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GOVERNMENT OF INDIA
MINISTRY OF TOURISM AND CIVIL AVIATION
(COMMISSION OF RAILWAY SAFETY)

RAILWAY ACCIDENT INVESTIGATION

REPORT

ON

**Derailment of 'Coal Special' train and its subsequent fatal fall from
Bridge No. 35 at Km. 12/10-11 between Adderley and Hillgrove
stations on Mettupalaiyam-Udagamandalam Metre Gauge
Ghat section of Southern Railway on 21st February 1982.**

SUMMARY

1. Date 21st February 1982.
2. Time 11-05 hours.
3. Railway Southern.
4. Gauge Metre.
5. Location At Km. 12/10-11 between Adderley and Hillgrove stations.
6. Nature of Accident Derailment and subsequent falling down the bridge.
7. Train involved 'Coal Special' Goods train.
8. Consisting of One coach and one BKC wagon hauled by a 'X' Class steam locomotive No. 37394.
9. Estimated speed at derailment About 65 Km./h.
10. System of Operation Absolute Block system.
11. Number of Tracks Single.
12. Gradient 1 in 12.5 falling.
13. Alignment 17.5° curve.
14. Weather Clear.
15. Visibility Good.
16. Casualties Killed—Eight (Railway Employees)
Injured—Nil.
17. Cost of Damage Rs. 16.36 lakhs.
18. Cause Train getting out of control.
19. Responsibility No individual railway staff is held primarily responsible.
Officials of the Mechanical and Engineering Departments of the Railway charged with the maintenance of the rack and pinion system are collectively held responsible for not ensuring proper maintenance of the same.

[20. Important Recommendations in Brief :

- (1) Maintenance tolerances of the rack and pinion arrangement in Kallar-Coonoor rack section to be laid down and rigidly followed.
- (2) Future supplies of rack bars to be obtained to the correct specification.
- (3) Track in the rack section to be laid with steel trough sleepers with a properly designed mounting arrangement for rack bars, replacing the existing wooden sleepers gradually.
- (4) Periodic joint inspections of the rack and pinion system by the Assistant Mechanical Engineer and Assistant Engineer to be prescribed.
- (5) The desirability of providing check rails on curves and guard rails on bridges in the rack section to be considered.
- (6) Pending compliance of the above, Passenger services on Kallar-Coonoor rack section to remain suspended.
- (7) Replacement of the present 'X' Class steam locomotives by Diesel locomotives of sufficient haulage capacity with the latest design of gripping arrangements to be considered.

CONFIDENTIAL

GOVERNMENT OF INDIA
MINISTRY OF TOURISM AND CIVIL AVIATION
(COMMISSION OF RAILWAY SAFETY)

From :

The Commissioner of Railway Safety,
Southern Circle,
Bangalore.

To :

The Secretary to the Govt. of India,
Ministry of Tourism and Civil Aviation,
Sardar Patel Bhavan,
New Delhi.

Through : *The Chief Commissioner of Railway Safety, Lucknow.*

Sir,

In accordance with Rule 4 of the Statutory Investigation into Railway Accidents Rules, 1973 (published by the Ministry of Tourism and Civil Aviation under their Notification No. RS.13-T (8)/71 dated 19th April 1973), I have the honour to report the results of my inquiry into the derailment of 'Coal Special' train and its subsequent fatal fall from Bridge No. 35 at Km. 12/10-11 between Adderley and Hill-grove stations on Mettupalaiyam-Udagamandalam Metre Gauge Ghat section of Southern Railway at about 11-05 hours on 21-2-1982.

1.2 Inspection and Inquiry :

I reached Mettupalaiyam on the morning of 23-2-1982 and inspected the site of occurrence in company with the Chief Traffic Safety Superintendent, Chief Motive Power Engineer and Chief Track Engineer, all from Southern Railway Head Quarters at Madras, the Divisional Railway Manager, Palghat and other Officers. I push-trolled the section between Kms. 12 and 20 and carefully inspected the damage suffered by the track in Kms. 12 and 13 as the train rolled down the steep gradient of 1 in 12.5 before derailling in the approach of Bridge No. 35. On the morning of 24th February, I visited the Steam Loco Shed at Coonoor where the Metre Gauge locomotives working trains in the Ghat section are homed and observed in detail, in company with the Chief Motive Power Engineer, the working of the pinion assembly on one of the 'X' Class locomotives in stripped off condition. On the morning of the 25th, I visited the Carriage and Wagon Depot at Mettupalaiyam and observed in detail the working of the pinion assembly fixed to coaches and wagons.

1.3 A Press Notification was issued on 22-2-1982 inviting members of the public having knowledge of the accident to tender evidence at the inquiry, which I commenced at Mettupalaiyam on the 23rd February (and concluded at Madras on the 26th) or to communicate with me by post.

1.4 The Civil and Police Officials of Coimbatore District of Tamil Nadu in whose jurisdiction the accident occurred were duly notified.

1.5 The Senior Administrative Officers of Southern Railway present at the inquiry were :

Shri B. R. Nair, Chief Traffic Safety Superintendent—on all days.

Shri M. A. Cherian, Chief Motive Power Engineer (R & L)—on all days.

Shri N. S. Raghavan, Chief Track Engineer—on all days.

Shri S. Ananthanarayanan, Chief Engineer—on 23rd only.

Shri K. Gopalan, Divisional Railway Manager, Palghat—on all days except 26th.

(1)

Evidence of 21 witnesses was recorded and relevant exhibits filed.

Note : In this Report :

- (i) the terms 'right'/'left', 'leading'/'trailing' and 'front'/'rear' where used are in reference to the direction of travel of the train on the descending grade while rolling down;
- (ii) the terms 'in advance of' (ahead of)/'in rear of' (behind) in reference to a location or of a Railway vehicle are used to define a position on the line beyond/before reaching the location as seen from the train while rolling down; and
- (iii) the abbreviation Km./Kms. denote kilometre/kilometres with reference to the telegraph posts/painted number plates alongside the line. Km./n. stands for kilometre per hour. There are 13 telegraph posts per kilometre in the vicinity of the accident site.

1.6 The Accident :

At about 11-05 hours on the bright sunny morning of 21st February 1982, 'Coal Special' train from Mettupalaiyam to Coonoor while negotiating the stiff climb of 1 in 12.5 gradient on Kallar-Hillgrove Block section failed to continue its climb beyond Km. 14/1 and started rolling back towards Kallar. At Km. 12/10-11 one of the left wheels of the locomotive mounted the rail on the outside of the 17.5° curve, derailed and continued to move in that condition upto Bridge No. 35 (2×18.29 m. girder spans) for a distance of about twenty metres before it left the track and fell down the Bridge, followed by both the vehicles which were behind it, to a depth of about 16 metres below the rail level.

1.7 Casualties :

Six Railway Officials were manning the train—a locomotive Driver, two Firemen, a Guard and two Brakesmen—and two others were travelling in one of the vehicles behind the locomotive. I regret to report that all the eight persons lost their lives, seven instantaneously on the spot and the eighth soon after admission to the Civil Hospital at Mettupalaiyam about 2½ hours after the occurrence.

II. RELIEF MEASURES

2.1 Intimation :

A Railway Gangman who was walking alongside the Railway track in Km. 13 while the train was climbing up and, a little later, while it was rolling down, rushed to the site, quickly assessed the situation, ran to the nearby Adderley station at Km. 12.27 and informed the Station Master at 11.20 hours. The latter had informed the Railway Divisional Control at Palghat and others concerned. The Fire Service personnel of Mettupalaiyam, who reached the site at about 11-58 hours, managed to extricate the lone seriously injured person from the debris and shifted him to the Civil Hospital at Mettupalaiyam. A little later the Fire Service personnel of Coonoor joined them and by their combined efforts all the dead bodies were extricated from the debris, lifted up the bridge from down below and handed over to their relatives before dusk.

2.2 The Railway Assistant Divisional Medical Officer of Coonoor reached the site of occurrence at about 12-45 hours and stayed there till the dead bodies were identified, cleared by the Police and handed over to their relatives. The Railway Medical Superintendent of Palghat who reached Mettupalaiyam at about 15-30 hours visited the Civil Hospital but by that time the lone survivor of the tragedy had succumbed to his injuries.

2.3 Restoration :

The section between Adderley and Hillgrove stations remains suspended for all types of traffic till the time of submitting this Report. The Railway authorities were advised not to resume passenger services in Kallar-Coonoor section pending Railway Ministry's decision on a recommendation which I had made in my Preliminary Report for their immediate consideration and which I reiterate in this report.

III. THE TRAIN

3.1 The composition of the 'Coal Special' in marshalling order was as under while leaving Mettupalaiyam :

- (1) Coach No. SRS 85 manned by Guard and a Brakesman.
- (2) BKC Wagon No. SR 53 manned by a Brakesman.
- (3) 'X' Class Engine No. 37394 manned by a Driver and two Firemen.

3.2 The train rolled down from Km. 14/1 in the reverse order. While rolling down the engine tender was leading.

3.3 The total length of the train was about 32 metres and weight including the locomotive was 89.7 tonnes.

3.4 The train was stated to have been fully vacuum braked and the record copy of the Brake Power Certificate issued at Mettupalaiyam prior to its departure indicated an average vacuum of 48 cms. (50 cms. in the engine and 46 cms. in the Brakevan) and all vacuum cylinders were stated to be operative. The hand brakes as well as the rack and pinion arrangement were also stated to be in working condition when the train departed from Mettupalaiyam.

