Chapter 2 - Planning and execution of track maintenance

Audit Objective 1: Whether the maintenance of tracks was planned and undertaken following the laid down norms and keeping in view the instructions of Railway Board?

2.1 Planning track maintenance

Maintenance planning include planning for manual as well as mechanised maintenance of track sections. These include activities to be undertaken on a regular basis within a year (regular maintenance) and activities which are undertaken after a year (periodical). The compliance of the prescribed procedures relating to planning for manual as well as mechanised maintenance of tracks was examined in the selected 37 sections of five Zonal Railways (NCR, SWR, SR, ECR and SER). The audit findings are discussed below:

2.1.1 Perspective Plan for manual track maintenance by sectional officials

As per laid down provisions[22], every P-way Inspector must prepare a perspective maintenance plan of his section one month in advance. The plan should include, apart from normal inspection, inspection of point and crossings, curves and level crossings, realignment of curves, deep screening, casual renewal, renewal of points and crossings, welding of joints, de-stressing of long welded rails, etc. so that optimum utilization of time and labour resources becomes possible. It was observed that

- In selected sections of SWR and SR, perspective maintenance plan and annual inspection plan were being prepared by the P-way Inspectors.
- In NCR advance perspective maintenance plan were not prepared. Advance monthly planning for realignment of curves, adjustment of creep, deep screening, casual renewal of points on crossing, welding, distressing, etc. was not carried out.
- In ECR, perspective maintenance plans were not prepared. Maintenance Schedule prescribes planning maintenance works as a preventive measure, whereas, SER was doing rectification of deficiencies on inspection.

2.1.2 Annual Plan for mechanised maintenance through Track Machines

For sections nominated for mechanized maintenance, annual plan for deployment of various track machines is to be finalized by Chief Track Engineer (Machine)/ Chief Track Engineer of the Zonal Railway who are required to arrange deployment of machines accordingly. Concrete sleeper track is required to be

[22]Para 205 of Indian Railway P-way Manual

maintained by heavy on-duty track tampers[23]. An annual machine deployment programme is to be drawn by Zonal Railway and circulated to the divisions before the beginning of the year. Compliance of these laid down provisions was checked in the selected sections and it was observed that

- In NCR, Annual Plan 2016-17, for deployment of various track machines was delayed and circulated to Divisional offices on 29 April 2016. Further, deployment plan of various track machines was not intimated in advance to concerned ADEN and SSE by the Divisional offices.
- In ECR, Annual Plan 2016-17, for deployment of various track machines was prepared and finalized division wise instead of section wise as per the norms.
- In SER, Annual Plan 2016-17, for deployment of Track Machines was prepared and finalized by Chief Engineer at headquarters level and communicated to the Divisional Engineers, but not to the concerned Sectional P-way Inspectors.

As a result, P-way Inspectors of selected sections who are primarily responsible for maintenance of tracks in the sections assigned to them were not aware of the Annual Plan in advance for actual deployment of track machines in their sections. In SWR and SR, annual plan for deployment of track machines were being prepared in advance and as per the norms.

It was further seen that in selected sections of NCR, maintenance activities were not fully mechanized. Maintenance activities like de-stressing of LWR, laying and welding of rails and deep screening of ballast were carried out both with the machines and manually.

The Expert Group for Modernisation of Indian Railways in its report recommended (February 2012) 100 *per cent* mechanised track maintenance on routes[24] A and B for superior quality of track laying and maintenance. However, all the selected sections covered in Audit are of route A or B, but track maintenance of these sections was yet to be fully mechanised.

2.1.3 Annual Programme for track maintenance

As per laid down rules[25], the annual programme of regular track maintenance and works incidental thereto includes the following:

[23] Track tamper is a machine used to pack the track ballast under railway tracks to make the tracks more durable (Para 1408 (3) of Indian Railway P-way Manual)
[24] Para 202 of IRPWM classifies broad gauge line of IR into six groups A to E on the basis of future maximum permissible speed (RB letter no. 2003/CE-II/TS/2 Part I dated 15 Feb 2008)
[25] Para 203, 204 of Indian Railway P-way Manual

Table 3– Annual Programme for track maintenance		
S. no	**Period**	**Work**
1.	***Post monsoon attention***: For about six months after end of monsoon	a. Attention to run down lengths in the entire gang beat to restore the section to good shape. b. One cycle of conventional systematic through packing/systematic directed track maintenance from, one end of the gang length to the others including overhauling of nominated sections. c. Normally four to five days per week should be allotted for works under item b and the remaining days for picking up of slacks, attention to bridge approaches, level crossings and points and crossings over the entire gang beat. Works such as lubrication of rail joints, joint gap adjustments as required and realignment of curves should be done during this period.
2.	***Pre monsoon attention***: For about 2 months prior to break of monsoon.	Normally two to four days in a week should be devoted to clearing of side and catch water drains, earthwork repairs to cess, clearing water ways and picking up slacks. In the rest of the days normal systematic maintenance will be carried out.
3.	***Attention during monsoon:*** For about four months	Attention to track as required. This will consist primarily of picking up slacks and attention to side and catch water drains and water ways. During abnormally heavy rains, patrolling of the line by gangs should be carried out in addition to regular monsoon patrolling.

Further, scattered renewals and earth work repairs is to be done as necessary. For maintenance schedule on Long Welded Rails (LWR)/Continuous Welded Rails (CWR)[26], special instructions in the LWR/CWR Manual[27]are to be followed.

