending on such factors as weight distribution, the periodicity of the front coil springs, the Cartazzi slides, the laminated bogie check springs, and the action of steam in the cylinders. Should track variations, insufficient in themselves to cause serious movement in a less sensitive machine, follow in sequence so as to coincide sufficiently closely with the engine's natural frequency under the conditions of the moment, oscillation may be rapidly and violently induced, and therefore heavy lateral forces may be set up, which in turn tend to displace the track bodily, or, if fastenings are sufficiently weak, to spread the gauge.

Remarks and Recommendations.

17.—(*a*) Having regard to the foregoing considerations and to the circumstances of this derailment, it was decided to make a trial under the following altered conditions, viz. the replacement of the leading axle Cartazzi boxes and of the coil springs by standard type boxes and laminated springs; the replacement of the bogie by a standard bogie with side bolsters, as used on the new 2-6-4 type tank engines; and the replacement of the screw reversing gear by a lever gear to facilitate the use of the engine for shunting purposes.

As a result, comparative tests, at speeds varying from 35 to 60 m.p.h., with one engine so modified and another not altered, were carried out a few days after the derailment at Moira, on a straight length of 2nd class track. The conclusion was reached that the unmodified engines were not suitable for working trains at speeds over 45 m.p.h., and, indeed, I was informed that severe oscillation was experienced at no more than 50 m.p.h., the passage of the engine causing some track damage. On the other hand, I understand that the alterations undoubtedly made for improvement, oscillation and roll being damped out, so that even when running at 60 m.p.h., the riding was satisfactory.

Having regard, however, to the facts that these engines now possess superheater boilers of standard design, which can be utilised for other engines, and that modern tank engines with lighter axle loading and higher tractive effort were becoming available, the Company decided that the above-mentioned alterations were not justified, and the majority of the engines have been taken out of

service with a view to early scrapping and the release of the boilers for use elsewhere; a certain number have been left in goods traffic for the time being, subject to a maximum speed of 45 m.p.h.

(*b*) A speed restriction of 40 m.p.h. has also been imposed on the branch line between Evesham and Ashchurch. This is a necesary protective precaution for the time being, pending the renewal proposed for 1936, as already mentioned, of some 2 miles of the down line covering the site of the accident, on the falling gradient between Hinton and Ashton-under-Hill where high speed is possible; in addition, the relaying of 2 miles of the same line, between Ashton-under-Hill and Beckford has already been approved for 1935. Similar proposals are in hand for the up line.

While I was informed that essential repairs will be effected forthwith, and I am aware of the extent of the efforts which have been made in the last few years to deal with renewals in this Division, I feel that the policy of " spot " replacement of sleepers should, if practicable, be discontinued, and that the renewal programme on this branch should be accelerated. The circumstances of this accident appear to show that unless conditions are abnormal, such as unusually rapid decay of timber, the merits of this method of maintenance are very questionable.

(c) With regard to the classification of this branch, it seems doubtful whether it did in fact bear a true relation to the speed and character of the traffic. Apart from the evidence of the District Engineer and of the Chief Permanent Way Inspector, there is the significant factor that, under the Company's progressive policy of scrapping older types of engine, the building of new, heavier, and speedier units is making rapid strides. I suggest that the whole question of the classification of branch lines, not only in respect of bridge loading, but of track fitness for speed in relation to types of engines, requires review, and that at the same time closer liaison between the Departments concerned should be maintained, so that speed maxima may be regulated in accordance with the authority of the responsible Engineer.

This matter also seems to warrant consideration from the economic aspect; the operation of this particular type of tank engine has, for example, probably caused much avoidable expenditure, as the result of abnormal track damage during recent years, following the efforts to increase speed. Apart from its tendency to destructive oscillation, the total hammer-blow of the engine amounts to 2·29 tons at 60 m.p.h., while those of individual axles are substantially higher, amounting to 9·66 tons in the case of the driving axle.

(*d*) In this connection generally, the value of the information to be gained from riding on the footplate by those responsible for maintenance of permanent way is of importance, and is recognised by the instructions issued on the subject. There could have been no better practical instrument than this type of engine for ascertaining where track defects exist, and I think that the instructions might well be more definite that Permanent Way Inspectors should make a regular practice of thus travelling over branch lines, as well as over main lines.

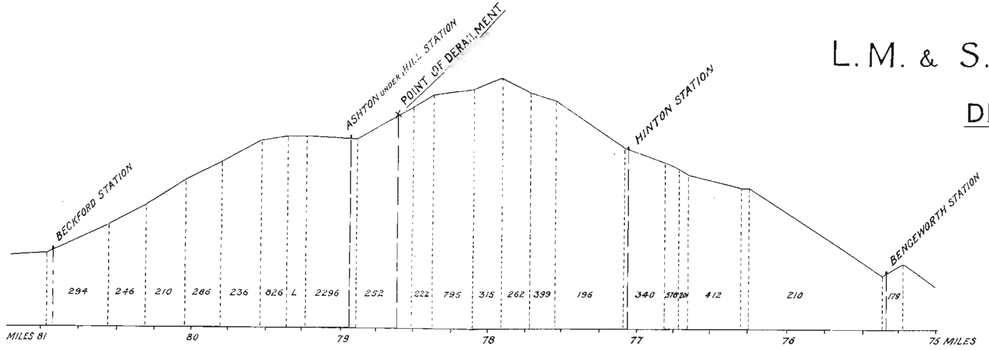
I have the honour to be,
Sir,
Your obedient Servant,
A. H. L. MOUNT,
Lieut.-Colonel.