3.5 Damage to Rolling Stock :

The train locomotive and the two vehicles behind it were a total wreck. The estimated cost of these vehicles is stated to be Rs. 4.60 lakhs.

3.6 Damage to Permanent Way :

There was extensive damage to the rack system on the Permanent Way for a length of about one kilometre. A few rails and bridge sleepers were also damaged on Bridge No. 35 but the bridge structure remained practically unaffected. The estimated cost of damage has been assessed as Rs. 11.76 lakhs.

3.7 There was no damage to other Railway assets.

3.8 The total estimated cost of damage to all Railway assets aggregates to Rs. 16.36 lakhs.

4. Local Features and Method of Working of the rack and pinion system of locomotion :

4.1 Local Features :

4.1.1 The accident occurred on the Girder Bridge No. 35 (2×18.29-m. spans) at Km. 12/10-11 between Adderley and Hillgrove stations on the Mountain Railway about half a kilometre from Adderley station. The accident site is located in Coimbatore District of Tamil Nadu close to the border between Coimbatore and Nilgiri Districts.

4.1.2 The Nilgiri Mountain Railway, which is of 1000 mm. gauge, starts from Mettupalaiyam, a terminal station for the Broad Gauge system of Coimbatore-Mettupalaiyam Branch line section of the Railway. Mettupalaiyam which is at an elevation of 326.441 m. is in the plains and the first block section from Mettupalaiyam to Kallar is relatively an easy section with gradients not exceeding 1 in 40 and curves upto 6° (291 m. radius), the total ascent in a length of about 7 kms. being about 78 metres. From Kallar the stiff ascent commences on 1 in 12.5 gradient with sharp curves of 100 m. radius (17.5°) and continues upto Coonoor, a distance of 19.57 kms. The total ascent between the two stations is about 1307 m. working out to an average ascent of about 1 in 15 or 6.7%. The rack and pinion system of locomotion commences from Kallar and terminates in the approach of Coonoor station.

4.1.3 The Permanent Way in the section consists of 50 lb. R rails, 12-13 m. long, of 1927 manufacture, laid alternately on wooden and steel trough sleepers over a bed of stone ballast. Neither check rails are provided on sharp curves nor guard rails on girder bridges in the rack section.

4.1.4 The rack and pinion system consists of rack bars in the Permanent Way and a pinion assembly on the locomotive which, when engaged to each other, controls the train on the stiff gradient and facilitates its movement at the prescribed speed of 13 Km./h.

4.1.5 The 'X' Class locomotives in use on the Railway have two different drives for transmitting the tractive effort from the engine.

- (a) Conventional drive of four coupled wheels transmitting the force by adhesion between the wheel and the rail.
- (b) A special drive transmitting the force from the locomotive through the pinion drive to racks fitted on the Permanent Way.

4.1.6 These two drives are independent of each other and can be brought into use independently or in combination. While the former is used on relatively easy gradients between Mettupalaiyam and Kallar and between Coonoor and Udagamandalam, the combined drive is brought into use on the rack section between Kallar and Coonoor where the ascent is the steepest.

4.1.7 A sketch showing the local features as well as the particulars of the rack bars is at Annexure-III. A few photographs of the scene of accident and another showing the pinion assembly on the locomotive are at Annexure-II.

4.2 Method of Working of the Rack and Pinion System of Locomotion :

Two rack bars of section 110 mm×22 mm and positioned 44.5 mm from each other are provided in the Permanent Way, having been fixed to the sleepers on cast iron chairs and bolts. The rack bar has grooves 67.5 mm in width at the top and 51.5 mm at the bottom and 50 mm deep, the pitch of the grooves being 120 mm (along the length of the bar). The bars are in lengths of 3.116 m or 1.556 m and are joined by flats and bolts, the joints being supported on cast iron chairs bolted to the sleeper. The steel to be used for the manufacture of rack bars is required to have an ultimate tensile strength of not less than 35 tons and not more than 40 tons per sq. inch yield stress not being less than 50% of the ultimate strength and elongation being not less than 20% with 35 tons and 17% with 40 tons of ultimate tensile strength.

4.3 Corresponding to the rack bars fitted in the Permanent Way, the engine has two sets of pinions, each having two cog wheels. When the two pinion assemblies on the locomotive are rotated, the teeth of each of the four cog wheels engage with the two rack bars transmitting the force necessary to move the locomotive forward.

4.4 The pinion assembly is fitted on the locomotive in between the frames firmly through bronze bearings. The lateral movement is arrested (within prescribed tolerances) by thrust pads fitted on either end of the pinion shaft. The assembly consists of (a) a shaft on which the drum is fitted; (b) two transmission rims with gear teeth on the outer surface; (c) two cog wheels and (d) spring assemblies fitted to correct the cog wheels to the centre drum.

4.5 The cog wheels are assembled on the centre drum. Interconnecting springs are fitted and two transmission rims are kept on the outside bolted together firmly through the centre drum. The assembly is such that when the transmission rims are rotated by the pinion teeth, the force is transmitted through the springs to the cog wheels. Each rack is expected to carry a force of about 3400 lbs. (1550 kg.) when fully brought into use.

4.6 Trains are operated on the Nilgiri Mountain Railway by what is called the Absolute Block System of train working and the Block instruments in use at various stations are of either Theobald or Neale's Tablet type. The stations are of Class 'B' for Block working and are equipped with rudimentary interlocking with 'Home Signals only' in each direction. The maximum permissible speed of trains in the non-rack section (between Mettupalaiyam and Kallar and between Coonoor and Udagamandalam) is 30 Km./h. and in the rack section (between Kallar and Coonoor) is 13 Km./h. Trains do not run through stations in the rack section.

4.7 The kilometrages of various locations and stations mentioned in this Report are as under :

Coimbatore (North)	0-00	on Coimbatore-Mettupalaiyam B.G.
		section.
Mettupalaiyam	32-83	Do.
	00-00	on Mettupalaiyam-Udagamandalam
		M.G. section
Kallar	7-46	
Adderley	12-27	

Site of Accident	12/10-11
Hillgrove	17-26
Coonoor	27-03
Udagamandalam (Ooty)	45.88

4.8 The Mountain Railway is under the Administrative control of Palghat Division, located on Erode-Shoranur Main line section of Southern Railway, at a distance of about 80 Kms. from Mettupalaiyam. The Divisional Railway Manager and all Divisional Officers are stationed at Palghat while the Assistant Engineer having jurisdiction over the Mountain Railway is stationed at Coimbatore. The loco Foreman and Permanent- Way Inspector are stationed at Coonoor where there is a Loco Shed for maintenance of the locomotives. Coaches and wagons are maintained at Mettupalaiyam where the Carriage and Wagon Foreman is stationed. Major overhauls of the Rolling Stock are done in the Railway's Workshops at Golden Rock near Tiruchchirappalli.

V. SUMMARY OF EVIDENCE

5.1 *Shri M. Ameer, Gangman*, stated that at about 11-00 hours on 21st February, while he was walking alongside the Railway track in the direction of Hill-grove, the goods train overtook him near about Bridge No. 39 and after about ten minutes the train was seen to be rolling down at a high speed, which he felt was about the same as that of a Broad Gauge train. As the train ran past him, down-hill, the Fireman indicated to him by sign that the circular brake was not functioning. He could also hear the shouts of the Fireman and the Brakesman to the effect that God alone would save them. Sensing something untoward, witness ran behind the train and noticed on his way several of the rack bars in a disturbed condition. Near Bridge No. 35 he had also noticed some boulders alongside the track and dust rising. As he reached the bridge he noticed that the entire train had fallen down. Hearing the shouts of one of them for water, he proceeded to Adderley to fetch water and also to inform the Station Master. He returned soon to the Bridge with water when he found that only one was alive and all others were dead. The injured person with burn injuries was taken up the slope on a stretcher and shifted to Adderley.

5.1.2 Answering questions, the witness gave the following further details :

- (i) He had earlier seen instances of trains rolling down-hill but after some distance they used to proceed forward—such instances were rather frequent.
- (ii) The boulders which he saw short of Bridge No. 35 were not there on his forward journey earlier. He did not expect boulders falling from above as such occurrences happened only during the monsoon months.
- (iii) The train was running very fast, faster than even the speed at which trains run between Mettupalaiyam and Kallar down the Ghats.

5.2.1 *Shri R. Subramani*, a Wood Cutter, stated that while he was returning from the forest where he went for cutting wood and was near foot-over-bridge No. 41, he noticed a goods train proceeding towards Coonoor. It stopped short of the bridge for a while and started rolling down at a good speed.

5.2.2 Answering a question, the witness said that he used to notice trains stalling on the gradient, roll backwards for a foot or two and then move forward. On this occasion the train continued to go downwards.

5.3.1 *Shri C. C. Job, Station Master, Adderley* said that the Goods train left his station at 10-40 hours after a halt of five minutes for watering. During that period he had no talk with the Driver but had a word with the Guard when he went up to the Brakevan. Everything appeared normal and the Guard did not complain about anything. At about 11-10 hours *Shri Ameer, Gangman*, reported to him that the train had fallen down the Bridge No. 35. He immediately informed the Section Controller at Palghat and sent two of his men to the spot. After about 15 minutes they returned to the station and, reported that a traffic Casual Labourer, by name Murgesan, was lying under the debris in a seriously injured condition. The injured person was brought into the station at about 12-35 hours and sent to the Government Hospital, Mettupalaiyam.