During the review of records related to selected sections of five Zonal Railways, audit noticed that

- In NCR, all schedules and frequency of inspection and maintenance were fixed in Track Management System (TMS). Pre-monsoon and post-monsoon activities were not mentioned in the Annual Plan and only need based inspection was carried out in monsoon season. However, no cases of delay in lubrication of rail joints, joint gap adjustments and realignment of curves were noticed in selected sections of NCR.
- In ECR, specific inspection programme for pre-monsoon, post-monsoon and during monsoon were not prepared. However, work like lubrication of rail joints, joint gap adjustment and realignment of curve, etc. were included in

[26]Long Welded Rails (LWR) of length 260 meters are joined together through welding to make Continuous Welded Rails (CWR) of longer lengths

[27]LWR / CWR sections require closure monitoring, inspection and maintenance due to variation and impact of temperature. Thus, Special instructions for Track Maintenance in LWR /CWR Section given in Manual of instructions on Long Welded Rails - 1996.

the gang chart and additional patrolling of tracks by gangs during abnormally heavy rains were conducted.

- In selected sections of SWR, regular track maintenance activities were conducted as per prescribed provisions. However, in Gadag-Hospet section and Kanginhal station the lubrication of rail joints was due during August and October 2016, but not done up to April 2017.
- In selected sections of SR, Annual Track Machines programme was prepared and circulated as per norms. Pre-monsoon and post-monsoon patrolling/maintenance activities were carried out. Lubrication of rail joints, adjustment of rail joint gaps, etc. were done. Track Tampers were used wherever necessary in the maintenance of track.
- In SER, it was noticed that there was no annual programme of track maintenance.

During Exit Conference (30 August 2017), Railway Board stated that in the present scenario, where track maintenance has become more and more mechanized, perspective planning for track maintenance entails machine deployment, identification of areas for deep screening, casual attention of track, etc. This is required to be done at Zonal Headquarter level (by CTE and CE (TM)) and then disseminated at the level of division and further communicated to sectional level viz., AEN/SSE. It was further stated that preparation of perspective plan by P-way inspector is not relevant for such activities. P-way inspector is required to plan locally for manual maintenance works such as oiling, greasing, etc. Audit is of the view that perspective planning in advance is required for both non-mechanized maintenance (to be conducted by the sectional officials) as well as for mechanized maintenance (to be conducted by the Zonal Headquarters). The mechanized maintenance requires the assistance of official in-charge of section. Further, as all items for mechanized maintenance have not been completely implemented over the high density network as seen during audit of selected sections and a mix of mechanized and non-mechanized maintenance is undertaken, a comprehensive advance perspective maintenance plan is required. This is required to be communicated timely to the official in-charge of sections who shall then prepare the comprehensive advance perspective plan incorporating the information received from Zonal Headquarters. This advance perspective plan is a functional requirement for planning, implementation as well as monitoring of track maintenance activities.

Thus, planning for track maintenance needed to be done comprehensively. Efforts to expeditiously cover maximum sections and maximum activities under

mechanized maintenance should be made both at planning and implementation stage.

2.2 Undertaking track maintenance

Besides, preventive and periodical maintenance, condition monitoring of track is undertaken by IR using a variety of means (both manual and mechanized). Officials and equipment with RDSO, Zonal Headquarters, Divisional Headquarters, Sectional formations are used for the purpose. This includes condition monitoring of track, detection of flaws in track conducted both through inspections as well as through use of machines/equipment. Monitoring of various track parameters such as rail fractures and weld failures also enables undertaking measures to address the deficiencies and defects noticed/detected by replacing rails, sleepers, ballast, etc. or imposing speed restrictions till the flaws are rectified.

2.2.1 Periodical maintenance activities - condition monitoring

Indian Railways has a laid down mechanism through which the track is inspected either visually or using equipment/machines in order to detect flaws in various component of tracks. This includes patrolling by patrolmen. Periodic inspections are required to be done by ADEN and SSE to check track conditions. They also use equipment such as Ultrasonic Flaw Detection machine, Track Recording Car, etc. to detect flaws in the track. Corrective actions are initiated to rectify the flaws detected during inspection and through use of these machines/equipment.

2.2.1.1 Patrolling of track

Railway tracks are patrolled to ensure the safety of the track and of the traffic moving over it. Patrolling basically involves to and fro movement of the patrolman/ watchman along the track as per the specified programme in order to look out for any unusual occurrence that may threaten the safety of the track.

Various types of patrolling include daily patrolling, patrolling during abnormal rainfall or storm, night patrolling during monsoon, hot weather patrolling, cold weather patrolling etc. The patrolling is done by track maintainers (keyman, gangman, trackman) also called patrolman, as per the beat allotted to them.

Beat is the portion of the track that a patrolman patrols. Beat of two kms in single line and one km in double line has been fixed for cold and hot patrolling as per Indian Railway P-way Manual. The patrolman walks over his beat slowly along one rail in one direction and on the other rail in the return direction. On double lines, he repeats this procedure alternately on the Up and Down tracks. He watches out for rail and weld fractures. He also keeps an eye on the gaps at the switch expansion joints at the ends of the LWR. The walking speed of a patrolman may

be taken as 3 kms per hour and the maximum distance covered by a patrolman should not normally exceed 20 km in a day.