The Secretary,
Ministry of Transport.

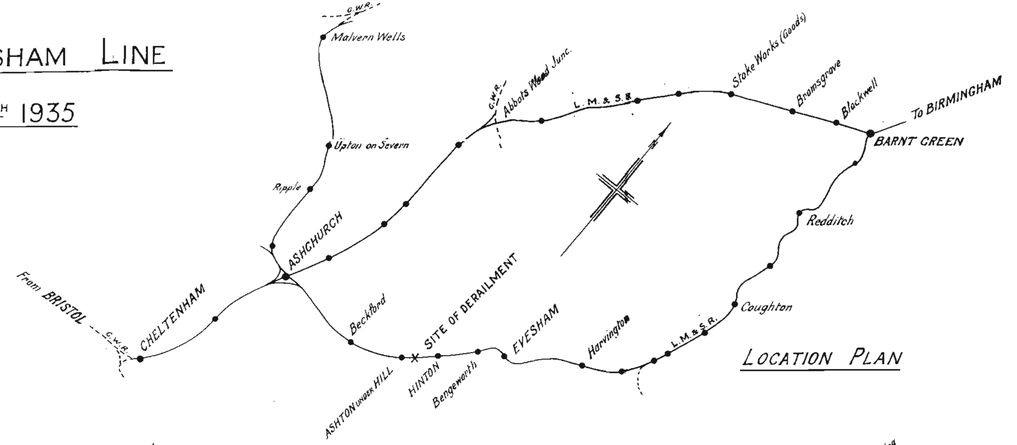
(29579—54) WL 386—59 625 6/36 P. St. G. 279/13

L.M. & S.R. ASHCHURCH & EVESHAM LINE

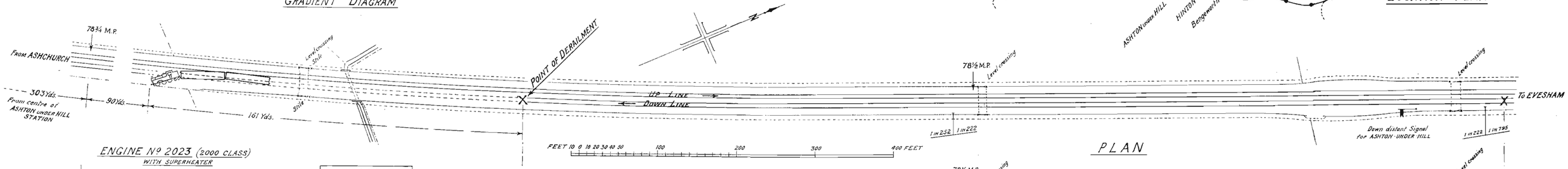
DERAILMENT ON FEB. 25TH 1935



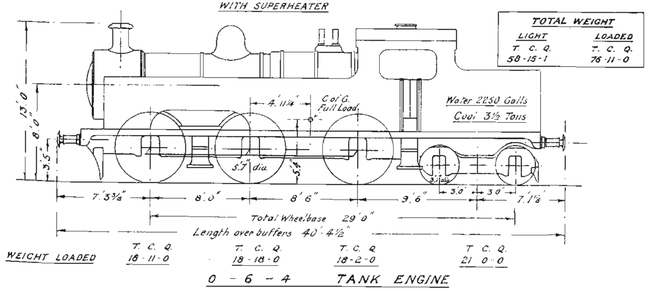
GRADIENT DIAGRAM



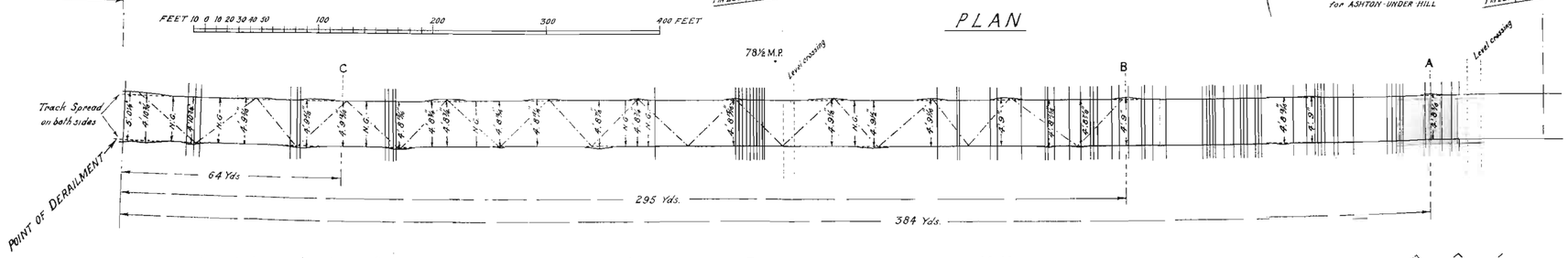
LOCATION PLAN



PLAN



0 – 6 – 4 TANK ENGINE



Changed Sleepers shown by cross lines
N.G. ..... Normal Gauge of 4'-8½"

DIAGRAM OF DOWN LINE BETWEEN PTS X. X.

Assumed oscillation of engine shown thus

H 523 W 268 625 S 35.89 923