5.3.2 Answering questions, the witness said that during the past two years there were about 50 cases of stalling of trains which were not able to climb the ghats and returned to Kallar. 11 of these were Express trains and others were mostly Goods trains. There was a case of even a

light engine not having been able to climb up and returning to Kallar. Witness learnt that such ~~stagnations~~ were due to their pinions not working.

5.4 *Shri K. Narayanan, Assistant Fire Officer, Mettupalaiyam*, said that on receipt of a telephonic message about the accident at about 11-10 hrs, he proceeded to the accident spot along with his crew and reached at about 11-58 hours. Only one injured person was alive and his men managed to send him up the bridge on a stretcher. That person had burn injuries all over his body and was asking for water. Later his crew managed to remove all dead bodies from the site and the process was completed before evening.

5.5 *Shri V. Thyagarajan, Station Fire Officer, Coonoor*, who had received a message about the accident at 11-25 hrs., proceeded to the site with his crew and reached at about 13-00 hours. His team worked in co-ordination with the Mettupalaiyam Fire Personnel and removed all the dead bodies before the evening.

5.6.1 *Shri B. Mathan, Assistant Divisional Medical Officer, Coonoor*, received a message about the accident at 11-45 hrs. and proceeded by trolley leaving Coonoor at 12-00 hours and reached the spot at 12-45 hours. By that time, the injured person had already been shifted and all others were found dead. Witness remained at site till all the seven dead bodies were taken out. He identified the Driver, one Fireman, and a Gangman who had extensive burns on their bodies. Others appeared to have died due to 'head getting crushed' or 'skull getting fractured'. The injured person who was reported to have been admitted to the hospital at Mettupalaiyam at 13-40 hours expired soon thereafter.

5.6.2 The witness knew the Driver, late Manickam for about four years. He was known to be of a sober type and not known to be having any ailments like diabetes or high blood pressure.

5.7.1 *Shri G. Natarajan, Loco Foreman, Coonoor*, on being informed of the accident at 11-30 hours rushed to the site by trolley and reached at 12-45 hours. Close to the bridge in the cutting he saw the hand railing of the tank of the engine and a few other parts. He saw boulders also near the track. He formed the view from these clues that some boulders which had fallen from the cutting had caused the train to derail. On his way to the site, he noticed in the track some disturbance to the rack bars. From that indication he concluded that the train was perhaps going backwards.

5.7.2 Answering questions, the witness stated the following :

- (i) The reason for the train to go back was possibly the engagement of the pinion with the rack bars getting disturbed. Normally when a situation like that happens the Driver tries to back the train for a while to see whether the train would re-engage the rack.
- (ii) From what he saw at site he felt that the speed of the train might have been about 40 Km./h. when its wheels mounted the rail and derailed. Possibly the pinion did not get engaged while the Driver backed it for that purpose and in the meantime the train picked up speed and the assistance received from vacuum and other brakes was not adequate.
- (iii) He had come across one similar instance of a goods train rolling down one and a half years earlier but in that case the Driver had been able to engage the pinion to the rack before it went out of control and brought the train to a stop. In his view a speed up to 15 Km./h. could be considered safe for the train without the pinion getting engaged (on the steep falling grade).
- (iv) He did not consider that the cause for the train to get out of control was either mismanagement by the Driver or any disability in the locomotive. Possibly the rack bar assembly gave way under the earlier train (No. 36 Express) and it got aggravated to such an extent that under the impact of the train in question the Driver was unable to get re-engagement of the pinion.
- (v) He was unable to say why Drivers of engine No. X 37394 recorded several bookings between 2-2-1982 and 7-2-1982. An examination of the engine by his staff on 2-2-1982 did not reveal anything wrong with the pinion.

5.8 *Shri R. K. Rajagopal, Wagon Foreman, Mettupalaiyam*, gave the following particulars about the Rolling Stock under his charge :

- (i) The two vehicles which formed part of the 'Coal Special' were examined by his staff on 21-2-1982 and certified fit. There was no vacuum exhaustor in the depot but the

testing was done by the train locomotive before the Brake Power Certificate was granted. The certificate covered also the correct functioning of the rack brake although that fact had not been specifically mentioned in the Brake Power Certificate.

- (ii) The two vehicles were not overdue P.O.H.
- (iii) There had been no complaints of poor brake power of any train in the recent past.

5.9 *Shri T. J. Mathew, Sr. Divisional Mechanical Engineer, Palghat*, answering questions gave the following information among other things :

- (i) A worn-out pinion (within condemning size) and wornout rack (with its condemning size not specified) in combination could result in disengagement.
- (ii) The pinion assembly is of high tensile steel but as the rack bar assembly is not of identical material, the rack-pinion system now in use is unable to take the design load.
- (iii) Due to rack level not being maintained as per manufacturer's drawing, the pinion assembly is not working on the pitch circle as designed for.
- (iv) Once a pinion is able to take an entry at the commencement of journey onto the rack-pinion system it could be assumed that the alignment of the pinion is in order.

5.10 *Shri M. A. Cherian, Chief Motive Power Engineer (R&L), Southern Railway, Madras*, answering questions, gave figures of brake power (as calculated in his office) contributed by (i) pinion/rack on the locomotive, carriage and wagons separately; and (ii) vacuum on the train on the gradient at various speeds. He has also furnished the lateral shift required to cause disengagement of the pinion on the rack bar, the maximum permitted wear on the locomotive component, shift of cog wheel from centre due to irregularities in curvature and net tolerance available in fixing rack bars. Answering specific questions, he made an assessment of the locomotives used on rack section and opined that "the pinion and rack assembly is an integrated system of gear transmission of the force for moving the locomotive forward" and that a "high degree of the rigidity of the rack assembly in relation to the rail geometry is required and has to be sustained within much closer tolerances than existing."

5.11.1 *Shri M. P. Jayaraj, Permanent Way Inspector, Coonoor*, for the last 1½ years, stated that the main problem he faced in the section was the damage to rack bars and the need to replace them frequently. His observation has been that certain engines were prone to the problem of pinions working out.

5.11.2 Answering questions, the witness made the following points among other things :

- (i) Track tolerances (including clearances of rack bars) are not prescribed in any Manual but are evolved as a working arrangement.
- (ii) When the pinion works out (on the run) and if the Driver is not very cautious and allows the train to proceed further, the rack alignment gets distorted and the pinion tooth travelling inside causes lateral thrust on the rack bar and the rack bolts get sheared. When such damage occurs the rack bars get attended only if the Driver reports. Otherwise they remain in damaged condition till they are detected by Permanent Way staff. If any other train passes before the damage is detected there will be further damage.
- (iii) When the rack chairs get laterally displaced due to insufficient grip of a decayed wooden sleeper on the bolts, the pinion works out.
- (iv) In the present arrangement of manufacture of rack bars there is a possibility of the rack bar longitudinally creeping and thus creating gaps upto 12 mm in service.
- (v) Witness was aware of an earlier instance (on 8-5-1981) of a Goods train rolling down the grade from Km. 14/6-7 to 14/0 where it had come to a stop and later backed to Adderley. Between Kms. 14/6-7 and 14/0 there was heavy damage to rack bar assembly on that occasion.
- (vi) Due to constraints on continuous reverse curves, variations of versines upto 25 mm (on 10 m. chords and consecutive stations 5 metres apart) are allowed to remain. There are no specific instructions that curves should be maintained to a finer alignment.

5.12 *Shri R. Gopinathan Nair, Permanent Way Inspector, Coimbatore*, who worked in the section from 1965 to 1969 stated that during his tenure there used to be occasional breakage of

rack bars but the problem was not of any magnitude. During that time imported rack bars were being used for replacements. Instances of pinions working out were rare. Rack bars were known to be breaking but there was no problem of wear. There were no specific instructions about the clearance to be maintained between rail gauge face and rack bar but as a practice slackness of upto $\frac{1}{4}$ " on inner rails of curves and upto $\frac{1}{2}$ " on outer rails was being allowed in practice.

5.13 *Shri P. O. Joseph, Sr. Divisional Engineer, Palghat*, answering questions, gave the following particulars :

- (i) There are no specific instructions to maintenance Inspectors about maintenance of rack bars but a procedure which had been evolved over the years from experience is practised.
- (ii) If the total misalignment of gauge and pinion assembly is 33 mm or more, the pinion will work out. Taking the lurch factor into account it may work out even with a lower figure.
- (iii) The thickness of rack bars manufactured from Arakkonam was 25 mm against 22 mm of earlier imported bars. This was ordered on Arakkonam Shops about eight years ago due to non-availability of 22 mm bars indigenously.

5.14 *Shri N. S. Raghavan, Chief Track Engineer*, answering questions, stated as under :

- (i) It would be necessary to lay down limiting tolerances for side play of pinions, wear on wheel flange and wear on gauge face of rail, if disengagement of the pinion is to be eliminated altogether.
- (ii) There had been no indication from the Division or from the Inspecting Officers regarding any special difficulties in the matter of maintaining the track to reasonable standards.
- (iii) Commenting on the recommendations made by a Swiss Locomotive Engineer in 1941, witness opined that with the advanced technology and information on Rail-Wheel interaction and movement over curves available now, a fresh study could be made jointly by Civil and Mechanical Engineers.
- (iv) Witness furnished a copy of the specification for steel rack bars taken out from old files and also a note leading to the circumstances in which 25 mm thick steel bars conforming to IS : 226 came to be used in the recent past.
- (v) Commenting on the non-provision of check rails on curves witness stated that there was no specific decision to that effect as seen from files but the practice was perhaps adopted as the speed permitted was low and due to factors inherent in the design of rack and pinion assembly.