Audit reviewed patrol books maintained in the SSE offices over the selected sections of five Zonal Railways to analyse the extent of beat allotted to track maintainers for patrolling. Audit noticed that

(i) In NCR, patrolling chart maintained in the office of SSE/Firozabad revealed that beat of the patrol men was not restricted to one km length of UP and DN line on double line section. The beat of patrolman was up to 2.75 km (UP and Down line - 5.5 km). However, in other SSE offices, beat were restricted as per the norms.

(ii) In SER, the beat of patrol men was not restricted to one km in the office of SSE/Santragachi and SSE/Kolaghat and ranged between two kms and five kms in Up, Mid and Down line.

(iii) In SWR, in all the sections reviewed in audit, beat of patrol men was not restricted to one km length of Up and Down line section and it was up to five kms per person with two rounds per day.

(iv) In SR and ECR, no deficiency was noticed in the allotment of beat to the patrolmen.

(v) Audit further noticed that patrol men were not equipped with any communication equipment to report any failure, fracture or damage immediately from the section where shortcomings and defects in track were observed.

During Exit Conference (30 August 2017), Railway Board stated that the beat of patrol men could not be restricted to one km due to shortage of patrol men in all Zonal Railways.

Audit is of the view that the shortfall of patrolmen is within the control of Railways and being a safety related aspect needs to be seriously addressed.

2.2.1.2 Inspection by Section Engineer (also called P-way Inspectors)

Rules[28] prescribe routine inspection of track of the entire section by SSEs by push trolley at least once in a month or more often as necessary. Inspection of the SSE include

1. Inspection of Gangs covering
    a. Check of the work done by gang, their recording and to ensure prompt action on items requiring attention

[28] Para 124 of Indian Railways P-Way Manual

b. Examination of small machines (fortnightly) and examination of gang tool (monthly) including arrangement for their repair and replacement.

2. Inspection of level crossings to examine the condition of rails, sleepers and fastenings and ensuring the defects are rectified; check the equipment with the Gateman and their knowledge of safety rules; and

3. Inspection of Points and Crossing and Curves

The SSE is required to maintain an inspection diagram of all the inspections carried out during the month as per the schedule and to submit the same to the Divisional Engineer through Assistant Engineer every month bringing out the reasons for shortfall in adhering to schedule of inspections, if any.

As per laid down rules[29], SSE is directly responsible for the safety of the track. He shall be vigilant to locate faults in the P-Way and promptly rectify them. He should bring to the Assistant Engineer's notice, track defects which are beyond his powers to rectify. Rules[30] also provide that SSE should arrange for patrolling of track as laid down through suitable gangmen and to arrange for necessary equipment. SSE should check the night patrolman once a month by train and by trolley during monsoon as per the prescribed schedules.

During the review of the compliance of schedule of above inspections in the selected sections of five Zonal Railways, the following was observed:

(i) In NCR, routine inspection of SSE was carried out and inspection notes were submitted to ADEN. However, surprise test check of patrolling was not conducted at all.

(ii) In SER and ECR, Inspection Note of SSEs were not prepared. In ECR, action taken and compliance of Inspection Reports was not entered in the TMS whereas in SER action taken and compliance of Inspection Reports was not found on record. Thus, compliance of inspection could not be monitored by Assistant Engineer.

(iii) In SWR, all SSEs carried out routine inspections of Track as per the Indian Railway Permanent Way Manual (IRPWM) and irregularities noticed, if any, were recorded and reported to ADEN, during the review period. All SSEs deputed suitable men from gangs and required Patrol Books and necessary equipment such as Simplex Jacks, tools, flags, detonators, torches, etc. - were provided to the gangs.

[29]Para 125 of Indian Railway P-Way Manual
[30] Para 126 of Indian Railway P-Way Manual

(iv) In SR, routine inspection of track, reporting of deficiencies to higher level officials, conduct of patrols, check of patrolmen by SSE, pre-monsoon and post-monsoon patrol, etc. were carried out as per schedule.

During Exit Conference (30 August 2017), Railway Board stated that inspection shortfall are mainly due to shortage of SSEs.

Audit is of the view that the shortfall of SSEs being a safety related aspect needs to be properly addressed.

2.2.1.3 Inspection by Assistant Divisional Engineer (ADEN)

Rules[31] provide that the ADEN shall conduct inspection in his jurisdiction as per the schedules laid down by the Zonal Railway Administration from time to time. He should maintain the records of the results of his inspection and ensure compliance of the instructions within a reasonable time. He should submit copies of the inspection diagram at the end of every month to the Divisional Engineer indicating the inspection carried out during the month. He should also scrutinise the registers maintained by P-way Inspector and see whether the schedules of inspection are being adhered to by the Inspectors and whether the necessary follow up action is being taken.The following inspections are prescribed[32] to be carried out by the ADENs:

Table 4 – Inspections schedule for ADENs

Type of Inspection	Details of inspection
Trolley Inspection	Entire sub-division once in two months. Work of minimum one gang in each SSE's jurisdiction every quarter
Fast Train Inspection	Entire sub-division once in a month.
Checking of curves, points and crossings	One curve in each SSE's jurisdiction every quarter and all points and crossings once a year on passenger lines
Monsoon Patrolling	Work of Patrolman at night once in a month
Inspections of LWR/CWR Track	Switch Expansion Joints (SEJs)/Buffer rails provided in the LWR/CWR track once in every six months.This implies that every SEJs/Buffer Rail[33] within the jurisdiction of ADEN should be inspected after every six months. This gets converted to number of LWR to be inspected every month.