5.15 *Shri N. C. Hore, Chief Chemist and Metallurgist, Southern Railway*, expressing his opinion about the specification of steel rack bars which were in use earlier and at present stated as under :—

- (i) Steel conforming to IS : 226 will have lesser ultimate tensile stress than the minimum of 35 tons earlier specified for the rack bars. Elongation will be higher than the minimum prescribed. From the specification made available to him witness classified it as conforming to Class IIIA to IS : 1875/1971; and
- (ii) because of higher strength of Class III A steel (to IS : 1875/1971) than that to IS : 226 it will not yield easily.

5.16 *Shri T. Simon, Driver 'A', Grade, Coonoor*, who worked No. 36 Express which negotiated the rack-section earlier on 21-2-1982, stated that the pinion worked out at 10 or 12 places and he had to back on each occasion so as to re-engage and proceed further. When he worked a train in the descending direction, on the previous day, the pinion had worked out at two places.

5.17.1 *Shri R. Kalimuthu, Driver 'B', Coonoor*, who had earlier worked in the section for about ten years as Fireman and currently as Driver for 1½ years in Mettupalaiyam-Udagamandalam section, stated that during the earlier spell of his service he had no occasion to experience the pinion working out of the rack and during the current spell of his service incidence of pinion working out was rather frequent.

5.17.2 Answering a question, witness said that he knew late Manickam, Driver, for a number of years. He was a quiet type of person, not known to be addicted to drinking. He was

known to be maintaining good health. Witness also knew that Shri Manickam had three daughters and a son but was not in a position to say whether he had any family problems to be worried about.

5.17.3 Answering another question, witness stated that when the pinion works out, the practice is that the whistle code is given asking the Brakesmen to apply the brakes and his own experience is that after a short time the pinion gets engaged in the rack and the train moves forward. Witness has had no occasion to bring back the train to the starting station due to pinions working out.

5.18 *Shri W. H. Githooly*, who worked in the section for about 15 years as Driver and retired as Driver/Grade 'A' Special, in 1979, said that earlier with the "moulded bars" on the rack there was no trouble on the pinions. Subsequent to the introduction of Arakkonam manufactured bars, the problem of pinions working out had started. If the pinion gets disengaged, while the train is on the ascending grade, the engine struggles, goes back a little and then again tries to get engaged. Generally it succeeds in such an attempt. Witness had not experienced nor heard of a train getting completely out of control on the section. From his knowledge of the section for about 40 years (his father was also a Driver in the same section) he would consider the present accident to be the worst in 40 years.

5.19 *Shri K. Ramachandran*, Driver 'A' Special, Coonoor, who has been working trains in the section since 1971, said that the main problem of working trains on the rack bar section is the pinion working out at specific places. He feels that the main cause for the same is alignment trouble of the rack bars. Sometimes on the same trip the pinion was known to be working out 20 to 25 times and the damaged bars were required to be replaced before the next day's train was scheduled to run. "This has become a regular practice now" he added.

5.20 *Shri A. K. Ramachandran*, Guard, Podanur, who has been working on the rack section for about four years, said that the trouble in the section was about the pinion working out and trains losing time on that account. On the descending grade when the pinion is working satisfactorily, only the adhesion brake is applied. If the train is seen to be picking up more speed the rack brake is also applied by him and the Brakesmen, on the Driver giving the necessary whistle for assistance. Witness knew late Jagadeesan, Guard, who worked the ill-fated train and in his view Jagadeesan was a quiet and alert type of Guard.

5.21 *Shri A. Kalimuthu*, Brakesman 'A', Mettupalaiyam, who has been working in that capacity in the same section for about 30 years, said that in the ascending direction there is no application of brakes by Brakesmen except when the train stops. In the descending direction the adhesion brake is continuously applied and when speed increases the rack brake is also applied. Witness had not come across any train getting out of control on the graded section.

Witness knew late Anthoniswamy and Ramaswamy, Brakesmen for a number of years. They were experienced men and sober by temperament.

VI. OBSERVATIONS AND TESTS

6.1 On 23-2-1982 I inspected the section between Km. 14 and 12/10 between Adderley and Hillgrove stations on push trolley and observed the condition of the damaged rack bar assembly on the track. At Km. 12/10-11 I inspected the wrecked locomotive and other vehicles lying 16 metres below the rail level at Bridge No. 35.

6.2 At my instance measurements of the track including clearances of rack bars were recorded by Railway officials at Km. 12/12-13, 8/1-2 and 10/5-6.

6.3 On 24-2-1982 I inspected the pinion assembly on one of the 'X' Class locomotives in stripped off condition at the Loco Shed, Coonoor. Later, I travelled on the foot plate of the locomotive hauling a test train for a distance of about a kilometre and observed the functioning of various controls on the locomotive. A demonstration was also given to me on the occasion as to how a disengaged pinion gets re-engaged to the rack.

6.4 On 25-2-1982 I inspected the pinion assembly on the coaches and wagons at the Carriage and Wagon Depot at Mettupalaiyam.

6.5 My observations on the above are discussed in detail in the relevant paragraphs under the heading "Discussion".

VII. DISCUSSION

7.1 Nature of evidence available

7.1.1 All the eight occupants of the ill fated train—a Driver and two Firemen manning the locomotive, a Guard and two Brakesmen manning the rear vehicles besides two others travelling by the train—perished in the accident and there is none to tell me what had actually happened to the train and how it had derailed and dropped down the bridge. The only eye-witness account available was that of a Railway Gangman walking alongside the track in Km. 13 as the train went up and, after a while, rolled down the gradient and the evidence of an outsider who had watched from an over-bridge near Km. 14/1 the train coming to a stop and moving back. The other evidence was circumstantial being in the nature of damage to the track and in particular to the rack bar assembly, some fresh markings on the left face of the cutting just short of the point of mount and some tools belonging to the locomotive as well as a couple of its parts besides some boulders of the cutting lying scattered by the side of the track.

7.1.2 Some fresh wheel burn marks were noticed on one of the rails on bridge No. 40 at Km. 14/1 and in consideration of the fact that this location is close to the foot-over bridge wherefrom one of the witnesses noticed the train coming to a stop and moving back, I consider that the train had in its forward journey towards Coonoor travelled only upto about Km. 14 before it started moving backwards.

7.1.3 From Km. 14 down to Km. 12/10-11 a length of about 1200 metres, there was extensive damage to the rack bar assembly. Over 50 rack bar joints were found spread out, a few were found bent and two bars were missing, one in Km 13/9-10 and the other in Km 12/11-12.

7.1.4 Just in the rear of the point of mount a number of tools and a couple of parts of the locomotive were found scattered on the left side cress in the rock cutting, besides a few boulders of the cutting. The parts found detached from their position on the locomotive were a hand railing and a cover of the built-in tool box flush with the left side surface of the locomotive. At the same location there were fresh markings on the cutting face indicating the possibility of the locomotive coming in contact with it. Unfortunately, efforts to locate the corresponding evidence on the locomotive proved unsuccessful due to the manner in which it was wrecked when it dropped down the bridge to a depth of about 16 metres followed by the other two vehicles which fell on top of it. The heights at which the fresh markings were seen on the cutting (2.0 to 2.7 metres above rail level) appeared to correspond with the level at which the hand railing and the tool box were fitted on the locomotive.

7.1.5 The position of brake gear as seen on the locomotive indicated that the Driver had applied the vacuum brakes and had also sought to engage the pinions with the rack bars. Two rack bars were also found entangled with the undergear of the locomotive.

7.2 From the above data, the event as it had occurred could be reconstructed as under :—

7.2.1 The fact that so many rack bars were found damaged indicated that the rack and pinion assembly had not been functioning as the train rolled down the gradient. Since, in its downward motion the locomotive was leading, the pinion brakes on the two vehicles which followed it, could also be considered as not functioning, even if they were in proper working order, as they had to negotiate the damaged rack bars.

7.2.2 The eye-witness, a Railway Gangman, who is quite familiar with working of trains in the section, sensed danger to the train as he noticed it rolling down at a high speed and rushed back to the site of the accident. (He was originally proceeding away from the site of accident towards the next station). Three significant points which he made in his deposition give a clue to the condition of the train at the moment it ran past him down the grade.

- (a) Its speed was very high. In the words of the witness the speed was "about the same as that of the Broad Gauge trains between Mettupalaiyam and Coimbatore" and it was running "faster than even the speed at which trains run between Kallar and Mettupalaiyam down the Ghats". (Trains in Mettupalaiyam-Coimbatore B. G. section run at a maximum speed of 90 Km/h. and are booked at 81 Km./h. On Kallar-Mettupalaiyam M. G. section trains run at a maximum speed of 30 Km./h. and are booked at 27 Km./h.).

- (b) The Fireman of the locomotive indicated to him "by signs" that his brake was not working. He could hear the shouts of the Fireman and the Brakesman to the effect that God only could save them.
- (c) As he approached the cutting, short of bridge No. 35, he saw some boulders alongside the track and dust was rising. On his way upto the cutting he noticed several of the rack bars in a disturbed condition.

7.2.3 I have no reason to disbelieve the statement of the witness who appeared quite intelligent as he deposed before me. From what he said it appears that the train was running down the gradient out of control and the engine crew as well as the Brakesmen were really worried about their safety.