(a) Shortfall in inspections

During the review of records in connection with the adherence to the inspection schedule as mentioned above, the following was noticed:

[31] Para 106 of Indian Railways P-Way Manual
[32] Para 107 of Indian Railways P-Way Manual
[33] SEJs/Buffer rails are used at the end of LWRs for thermal expansion. Butter rails are ordinary rails of a much higher standard. SEJs involve use of switch for the purpose.

- Check of records of monthly inspection charts of ADEN revealed that there were shortfalls in inspections conducted by ADENs in NCR as given below:

Table 5 – Deficiencies noticed in conducting inspections by ADENs during 2016-17[34] in NCR

Name of the Selected Section	Related ADEN	Types of inspection	Details of inspections not done along with section
Jeonathpur – Mughalsarai /	ADEN, Chunar	*Push Trolley inspection*	UP line of Jeonathpur – Kailahat section in January to April 2016
		Curve inspection	Entire jurisdiction of ADEN during January to March 2016.
Naini - Cheoki	ADEN, Mirzapur	*Push Trolley inspection*	UP main line section of Meja Road - Naini during January and February 2016 and DN line of Vindhyachal – Unchdhi section during January to April 2016.
		Foot plate inspection	DN line of Jhingura – Naini during January and February 2016 by ADEN, Mirzapur.
Allahabad - Kanpur	ADEN, Line, Allahabad	*Push Trolley inspection*	UP line of Bharwari – Shujaatpur and DN line of Bamhrauli – Manoharganj during January – February 2016
			UP line section of Bharwari – Sath Naraini in the month of March and April 2016
		Foot plate inspection	Allahabad- Sath Naraini in DN line in the month of January 2016 to April 2016
Juhi – Kanpur, Panki – Jhuhi, Jhuhi – Kanpur and Panki - Shikohabad	ADEN, Line, Kanpur	*Push Trolley inspection*	Goods Marshalling Yard Kanpur (GMC) – Rura section during January – February 2016 and in DN line during March – April 2016.
		Foot plate inspection	GMC – Rura section in January – February 2016
		Inspections of LWR	For the Year 2016 out of 110 inspections of LWR 40 inspections were carried out in same month of planning. Remaining 70 inspections were not done in planned month and conducted in later months.
		Inspections of Curve	Out of 48 curve inspection planned in 2016 only one inspection of curve was not delayed. Remaining were delayed by a month.
Shikohabad - Panki	ADEN, Etawah	*Push trolley inspection*	Phaphund – Ghasa during March – April 2016.
Tundla - Shikohabad	ADEN, Firozabad	*Push trolley inspection*	UP main line section between Bhadan – Shikohabad during January –February 2016
		Foot plate inspection	UP main line section of Jaswantnagar – Shikohabad during January – February 2016

As seen in Audit, inspections were not carried out as per scheduled plan in the above sections of NCR. All the above sections are heavy traffic route and required frequent and regular inspections to detect flaws in track. Audit further noticed that in the selected sections, though inspections of SSE offices,

[34] Inspection programmes of ADEN are prepared and updated in TMS on the basis of calendar year i.e. January – December. Therefore, shortfall in inspection noticed in Audit during January 2016 to March 2016 were included in Audit findings. The results of inspection of last quarter of 2015-16 consequently fall in 2016-17 and that of 2016-17 (last quarter) in 2017-18.

stores and small machines were conducted by the ADEN as per the plan, the inspection notes were not updated in TMS.

- In ECR, in respect of non-HDN route, 415 inspections were done out of 1834 inspections due, leaving a shortfall of 1425 inspections (78 *per cent*), which were mainly in inspection of LWR, points and crossings. In respect of HDN routes, out of total 793 inspections due to be done (LWR, Points & Crossings, Curves, etc.) 767 inspections were done. However, there was a shortfall of 11 *per cent* in inspection of LWR.
- No shortfalls in inspection of ADENs were noticed in the selected sections of SER, SWR and SR during 2016-17.

During Exit Conference (30 August 2017), Railway Board stated that though ADENs are responsible for maintenance of track, they are also given the responsibilities relating to punctuality, cleanliness, protocol duties, special drives, etc. This results in arrears in their scheduled activities of inspection. Audit is of the view that Railways need to address this issue so that ADENs are able to provide due attention on their primary responsibility of track maintenance.

Shortfall in conducting inspections as per prescribed norms, deficiencies in conducting inspections and not preparing notes of inspections in the HDN routes test checked in Audit are areas of concern, which Railways need to address expeditiously.

(b) Use of GPS based device for safety inspections

It was further seen during foot plate/ brake van/ inspection car/ Push trolley/ motor trolley inspections, a GPS based device can be used for marking and storing the location of track defects. The GPS based foot plate inspection device[35] consists of a GPS receiver and a recording unit. The device stores the location ID of defects which can be retrieved on graphic LCD display in terms of latitude and longitude. Defects of un-evenness of track, ballast deficiency, bad weld, weeds on cess, loose packing, etc., are some of the defects which can be marked through the device. These devices are thus useful for effective monitoring of safety inspections. It was observed that GPS based Foot plate inspection device was not procured by any of the selected five Zonal Railways and inspection of track was carried out through traditional means.

During Exit Conference (30 August 2017), Railway Board stated that assets of Indian Railways are not on GPS platform.

[35] RDSO has finalized the specifications for this device vide specification no. TM/SM/326 dated 03.07.2012

Audit is of the view that Railways need to use GPS based inspection device for inspection purpose. This would also facilitate effective monitoring of safety inspections.

2.2.1.4 Testing using Ultrasonic Flaw Detection (USFD) machine

The USFD manual prescribes a need-based concept of USFD testing[36] of rails, under which the rails already laid in track will be tested after the passage of eight gross million tonne (GMT) of traffic. In this method, by sending an ultrasonic signal directly into the rail and measuring the time it takes for the signal to bounce back, cracks can be located. Since a crack prevents the signal from reaching the base of the rail, it will bounce back more quickly, alerting the inspector to its presence.

Departmental USFD testing of rail is carried out under control of Sr. Divisional Engineer, Co-ordination. He is assisted by Divisional Engineer Track and SSE, USFD. At the field level USFD team headed by Senior Section Engineers take care of day to day operations of USFD testing. Further, quality check of USFD testing is carried out by the concerned ADEN by 5 *per cent* test check of the section. Rules[37] provide that the Inspectors carrying out the ultrasonic testing of rails shall be trained by RDSO, in the techniques of USFD testing. Each Zonal Railway shall create adequate number of *ex-cadre* post of Inspectors to ensure that entire track length in their jurisdiction is ultrasonically tested as per laid down periodicity. Railway Board (May 2015) also instructed to train all DENs/ADENs handling USFD Machines independently. In April 2015, Railway Board expressed[38] concern over increasing arrears in the USFD testing due to non-finalization of agency for outsourcing. Railway Board also expressed serious concern on outsourcing of safety critical USFD work and felt that outsourcing by Zonal Railways may be resorted to only as an interim measure to clear the increased workload due to increase in frequency on account of increased traffic density, etc. and not as a regular measure.

(i) Audit reviewed the utilisation of USFD machines over 37 selected sections of five Zonal Railways. It was observed that

- Over selected sections of NCR, USFD testing was carried out by ten departmental teams under the control of DEN/Track Allahabad**.** Workshop for training and working of USFD testing was organised and all Sr**.** DEN/DEN /ADENs were trained to handle USFD machines**.** In SWR, only DENs/ADENs of Hubli Division were trained in the Workshop organized in February 2017.

[36] Analog and digital
[37] Para 3 of Revised USFD manual
[38] Railway Board letter No.Trackl21/200410902/7/Vol. Il dated 22 April 2015

- As per rules[39], no rail untested by USFD is to be laid in the track whether for new lines or layouts or renewals or for repair works. For repairs and casual renewals a location wise creation of stock of tested rails of various lengths has been prescribed for each SSE. These USFD tested rails should be kept segregated in a lot and each such rail should be paint marked on the flange from each end as 'USFD tested'. In NCR, instructions for preparation of location wise stock of USFD tested rail was issued from time to time by divisional and Zonal offices. However, check of records of SSE and ADEN offices of selected section revealed that location-wise stock of USFD tested rails was not made and no system existed to ensure that only USFD tested rails were used for repair and casual renewal work.
- As per provisions[40], railway staff should test check five *per cent* of the testing done by the contractor, within 25 *per cent* time period of frequency of USFD testing done in that section or one month whichever is earlier. Further, if any new flaw is detected which was left out by the contractor during testing; the whole length of track (Track length of 50 kms) should be tested again by the contractor without getting any extra payment for the same**.** In all selected section of NCR (ADEN – Allahabad, Firozabad, Kanpur, Mirzapur, Aligarh, Etawah, Chunar) and SWR where the USFD testing was carried out by the contractor, five *per cent* test check was not conducted by the concerned ADEN. Consequently, this impacted the assurance of the quality of USFD testing carried out through outsourcing. This check was carried out in SER and not required in SR and ECR, as USFD testing was done departmentally.
- As per RDSO's guidelines, provision for capturing scanned images/peak patterns should exist in the USFD machine to save the scanned data for use as and when required by the operators**.** However, over selected section of NCR and ECR, scanned images /peak patterns was not saved by the USFD teams**.** Thus, scrutiny/analysis by concerned supervisory officers was also not possible during successive USFD tests**.** As such, the system of 5 *per cent* test check by ADEN has been rendered redundant, as post check comparison of output of the USFD test by the outsourcing agency between the two tests was not possible. In SR, the USFD was being done departmentally and in regard to capturing of scanned images/peak patterns, no failure was noticed. In SER and SWR, scanned images/peak patterns of USFD Testing were saved for the test conducted by contractors. In respect of Departmental USFD Team, Scanned images/

[39]Para 252(4) of Indian Railways P-way Manual
[40]Para 16 of Special Condition of the Contract

peak patterns were saved only in cases of welds and rails requiring immediate replacement. The non-saving of other images/peak patterns were attributed to shortage of staff. This is not convincing as no additional manpower is required to save images/patterns.