7.2.4 As I piece together the statement of the eye-witness and the circumstantial evidence available on the face of the cutting and on the cess of track in the cutting, it appears that the train went out of control, picked up speed on the falling gradient, the locomotive started oscillating violently as it negotiated the cutting at high speed and had come in contact with its face. As soon as it left the cutting, its wheels mounted the rail, derailed and as the bridge is closeby and as there are no guard rails on the bridge to prevent the lateral movement of the derailed wheels, the locomotive followed by the other vehicles dropped down to a depth of 16 metres, killing all the occupants.

7.3 Having traced, with the available evidence, the course of events leading to the disaster, I have to determine the circumstances under which the train was required to be backed and how it went out of control. These issues are dealt in the following paragraphs.

7.4 Condition of rack and pinion assembly

The rack and pinion system of train operation on Kallar-Coonoor gradient section has been in use for over eighty year. Available evidence indicates that upto a few years ago it was working satisfactorily and failure of the pinions to engage with the rack bar used to be a very rare event. According to Shri W. H. Gilhooly, retired locomotive Driver, who worked in the section for about 15 years before he retired as Grade 'A' Special Driver in 1979, with the "moulded bars on the rack" (by which he meant the imported bars) there was no trouble on the pinions but "after the introduction of the Arakkonam manufactured bars" (which as per information supplied by the Railway Administration commenced in the year 1977) the problem of pinions working out had started. According to him if the pinion gets disengaged while on the ascending grade, the engine struggles, goes back a little and then again tries to engage in which it generally succeeds. Shri K. Ramachandran, a serving Special Grade 'A' Driver, who has been working in the section since 1971, stated that during the last two years cases of pinion working out had become a frequent occurrence. He had experience of the pinion working out 20 to 25 times on a single trip and, according to him, "It has become a regular practice now". Shri Gopinath Nair, Permanent Way Inspector, who had worked in the section between 1965 and 1969 felt that during his time there used to be occasional breakages of rack bars but the problem was not of any magnitude, as imported bars were being used. Shri M. P. Jayaraj, the present Permanent Way Inspector, who has been maintaining the section for about 1½ years, expressed the view that the main problem in the section was the frequent damage caused to rack bars needing their replacement. In his view certain locomotives were particularly prone to cause damage. Between April 1981 and February 1982 (out of which the section remained closed for traffic for about three months) as many as 842 rack bars, 1350 rack chairs and over 7000 bolts had to be replaced. Shri C. C. Job Station Master, Adderley stated that during the last two years there were about 50 cases of stalling of trains in Kallar-Adderley Block section and their returning to Kallar, not having been able to proceed further, up the grade due to their pinion assembly not working. Of these, 11 cases were of Express trains and the rest were of Goods trains. Shri G. Natarajan, Loco Foreman, who was aware of the frequent instances of pinion working out, kept records of bad spots and in his view the locomotives were in a satisfactory state of maintenance and if the rack bars were maintained properly there was no need for so many disengagements of pinions suffered by the locomotives.

7.5 Pinion Assembly

I have gone into the working of the pinion assembly on the locomotive in great detail and my observations are as under.

7.5.1 With the wheel arrangement on the X Class locomotive and the cog wheel assembly fitted on to its frame, the maximum lateral shift of the pinion on a 17.5° curve (100 m. radius), which is the sharpest curve in the section is 15 mm as worked from Vogel's diagram. The

design of the rack bar assembly on the track and the pinion assembly on the locomotive are such that a theoretical lateral shift of 31.75 mm has to take place before the pinion gets disengaged from the rack bar by lateral displacement while the train is on run. There is thus freedom to the extent of 16.75 mm for lateral play of the rack and pinion assembly on 17.5° curves due to all conceivable causes arising out of their maintenance.

7.5.2 All mechanical working parts do develop variations due to wear and tear and accordingly maintenance tolerances are prescribed. On this basis, the permitted maximum lateral play due to wear of the locomotive components is about 7 mm, as stated by the Chief Motive Power Engineer. Thus the lateral play that is available due to wear and tear of the rack bar assembly on track is about another 10 mm.

7.5.3 The locomotives currently in use on the rack section were commissioned around 1953 and presumably wear and tear in the earlier years did not account for much lateral play. But with locomotives getting advanced in service life, it appears that the wear and tear has been on the increase, which is only to be expected in a mechanical assembly. Although the Loco Foreman maintained that the play was at no time allowed to go beyond 6 mm, instances of a larger play having been noticed in the assembly have been brought to my notice by some witnesses. A joint examination on 23-1-1982 by the Assistant Engineer and Loco Foreman of locomotive No. X 37394, the one involved in the accident, the rear transmission rims were having clearances of 355 mm (right) to 345 mm (left) (from the nearer frame to the outer face of the rim) with reference to the available clearance of 350 mm on the front ones. Again during another joint examination in March 1981, the lateral shift noticed on the pinion of a different locomotive was 19 mm. Another joint examination in June 1981 on a third locomotive showed a variation of lateral clearance of 10 mm. on rear pinion and 18 mm on the front pinion.

7.5.4 While the Loco Foreman has claimed that all such variations had been attended to whenever noticed, the fact remains that the locomotives with their advancing service life had been developing lateral play in pinion assembly beyond the prescribed tolerance. A perusal of the maintenance records in respect of locomotive No. X 37394, involved in the accident, indicated that its pinion assembly received attention on *ten occasions* between 5-8-1981 and 30-1-1982 (which included an idle period of three months due to closure of the section for traffic during the monsoon season). Subsequent to its attention on 30-1-1982 there were bookings again in the repair book between 1-2-1982 and 7-2-1982 by different Drivers as under :

- 1-2-82—Both sides pinion stay and stud to be examined and drum bolts and nuts to be examined.
- 2-2-82—Both bottom pinion right side worked out, to be examined.
- 3-2-82—Pinion stay and stud to be examined.
- 4-2-82—Both front bottom pinion wedge bolt nuts to be fitted; Left back top pinion long stud nut slack; Left side front bottom pinion side plate nuts and studs slack.
- 4-2-82—Both side big end knocking very badly; pinion worked out thoroughly to examine the pinion height.
- 5-2-82—Pinion worked out, thoroughly, pinion stay bolt stud, wedges, stay to be examined. Pinion working out of rack bars badly.
- 6-2-82—Bottom pinion drum bolt to be examined. Both top pinion stud and stay bolt to be examined.
- 7-2-82—Left front bottom pinion side plate stud one missing and nuts slack. Left back bottom pinion wedge nut to be fitted. Left front bottom pinion brass metal out."

7.5.5 While the exact condition of the locomotive on 21-2-82 is not available and can never be found due to its having perished in the accident (even the Engine Repair Book in use after 7-2-82 could not be recovered from the debris) the above observations go to show that all was not well with the locomotive pinion assembly and repeated bookings were being recorded almost after every trip about the poor condition of the pinion assembly.

7.6 Rack Bar Assembly

7.6.1 From the curve register of the Permanent Way Inspector, Mettupalaiyam, it was seen that versines upto 180 mm, on 10 m. chords were common on 17.5° curves indicating irregularities upto 24°. The versine recorded on the curve in Km. 12/11-12 after the accident was 187 mm indicating a curvature of 25°. Accordingly studies were made from Vogel's diagram for the X Class locomotives for curves upto 26° which indicate that when the curvature

is 23° the lateral shift of the pinion assembly is about 19.5 mm—4.5 mm in excess of the shift on a 17.5° curve—and in the case of a curve of 26° it is 21 mm—6 mm in excess of it.

7.6.2 To suit the pinion assembly centrally placed on the locomotive frame, the rack bar clearance from the nearest track gauge face should be 455.75 mm whereas the fitment of rack bars as a regular practice had been with a clearance of 452 mm. (No authority could be quoted by the Engineering Officials for this practice but it appears to have been traditionally practised by successive maintenance Inspectors). Even for this fitment, variations were taking place in day to day maintenance and the Permanent Way Inspector has conceded a maximum variation of 6 mm in this respect. During a sample check conducted at Km. 10/5-6 at my instance the variation in this dimension was as much as —9 mm on inside and +15 mm on the outside.

7.6.3 Apart from the actual variations under 'No load' conditions, it is more than likely that rack chairs fitted on wooden sleepers through bolts, were yielding under load, the variation due to such yielding depending on the condition of the wooden sleepers. While the sleepers, generally speaking, were in a satisfactory condition, about 10% were unserviceable and in such locations a further variation in lateral play was to be expected.

7.6.4 For the pinion teeth of the locomotive to correctly engage the corresponding grooves on the rack bars and make proper contacts on the surface of the rack bar teeth, it is very essential that the level at which rack bar surface is fixed on the sleeper is maintained within a prescribed tolerance. At some locations, in Km. 13-14 when the levels were recorded on 23-2-82 (in locations unaffected by the damage caused by the track on 21-2-1982) the variations were as much as —12 mm.

7.6.5 Surprisingly, tolerances are not 'specified' by the Civil Engineering Department of the Railways in respect of (i) variations in versines on sharp curves; (ii) variations in clearances of rack bars from rail gauge face; (iii) variation in the height of rack bar surface; and (iv) gaps in between rack bars. Items (i) and (ii) are relevant from the view point of lateral shift of the pinion while the locomotive is in motion and items (iii) and (iv) are relevant from the view point of correct vertical contact of the pinion teeth with the rack bar grooves. In the absence of specified tolerances Permanent Way Inspectors have been adopting tolerances to the best of their understanding which, as seen from the observations made in paras 7.6.1 to 7.6.4 above, could, under certain circumstances, add up to a total considerably in excess of the available lateral play or vertical play.