(ii) Further, as per codal provisions, new weld should be tested as soon as possible through USFD and after 1st testing it should be entered in USFD schedule for next testing. It was seen that

- In Kharagpur Division of SER, 3299 new welds were done contractually during April 2016 to Dec 2016. Of these, only 763 welds were USFD tested and balance 2536 welds were not tested till March 2017.
- In SWR and NCR, in selected sections, cases were noticed where new welds were not tested by USFD within 30 days of welding. In SWR, testing of 40 welds out of 350 welds (during the period covered in Audit) was done beyond 30 days with delays ranging between four to eight months. In NCR information regarding date of testing of new weld was not recorded in the jurisdiction of ADEN/Kanpur in all cases and by ADEN/Chunar in 23 cases. Information was also not maintained over NCR by ADEN/Mirzapur and ADEN/Etawah. In jurisdiction of ADEN/Mirzapur and ADEN/Etawah, three and two welds respectively were seen from weld failure report where delays were up to 19 days. In ECR the new welds were being tested by USFD machine within 30 days.
- In SR, USFD testing was done as per schedule and the same was monitored by SSE/USFD nominated for the purpose.

(iii) A number of cases of failure of rail facture/weld failure during 2016-17 were detected within 30 days of these having undergone USFD testing. The details of these are given below:

Table 6– Number of rail fracture/weld failure within one month of USFD testing during 2016-17 over selected sections

Zonal Railway	Numbers	Remarks
NCR	50	--
SER	21	In 19 cases, the result of USFD testing was found satisfactory during the course of USFD testing
SWR	10	The USFD test preceding the event indicated the result of such a test as good.
ECR	6	--
SR	1	--

Incidence of failure was seen within three to 30 days of USFD testing, which showed deficiency in quality of USFD testing. In one particular case of ECR, where a train accident occurred on Buxar – Ara section on 25 July 2016, Audit noticed that USFD testing of the section was carried out at a twelve month interval,

whereas USFD testing of the section should have been carried out every three months as per provisions[41] as the GMT of Buxar – Ara section (non – HDN route) was 39.274. It was further seen that enquiry report of the accident mentioned the final cause as 'Multiple rail fracture and slackness in supervision'.

During Exit Conference (30 August 2017), Railway Board stated that at present, the USFD testing plan are uploaded in the TMS and results/ report of testing are also put into the system. The alert for the arrears is also displayed in the dashboard for monitoring purposes. It was also stated that there is an option to save scanned images/ peak patterns of the USFD test undertaken. The response does not address the audit findings specifically. As observed in audit, despite existence of the facility for saving the images, the same was not being utilized in the selected sections of NCR and ECR.

Thus, there were shortcomings in USFD testing being done. Timely USFD testing could help detect the vulnerable points and accidents can be avoided.

2.2.1.5 Recording of track using Track Recording Cars

The Track Machines and Monitoring Directorate of RDSO monitors the track using Track Recording Cars[42] (TRC). The main purpose of these special carriages is assessment of the condition of track, identification of locations needing maintenance and providing data to Railway Board and Zonal Railways. While track geometry monitoring of Metre Gauge routes[43] is not to be done by TRCs, the Broad Gauge routes should be monitored by TRC as per the following frequencies (except for the routes where track recording has been dispensed with):

Table 7 – Frequency of track recording prescribed	
i) Routes with existing speeds above 130 kmph	Once in 2 months
ii) Routes with existing speeds above 110 kmph and up to 130 kmph	Once in 3 months
iii) Other Group 'A' and 'B' routes	Once in 4 months
iv) Group 'C', 'D' and 'D Special' Routes	Once in 6 months
v) Group 'E' and 'E Special' Routes	Once in 12 months

On receipt of track recording car programme from the RDSO, the Zonal Railways should arrange for suitable power and path along with telecommunication arrangement between the track recording car and the locomotive[44]. The Headquarters should advise the Divisions concerned for making necessary arrangements to ensure that the Track Recording Car has an uninterrupted run.

[41] Para 3 of Revised USFD Manual- where GMT is between 30 and 40, the USFD testing should be done quarterly
[42] These include five Microprocessor Based Track Recording Cars, one LASER based contact less sensors TRC and one Rail Profile Inspection & Analysis System
[43] Para 606 ofIndian Railway P-way Manual
[44] Para 609 of Indian Railway P-way Manual

The Divisional Engineer, Assistant Engineer and P-way Inspector of the section and nominated officer/staff of Headquarters office should accompany the Track Recording run[45]. The recording speed range of a Broad Gauge car is 70-80 kmph. The recording done below these speeds are taken as 'non-recorded'. For obtaining comparable results between successive recordings, it is necessary to run the TRC at a uniform speed. The TRC must run on through lines of all stations. Recording should be done during day light hours. Spots (kms) requiring immediate attention, indicated by large peaks should be noted down by the Assistant Engineer/P-way Inspector accompanying the car and immediate attention should be given to these spots without loss of time[46].