7.6.6 Added to the maintenance problems, was the problem of the supply of rack bars to wrong specifications. As per specification, the steel used in manufacture of racks bars should have an ultimate tensile strength of 30-40 tons/sq. inch, the yield stress being not less than 50% of the tensile strength and elongation being not less than 20% with 35 tons and 17% with 40 tons of ultimate strength. This specification conforms to Class III A Steel to I.S. 1875/1971 while the steel used in rack bars manufactured in Railway's Workshop at Arakkonam conforms to IS : 226. This appears to be one of the reasons for the rack bars being subjected to undue wear easily yielding laterally and vertically under load requiring frequent replacements, aggravating an already difficult situation.

7.7 Problem of pinions getting disengaged from the rack bars.

7.7.1 The Loco Foreman maintains a 'Track defect register' wherein the locations at which the locomotive pinions get disengaged by various trains every day are recorded by Drivers and transmitted to the Permanent Way Inspector for attention. A perusal of the register with entries from 3rd October, 1979 indicates practically trouble free service upto 28-2-1980 when the first entry was recorded by a Driver. During March 1980 there were 11 entries, each entry being confined generally to one location and only in one entry there were three locations. During the subsequent months the number of entries appearing in the register was as under :—

April 1980	3	January 1981	6	August 1981	10
May 1980	2	February 1981	15	September 1981	15
June 1980	4	March 1981	28	October 1981	12
September 1980	4	April 1981	18	December 1981	9
October 1980	14	May 1981	18	January 1982	29
November 1980	4	June 1981	18	February 1982	
		July 1981	10	(upto 22nd)	21

(Note : The section was closed for train services from 26-10-81 to 28-2-82 but partially resumed from 28-12-81)

7.7.2 While the number of locations where the working out of pinions was reported by a Driver after a single trip was generally one in March 1980 (and three on a single occasion), the maximum number of locations entered in the register on a single day in 1980 was 9, while it was 32 in 1981 and 27 in 1982. The Driver of No. 36 Express of 21-2-1982 which negotiated the rack section immediately ahead of the ill-fated goods train stated in his deposition that there were as many as 12 disengagements for his train on that day. A perusal of the individual locations recorded in the register indicate that certain kilometrages where sharp curves are located were repeatedly figuring, indicating thereby that curved alignment is more prone to such disengagements than straight track. While there is no record of reasons for variations in figures of 'disengagements' from day to day and from train to train, it appears that it was based on the attention given to the rack bar assembly by permanent way men and the condition of individual locomotives from time to time.

7.8 What had actually happened to "Coal Special" on 21-2-82, resulting in its derailment?

7.8.1 It has not been possible to identify any positive fault in the locomotive or the other vehicles which could have led to the derailment, due to their having been extensively damaged. It has also not been possible to identify any positive fault in the rack bar assembly between Km. 12/10-11 and 13/12-13 due to extensive damage having been suffered by the same almost throughout the length. Measurements recorded at Km. 13/12-13 on the undamaged portion (at Coonoor end of the post brought out a maximum variation of rack bar clearance of 8 mm and a level variation of 7 mm on the rack. Several rack bolts and rack chair bolts were loose and some were even missing. I consider that even prior to the bars getting damaged the rest of the track might have been in a similar condition.

7.8.2 From the versine readings of track in Km. 12/11-12 and Km. 13/1-5 which was not affected (although the rack bars got damaged), it is clear that the curves had versines upto 187 mm. and 162 mm. respectively against 130 mm. on a 17.5° curve indicating irregularities upto 25° and 22° respectively. This reflects the general condition of track alignment in the section.

7.8.3 Measurements taken at Km. 10/5-6 (not affected by the accident) indicated rack bar clearance variations upto 15 mm and height variations of rack bars upto 12 mm. In this kilometrage there was evidence that there had been a disengagement of pinion and consequent damage to the rack bar assembly, when No. 36 Express negotiated it a little earlier (as deposed by the Driver of that train). This situation indicates that not only at Km. 10/5-6 but at other locations also the Coal Special which followed the Express had to negotiate such damaged locations thus making its movement vulnerable when it negotiated the same spots.

7.9 Factors leading to the accident

In the absence of positive evidence of track and rack bar condition near the point of derailment or from the location where the train rolled down (except for versines) prior to its movement, I consider that it must have been similar to what has been brought out in paras 7.8.1 to 7.8.3 above. Similarly in the case of the locomotive pinion assembly, in the absence of positive evidence, I consider that it must have been similar to what has been brought out in paras 7.5.3 to 7.5.5. With this combination and in the general background of the condition of rack and pinion assembly as evidenced by the large number of disengagements which were taking place during the days, weeks and months prior to the accident, I come to the following conclusions as to the factors leading to the accident :—

- 7.9.1 Due to track tolerances, particularly those which have relevance to the functioning of the rack and pinion assembly, not having been prescribed, lateral and vertical play of the pinion on the rack bar tended gradually to go beyond the desirable limits.
- 7.9.2 The situation became further aggravated due to the gradual wear and tear developed in the pinion assembly on locomotives due to age which had also often exceeded prescribed limits of tolerances.
- 7.9.3 Whenever the combined effect of 7.9.1 and 7.9.2 was beyond the designed lateral or vertical play in the rack and pinion assembly, disengagements resulted and these tended to gradually increase during the last few years.
- 7.9.4 The discontinuance of use of High tensile steel rack bars and their substitution by bars of ordinary steel made the rack assembly more vulnerable to lateral and vertical stresses caused due to frequent disengagements between the rack and pinion on account of factors detailed above.

- 7.9.5 This started a vicious circle, disengagements causing damage to rack bars and damaged rack bars causing more disengagements with the result that by February 1982 the rack and pinion system of operation became unreliable.
- 7.9.6 The damage caused to rack bars by a single train negotiating them had gradually risen so high that it became unsafe for the next train unless the rack bars damaged by the earlier train were repaired or replaced. During a demonstration of "disengaged pinions being re-engaged" given to me on 24-2-1982 at Coonoor, I noticed that the process of re-engagement involves application of violent lateral and vertical force on the rack bar by the pinion assembly, resulting in damage to the rack bars and breakage of chairs and bolts.
- 7.9.7 In such a situation the ill-fated Coal Special was required to negotiate the section on 21-2-1982 closely following No. 36 Express. In its forward journey upto Km. 13/12-13, besides having to negotiate rack bars damaged by the earlier train, it might have itself damaged several rack bars in the course of re-engaging the pinion on to the rack on its upward journey. When ultimately the Driver considered it impossible to proceed further, he might have decided to return to Adderley station and in pursuance of that decision backed the train. Due to a high degree of damage already caused to the rack and pinion system in his path, he had not been able to take advantage of the grip afforded by the rack and pinion system for controlling the train on the steep descending grade.
- 7.9.8 The pinion brakes of the two vehicles which followed the locomotive on the descending gradient could also not afford any assistance for controlling the train due to the rack bars having been already damaged by the locomotive and the Driver had to depend entirely on the vacuum brake power.
- 7.9.9 The Driver who was accustomed to returning the train to the station down-hill whenever he was faced with a similar situation (there were at least 50 cases of stalling and consequent return movements to the next station down-hill during the last two years as per records maintained at Adderley station) had probably expected to reach the station safely as the distance to be covered was less than 1.5 Kms. Due to non-availability of grip in the rack and pinion system the train might have picked up speed and reached an uncontrollable figure and derailed in the approach of Bridge No. 35 (Km. 12/10-11).
- 7.9.10 Due to the proximity of the bridge and non-availability of guard rails on the bridge, the engine had dropped down the bridge followed by the two trailing vehicles.
- 7.10 *What could have been the maximum speed which the train might have attained prior to derailment*
- 7.10.1 The only eye witness to the episode who deposed before me was not able to estimate the speed in terms of so many kilometres per hour but he did the next best thing—comparing it to the speed at which Metre Gauge trains run in the non-rack section and stated that it was higher than that speed (30 Km./h.). He had also stated that it was about the same speed at which Broad Gauge trains run between Mettupalaiyam and Coimbatore (i.e. 90 Km./h.)
- 7.10.2 The Railway Administration has furnished certain calculations of speed which the train might have attained, based on the distance covered, gradients negotiated, the load of the train and certain assumptions about frictional resistance of vehicles, etc. normally made for calculating speeds. The speed arrived at on this basis was about 108 Km./h. Based on the "criteria for assessment of stability of locomotives and rolling stock on Indian Railways" the equilibrium speed for derailment by mounting has been arrived at as 88 Km./h. for a 17.5° curve. If a 25° curve is considered (to accord with the versine recorded in Km. 12/11-12 just ahead of the derailment point) the equilibrium speed gets reduced to about 65 Km./h.
- 7.10.3 While I have no means of precisely evaluating the speed at the moment of derailment, I estimate, based on the available evidence and the calculations made on theoretical considerations, that the train might have been rolling down at a speed of about 65 Km./h. while approaching Bridge No. 35.
- 7.10.4 It appears from the engine parts and tools located by the side of the track in the cutting immediately in the rear of the point of derailment, that the locomotive, while negotiating the cutting, had come in contact with the cutting face. Fresh markings on the cutting face which correspond to the heights at which the hand railing and tool box cover are fitted on 'X' Class locomotives lend support to the view. For the locomotive to have come in contact with

the face of the cutting, it was necessary that it must have been violently oscillating as it negotiated the cutting. When it is considered that it has to make an angle of 40°—45° from the vertical, for its surface to come in contact with the rock a doubt arises as to whether the locomotive could have remained upright after it had left the cutting. While this looks impossible, it appears that the impossible had happened, judging from the manner it had dropped down the bridge after damaging track for about 12.5 metres on the bridge. After the wheel had mounted the rail, the total distance negotiated by the locomotive was about 20 metres before it fell down the bridge headlong. Considering that the train was moving at a speed of around 65 Km./h., the time required to cover 20 metres could be as little as a second and it appears that it had taken that much time to drop down after its wheels had left the rail.