(i) Check of records of annual deployment plan of TRC at Track Machine & Monitoring Directorate, RDSO, Lucknow for the year 2016-17 revealed that track recording was not conducted as per plan due to non-availability of adequate number of TRCs. There were only four[47] TRCs in the RDSO for recording of entire track of Indian Railways. The details of functioning of these four TRCs during the year 2016-17 are mentioned below:

Figure 3: Track Recording Car

Table 8 - Deployment of Track recording Cars over BG sections of Indian Railway during 2016-17

Month	Track recording in Km			
	TRC 7965	*TRC 7967*	*TRC 7968*	*TRC 7969*
April 2016	3604	3185	3658	Under repair
May 2016	2784	3332	Under repair	Under repair
June 2016	1292	915	Under repair	4626
July 2016	3149	3582	Under repair	3171
Aug 2016	1993	Under repair	Under repair	Under repair
Sep 2016	2619	Under repair	Under repair	3631
Oct2016	3441	Under repair	Under repair	2650
Nov 2016	Under repair	Under repair	Under repair	Under repair
Dec 2016	4575	3080	Under repair	Under repair
Jan 2017	5037	Under repair	Under repair	4934
Feb 2017	4115	3835	Under repair	871
Mar 2017	2895	6309	Under repair	Under repair
Recording plan cumulative (kms)	**36581**	**24621**	**3645**	**20265**

[45]Para 610 of Indian Railway P-way Manual
[46]Para 611 of Indian Railway P-way Manual
[47]TRC 7965, TRC 7967, TRC 7968 and TRC 7969

Table 8 - Deployment of Track recording Cars over BG sections of Indian Railway during 2016-17				
Month	Track recording in Km			
	TRC 7965	*TRC 7967*	*TRC 7968*	*TRC 7969*
Actual run cumulative (kms)	**35504**	**24238**	**3658**	**19883**
Short/excess cumulative (kms)	***-1077***	**-383**	**13**	**-382**

From the above table, it can be seen that three of the four TRCs available with RDSO were under repair for substantive part of the year and one TRC was run only during one month in 2016-17 and remained under repair for the entire year. Out of the total recording plan of 85112 km, the four TRCs covered 83283 kms with only a shortfall of 1829 kms, because no track recording was planned in the months when TRCs were under repair. As per the report for the year 2016-17 of the Track Monitoring Directorate of RDSO, total liability of track recording on IR was around 1,95,000 track kms.

(ii) Audit further observed that

- In NCR track recording was conducted once against required four runs in 2016-17. TRC did not have an uninterrupted run over selected sections of NCR and the speed of TRC was also not uniform**.** Thus, comparable results between successive recordings were not produced by TRC**.**
- In SER, TRC was run once in selected sections against four scheduled runs to be conducted in a year in HDN route (A route). No TRC run was done during the last three years in Santragachi-Tikiapara and Tikiapara – Howrah section as the TRC starts its journey from Santragachi onwards. TRC run was not done in the selected non-HDN routes during the year 2016-17.
- In ECR, track recording were not conducted as per frequency prescribed. In both HDN sections (A route) and non-HDN sections (B route), TRC was run two times during the year 2016-17 against the provision of once in four month for both A and B routes.
- In SWR, no TRC run was done during the year 2016-17 in 'D Special' route.
- In SR, against three track recordings to be done in a year, only two track recordings were conducted during the year 2016-17.

During Exit Conference (30 August 2017), Railway Board stated that the results of track recording data are handed over to division for uploading in TMS and the same is used as one of the inputs for planning track maintenance activities in the section. They however, agreed with audit observation regarding TRCs not having an uninterrupted run in Zonal Railways and stated that it is desirable to have an uninterrupted run, but it may not be possible due to heavy traffic density in the sections. It was also stated that all four TRCs are at present working, but are not adequate for the entire Indian Railways. It was mentioned that RDSO has placed

an order for one more TRC and preparation of specification for three more TRCs was in process for procurement.

Thus, TRCs could not be used optimally due to frequent breakdowns and repairs. Non-deployment of TRCs over the planned sections led to non-checking of track parameters viz., position, curvature, alignment of track, smoothness, rail profile, etc. as per laid down frequency.

2.2.1.6 Track circuiting for detection of rail fractures

a) Track Circuits

Track circuits are electrical circuits, that are set up in such a way that when a train is on the tracks that are part of the track circuit, the circuit is altered in some way (usually, by current that normally flows in the track circuit being shunted through the conductive body of the train), thereby activating a detector which may then be used, e.g., to set signals at danger for the section.

In substance, Track Circuit is a low powered electrical circuit in which running rails are used as a part of the circuit. With the help of track circuit, one can identify whether the particular section is clear or occupied by a train / vehicles or track circuit is in failed condition. It is highly reliable for effective and safe running of trains. A Direct Current (DC) track circuit has mainly two ends i.e. feed end and relay end. A track circuit gives two indications:

Table 9 – Indications in track circuiting

1. Yellow / White / No light indication	When track circuit portion is clear i.e. when line is unoccupied.
2. Red indication	When track circuit portion is occupied by a vehicle or track circuit is in failed condition. Reason of failure of track circuit could be fracture in rail or failure in power supply.

Track circuits work by running a circuit using the rails to connect a power source at one end of the block with a relay at the far end. The relay and power source are connected to each rail by cables. As long as the circuit is complete the relay will be energized, which keeps signals in the “clear” position. When the circuit is broken due to occupation by a vehicle the track circuit system gives reports with red indication. The track circuit system also reports a red indication when the circuit gets interrupted for other reasons which primarily could be weld failure / rail failure due to fracture or non-availability of power supply.

b) Axle Counters

Axle counters are devices that can count the number of axles of vehicles passing through them on the track. Axle counters are installed at either end of the section of track of interest; when the number of axles counted at entrance to the section

is the same as the number of axles counted exiting the section, it means the train has passed through the section intact. Axle counters are used in some cases where track circuits are hard or impossible to operate (e.g., where metal sleepers are provided or where conditions are such that there is too much electrical noise and conductivity problems that make track circuits unworkable).

c) Provision of Dual Detection - Digital Axle Counter in parallel with AFTC /DC track circuits

The availability of track vacancy detection equipment in station section (DC track circuits) and in Automatic Block Sections (Audio Frequency Track circuit) is increased by providing Axle counter to work in parallel with DC track circuits / AFTCs. This arrangement is called as 'dual track vacancy detection' (AFTC or DC track circuits + Axle Counter) which in turn ensures less disruption of train traffic.