7.11 Could the accident have been averted by the Driver

The actual condition of the locomotive and its brake power at the time the Driver decided to return to Adderley from Km. 13/12-13 is not available. Available evidence indicates that when the train left Mettupalaiyam that morning brake power was adequate. The fact that no complaint was made at Adderley, fifteen minutes prior to the occurrence indicates that the Driver had no problem with brake power till that time. Late Shri Manickam was an experienced Driver having worked in the Ghat section on X Class locomotives for a number of years and I have no reason to believe that he had not been able to handle the locomotive properly. He must have done his utmost to keep it under control but had failed due to the damaged condition of the rack and pinion assembly which he had to negotiate. In the best traditions of locomotive Drivers, he stuck to his post till the last moment and sacrificed his life in his attempt to save the train.

7.12 Could the accident have been avoided?

With the evidence placed before me, I have no doubt in my mind that the gradually deteriorating condition of the rack and pinion assembly was known to the Railway Officials concerned months prior to the accident. The Supervisory Officials of the Engineering and Mechanical Departments were aware of the vulnerability of the system with frequent disengagements of pinion from the rack but unfortunately the Civil Engineers were imagining that the pinion was the only culprit and the Mechanical Engineers were of the view that the rack was the lone culprit. Thus the Loco Foreman kept record of the locations of disengagements suffered by each train in what is called a "Track defect Register" and the Permanent Way Inspector kept record of the performance of particular locomotives. It did not occur to them or to their Superiors that the rack and pinion assembly was to be considered as ONE and its overall state of health was to be viewed for the safety of the train. Had such an integrated approach been made to the problem, the malady would perhaps have been understood in its correct perspective and steps would have been taken to correct the same or at least risky operation of trains would have been avoided. While I do not consider that there was any act of negligence on the part of any individual, I consider that it was the lack of understanding of the entire assembly as an integrated system which had led to the disaster for which the Supervisory Officials of both the Engineering and Mechanical Departments have to share responsibility collectively.

VIII. CONCLUSION

8.1 Cause of the Accident

Having carefully considered the factual, material and circumstantial evidence at my disposal, I have arrived at the conclusion that the derailment of Up 'Coal Special' train at Km. 12/10-11 between Adderley and Hillgrove stations on the Mettupalaiyam-Udagamandalam Metre Gauge Ghat section of Southern Railway on the morning of 21-2-1982 and its dropping down the bridge No. 35 at that location was brought about by the train getting out of control of the Driver when, after climbing upto Km. 14, he was forced by circumstances to return to the station below and was not able to get any assistance from the rack and pinion assembly during his descent on the steeply graded section.

8.2 Responsibility

I do not hold any individual responsible for bringing about the disaster. I, however, consider that the Supervisory Officials of both the Engineering and Mechanical Departments of the Railway charged with the maintenance of the track and locomotives respectively were collectively responsible for not having been able to correctly diagnose the condition of the rack and

pinion system which had gradually deteriorated to the extent of becoming unfit for safe train operation and for having permitted trains to operate in that condition.

8.3 Relief Arrangements

I am satisfied with the relief arrangements. The Fire Service personnel of the State Government, stationed at Mettupalaiyam and Coonoor promptly responded to the request of the Railway Administration and, despite the difficult terrain they had to negotiate, succeeded in reaching the scene of the tragedy within about an hour of the occurrence and managed to shift the lone injured occupant of the train to the Civil Hospital at Mettupalaiyam. Their subsequent assistance in extricating the dead bodies of other occupants of the train out of the debris and lifting them up to rail level from a depth of 16 metres in a difficult location before day light faded was praise-worthy.

IX. RECOMMENDATIONS

9.1 In my Preliminary Report submitted on 6-3-1982, I made a recommendation having a bearing on the operation of trains on the Nilgiri Mountain Railway for immediate consideration of the Ministry of Railways. Except that passenger services in the rack section remain suspended, I have not heard anything about the decision taken by the Government on that recommendation. I reiterate the recommendation (with slight variation) vide Annexure-I.

9.2 Southern Railway Administration may consider bringing out a Manual dealing with the various technical and operational aspects of working of trains on the rack and pinion system of locomotion, on the Nilgiri Mountain Railway for guidance of all categories of their staff connected with it.

Yours faithfully,
- Sd/-
B. P. SASTRY,
Commissioner of Railway Safety.

Bangalore,
30-4-1982.

ANNEXURE I

Recommendations referred to in Para 9.1 of the Report

On the basis of my inspection of the track in Kallar-Coonoor rack section and the 'X' Class locomotives operating in the section as well as the evidence at my disposal, I am of the opinion that in the present condition of the track and locomotives, particularly the condition of the rack and pinion arrangement between them, it is not safe to operate passenger services. Factors which have led me to this conclusion are briefly indicated below :

2. Design considerations

2.1 With the wheel arrangement on the 'X' Class locomotives and the cog wheel assembly fitted on to the locomotive frame the maximum lateral shift on a 17.5° curve (100 m. radius) which is the sharpest curve in the section is stated to be 15 mm.

2.2 The design of the rack bar assembly on the track and the pinion arrangement on the locomotive requires a theoretical lateral shift of 31.75 mm before the pinion gets disengaged from the rack bar by lateral displacement while the train is on run.

2.3 There is thus freedom to the extent of 16.75 mm for lateral play of the rack and pinion assembly on 17.5° curves due to all conceivable causes arising out of their maintenance.

3. Condition of the locomotives

3.1 The permitted maximum lateral play due to wear of pinion, shift of the pinion itself and the play between the frame and axle box on the locomotive is stated to be around 7 mm.

3.2 I have reason to believe that in the present condition of the locomotives, the permitted maximum lateral play is of common occurrence and evidence placed before me indicates a play of even 19 mm in an extreme case on a particular locomotive in the recent past.

4. Condition of the Permanent Way

4.1 The Civil Engineering Department has not prescribed any maintenance tolerances relevant to the rack section.

4.2 From the maintenance practice followed by the Permanent Way staff in the section, the clearance between the inner rail gauge face on a curve and the nearest rack bar is 452 mm against 455.75 mm required from design considerations of the rack and pinion arrangement. Even out of the 452 mm clearance, variations upto 6 mm are permitted in day to day maintenance as deposed by the Permanent Way Inspector. Variations upto 8 mm existed in the track as could be seen at certain locations checked, thus causing a lateral shift of the pinion by 11.75 mm on this account when the two factors become additive.

4.3 Versines taken at some locations indicate irregularities in the curves upto about 25°. From Vogel's diagram drawn for the wheel arrangement of the locomotive a 25° curve causes an additional 5.5 mm lateral shift of the pinions. This factor has thus the potential of causing an additional 5.5 mm to the lateral shift (beyond 15 mm for a 17.5° curve) on badly aligned curves.

4.4 Slack gauge in track contributes to lateral shift of the pinion and a 1941 study into the working of the rack system by a Swiss Locomotive Engineer at the instance of the then South Indian Railway Company recommended elimination of slack gauge on curves. At present, the practice is to provide 12 mm slackness on curves adding to the lateral shift.

4.5 Under dynamic conditions, the rack bar assembly in the track does yield laterally, the extent of yield depending on the condition of the wooden sleeper and the condition of the fittings with which the rack bar is fixed on the sleeper. This could be 4-5 mm under average conditions of wooden sleepers in the section at present.

4.6 The rack bars currently in use are of steel manufactured to ISS : 226 while the steel specified for rack bars corresponds to Class III-A steel with high tensile strength and yield value and low elongation. This factor causes fast undue wear of the rack bar grooves and the bars also easily yield laterally and vertically aggravating the already existing situation.

4.7 The wear on the inclination of the grooves on the rack bar in which the pinion teeth get engaged is at present considerable preventing contact between the rack and pinion which in turn reduces the load transmitted by the pinion on to the rack.

4.8 The situation in 4.7 gets further aggravated by the rack bars not being of exact longitudinal dimensions resulting in a gap between two bars. Due to manufacturing variations in the length of bars and creep of the bars in the assembly, a gap of as much as 6 mm between two bars was noticed at some locations which disturbs the pitch of the pinion teeth resulting in the pinion not getting engaged in the rack but travelling on the surface of the bar.

4.9 The difference between the rail level and the level of the pinion teeth on the locomotive is 63 mm but due to tolerances not having been prescribed for the Permanent Way the engagement between the pinion and the rack suffers when there is depression in the rack bar assembly for any reason whatsoever.

5. Present condition of the rack and pinion system

5.1 When the lateral shift brought about by various factors detailed in para 3 and paras 4.1 to 4.6 above become cumulative partly or in full under a given set of circumstances, conditions for disengagement between the rack and pinion by lateral displacement are created in the system. Similarly, when conditions described in paras 4.7 to 4.9 are additive, disengagement by mounting is the result.

5.2 Available evidence indicates that such 'disengagements' have been gradually increasing during the last few years and the present situation is such that on a single trip between Kallar and Coonoor, the number of such 'disengagements' a train suffers is as high as 25. The Express train which preceded the ill-fated 'Coal Special' was reported to have suffered 12 'dis-engagemnts' on its run between Kallar and Coonoor.

5.3 The process of 're-engagement' as practised by Drivers on the run causes violent oscillations of the pinion assembly which gets transferred to the rack bars and has the effect of damaging them, breaking the rack chairs and shearing the bolts, thus rendering the Permanent Way vulnerable for subsequent train when it remains unattended during the interval between two trains.

6. Remedial action needed

6.1 Before the rack and pinion arrangement can be termed 'safe' for the train services, some basic pre-requisites are to be complied with.

6.2 Maintenance tolerances for track as well as the locomotives relevant to the rack and pinion arrangement have to be fixed, keeping in view their respective design aspects and maintenance men have to rigidly observe them.

6.3 The rack bars now in track manufactured out of steel conforming to ISS : 226 should be replaced by bars manufactured to the correct specifications and all future supplies should be obtained from such high tensile steel only.

6.4 Wooden sleepers in good condition may continue for the time being as they are able to provide adequate grip on fittings but all replacements should be by steel trough sleepers with a properly designed mounting arrangement for rack bars.

6.5 Periodical joint inspection by an Assistant Mechanical Engineer and Assistant Engineer should be prescribed to ensure and certify that the prescribed tolerances are not exceeded either in the Permanent Way or on the locomotive.

6.6 The track does not have check rails on curves nor guard rails on bridges. This aspect needs a review from safety considerations.

7. I recommend that pending compliance of the items under para 6 above, the operation of passenger services in Kallar-Coonoor rack section may remain suspended.

8. The present schedule of one pair of passenger trains in the rack section with a capacity to haul hardly three coaches having seating capacity for less than 200 passengers does not meet even a small fraction of the large number of passengers (about 5000 daily on an average according to

one estimate) stated to be visiting the Hill station. Ministry of Railways may consider whether the 30 years old steam locomotives currently in use will need replacement by Diesel locomotives of sufficient haulage capacity with the latest design of gripping arrangements on this steeply graded section to adequately serve the needs of traffic to the popular Hill station of Udagamandalam (Ooty).

B. P. SASTRY
Commissioner of Railway Safety

VIEWS OF THE RAILWAY BOARD ON VARIOUS PARAS OF THE REPORT

4.3 Cause and responsibility for the accident

Subsequent to the accident, the interim report of an Expert Committee on the working of Neelagiri Mountain Railways was sent by GM/Southern Railway vide D.O. No. W(X)8/NM Rly. dated 12th July '83. The investigations done by this Expert Committee certainly and in better appreciation of the train accident under consideration. Vide para 5.3, page 40 the Expert Committee have brought out that they did not notice any tendency for dis-engagement of rack and pinion when a new set of pinions was used on the loco and meticulously maintained rack tolerances were used for the trials with engine No. X 37391. All the tolerances on the engine and the rack were kept within the new prescribed limits. The committee has further brought out vide para 5.5, page 42 that in the process of dis-engagement and subsequent attempt to re-engage, serious damage to rack bars and cog wheels is bound to be caused which if not immediately attended to and rectified, can lead to further dis-engagements, thereby setting in motion a vicious pattern of fast deterioration of rackbars and the pinion assembly on the engine. As regards brake power, the Expert Committee feels that in a down gradient of 1 in 12.5 with a trailing load of two loaded wagons and one coach the train at a speed of 13 Kmph could not be controlled by vacuum brakes alone but air brakes were essential. However, without the assistance from the Brakeman of trailing loads the train could be controlled with the help of air and vacuum brakes (para 5.6 page 42). They have also brought out that even if no brake on the loco is applied, handbrakes and rack brakes of the trailing loads alone are adequate to control the train (vide para 5.7).

CRS, Southern Circle has brought out the critical condition of the rack and pinion assembly, vide para 7.5 and 7.6. Although an engine repair book, in use, after 7-2-1982 had perished in the accident, the engine repair book from 1-2-1982 to 7-12-1982 indicated as many as 8 book-ings, all related to the defective pinion working on the loco. Similarly for the rack bar assembly no tolerances were specified by the Civil Engineering and the tolerances as noted by CCRS at Kms 12/11-12, 10/5-6 and between 13-14 Kms are in excess of the maintenance tolerances suggested by the Expert Committee. In Jan '82 as many as 29 cases of pinions getting dis-engaged from the rack bar and upto 22nd Feb. as many as 21 cases of pinion getting dis-engaged from the rack bar had occurred.

The observations of CRS, therefore, clearly indicate that conditions of the pinions and rack bar assembly were on the unsafe side.

Even the Driver of 36 Express which negotiated the wrecked section immediately ahead of the ill-fated goods train stated that as many as 12 dis-engagements were noticed for this train on that day i.e. 12-2-1982.

Keeping the above in view and also the following facts :

- (i) From Km 14 to Km 12/10-11 extensive damages to rack bar assembly were noticed (para 7.1.3 of CRS).
- (ii) The position of the brake gear as seen on the wrecked loco indicated that the Driver had applied vacuum brakes and had also sought to engage the pinions with rack bars. Two rack bars were also found entangled with the under-gear of the loco (para 7.1.5).
- (iii) Measurements taken at Kms 10/5-6 (not affected by the accident) indicated rack bar clearance variations upto 15 mm and height variations of rack bars upto 12 mm. At this kilometrage, there was evidence that there had been disengagement of pinion and consequent damage to the rack bar assembly, when 36 Express negotiated at a little earlier. This situation indicates that not only at Kms 10/5-6 but at other locations also, the Coal Special, which followed the Express had to negotiate such damaged locations thus making its movement vulnerable when it negotiated the same spots (Para 7.8.3 of CRS).
- (iv) The engine crew as well as brakesman had no record of previous accidents and were experienced men with sober temperaments;

Unfortunately none of the persons involved in the accident are alive to enlighten us regarding the cause of the accident. The facts of the case indicate that the train was being backed with the application of brakes as well as with the help of pinion and rack assembly. However, the pinion and rack assembly must have given way. This has resulted in sudden jerk to the train and in making the train roll down at an uncontrollable speed after which the crew could not make use of the pinion and rack. The train eventually came across a boulder in the cutting at Kms 12/10-11 and got derailed and finally fell down the bridge. Some parts of the locomotives, be-

sides some boulders, were found lying scattered by the side of the track just short of the point of mount indicating the accident with the boulder.

Therefore, the cause of the accident is the failing of pinion and rack assembly and no individual can be held responsible.

Para 5(a) i—Rack and pinion arrangement

The C.R.S. recommendations No. 6.1 that before the rack and pinion arrangement can be considered safe for the train services, some also basic pre requisites are to be complied with, is noted.

Para 5(a) ii—Maintenance tolerances for track and locomotives

The CRS's recommendation No. 6.2 reproduced below is accepted :—

“Maintenance tolerances for track as well as the locomotive relevant to the rack and pinion arrangements have to be fixed, keeping in view their respective design aspects and maintenance men have to rigidly observe them.”

Instructions have been issued to Southern Railway accordingly.

Para 5(a) iii—Rack bars

The CRS's recommendation No. 6.3 that rack bars now in track manufactured out of steel conforming to ISS 226 should be replaced by bars manufactured to the correct specifications and all future supplies should be obtained from such high tensile steel only, has been carefully considered by the Board. Expert Committee appointed by the Southern Railway has opined that mild steel 25 mm rack bars are a fairly good substitute to the original rack bars, and that even earlier rack bars were conforming to class III A or Class IV of IS 1875/1971, which is not significantly different from mild steel. Also keeping in view the difficulty of getting high tensile steel indigenously, high cost of replacement of rack bar—Rs. 10 to 12 lakhs per Kms., Board are unable to accept the above recommendation as such. The Southern Railway would, however, be directed to consult Metallurgical Directorate of RDSO regarding suitable quality of steel for rack bar, and to carry out trials with recommended steel for about 1/4 Km. length. Further action could be taken on the basis of performance and cost evaluation.

Para 5(a) (iv)—Replacement of wooden sleepers

Since M.G. steel sleepers are not rolled in the country and it is not possible to establish production of M.G. steel sleepers for such a small requirement, there is no alternative to the use of hard wood sleepers. As recommended by CCRS Board agree that emphasis would have to be on their being in good condition.

Para 5(a) (v)—Periodical Joint inspections.

Southern Railway Administration have since prescribed monthly inspection by an Asstt. Mechanical Engineer and an Asstt. Engineer as recommended by C.R.S. This has been noted by CCRS.

Para 5(a) (vi)—Check rails on curve.

Board have carefully considered the CRS's recommendation that question of providing check rails on curves and guard rails on bridges (not provided at present) need a review. The Expert Committee has examined this question and have not favoured the provision of check rails in view of elaborate fixtures that would be necessary, low speed on the section, wear on curves not being a serious problem and difficulty in maintaining rigid check rail clearances with the type of locomotives working on the section. In regard to provision of guard rails the recommendation is accepted in principle. Southern Railway has been instructed to provide guard rails on a trial measure on 4 bridges and on the basis of experience to extend the practice on all bridges.

Para 5(a) (vii)—Operation of passenger train services on Kallar-Coonoor Section

As per CRS's recommendation No. 7, the operation of passenger services on Kallar-Coonoor Section was kept suspended.

Para 5(a) (viii)—Provision for Diesel locomotives.

Replacement of steam locos with Diesel locos incorporating the latest design of grip arrangements would depend on the availability of funds.

Para 5(b)—Bringing out a unified manual incorporating all the technical and operation aspects.

This recommendation has been accepted and necessary instructions have been issued to Southern Railway.

Price : Inland Rs. 26.00
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