During failure of DC track circuit / AFTC, the axle counters will be available and signal will continue to display, red/yellow/green depending upon whether the section is occupied by a train/vehicle. Similarly, during axle counter failure, DC track circuits / AFTC is available in order to avoid traffic disruption.

Thus, it is essential to provide continuous track circuiting or axle counters in the Automatic Block System[48]. The Automatic Block System controls the movement of trains between the blocks using automatic signals. In this system, signals are designed to allow trains operating in the same direction to follow each other in a safe manner without risk or rear-end collision. Continuous track circuiting not only helps in improving the capacity with automatic block signaling where more than one train can be sent in a block section, but also improves safety. If double rail track circuit (audio frequency track circuit) is adopted, it can detect electrical discontinuity in rails due to rail/weld failures or acts of sabotage, etc. and thus can be used for detection of rail fracture/weld failure.

In Indian Railways dual detection system comprising of track circuiting as well as axle counters simultaneously is used on the same track length of the automatic block section. The use of dual detection system ensures that signal remains in a clear position, even if there is an electrical discontinuity in the circuit due to power failure/rail fracture. So a red indication in the signal requiring restricting the movement, would arise, when both axle counter and track circuiting simultaneously satisfy the condition that the concerned track length is occupied by the train. In other words as long as either of the two i.e. track circuiting or axle counter gives a clear signal, the signal to the locomotive driver would be clear. From the control panel located at the station, the Station Master would know if

[48] Both the axle counters as well as track circuiting can work simultaneously in an Automatic Block System

there is a failure of track circuiting without knowing the reason for the same. In such circumstance, he can switch over the system to axle counter mode only and allow the train movement on the basis of signal based on axle counter mode.

Thus, as long as Railway Administration assures itself that error signal by the track circuiting system is not related to track occupancy and hence the collision of the trains is not an area of concern, the error signal of the track circuiting is bypassed by switching over to axle counter mode. As the error signal in the track circuit could also be an indication of a rail fracture among other reasons, there is a need to explore the possibility of using the same for detection of potential rail fracture and putting in place a control mechanism like speed restrictions, for ensuring safety for rail operations. Audit observed that the operation instructions did not require the Station Master to look into the reasons for failure of track circuiting and take any action like imposing speed restriction on the movement of the trains or issue any alert.

In NCR, Allahabad-Ghaziabad section has Automatic Block Signaling System. An accident of Train no. 12987, Sealdah-Ajmer Express occurred at Rura on 28.12.2016 at 5:30 hrs in which over 50 persons were injured and a loss of ₹ 5.16 crore was estimated on account of damages to assets. The enquiry by Commissioner for Railway Safety (CRS) was still going on. The preliminary report which is required to be given after one month and Final report which is due from CRS within six months of the date of accident, were yet to be given. (June 2017)

Audit reviewed the records of joint observation note of supervisors on accident and found that though DC track circuit failure incident occurred at 2:16:47 on 28 December 2016, no follow up action was taken by Station Master on the incident of failure of track circuiting. A number of trains travelled on the track between 2:16 to 5:30, before the Train no. 12987 derailed. As per the Supervisors Joint note of Rura accident, the probable finding was rail fracture. The current approach in Indian Railways is not to use the output of track circuiting for detecting rail fracture and bypass such indication, till the time it is not related to track occupancy and hence could result in collision. Had the Railway Administration used this failure indication of track circuiting for examination of potential rail fracture, this rail accident could have been prevented. Since track circuiting failure have the potential of identifying rail fractures on real time basis, directives to use it for identification or ruling out of rail fractures should be considered.

During Exit Conference (30 August 2017), Railway Board stated that track circuiting is a reliable method of detecting defects in track. In the dual detection

system, axle counters are used as an alternative in case of failure in track circuiting. In the particular accident case pointed out by Audit, when the track circuiting failed, mode of train operation was shifted to axle counter without ascertaining the cause of failure of track circuiting. It was further stated that world over Railways only use one methodology viz., track circuiting for train operation and do not use dual detection system. However, due to traffic density, Indian Railways use dual detection system.

It was also stated that while using dual detection system, utmost caution is required. In case of failure of track circuiting while switching over to axle counters, speed restriction with caution order need to be imposed. Safety Review Committee (Para 20.5.7) had also recommended that the signal should be put to single yellow/double yellow aspect as soon as track circuit drops in dual detection territory, so that train speed is controlled to lower speed while passing the affected zone, which may have rail fracture.

Audit is of the view that Railways need to put a mechanism in place to examine the reasons for the failure of track circuiting and only after being satisfied that the reason is not rail fracture, should the train be allowed to move further. In such circumstances, the error signal of track circuit should be examined for rail/ weld fracture and till such time, a speed restriction should be prescribed for the identified track length.

2.2.2 Periodical maintenance activities - Preventive measures

In order to maintain the track in good condition, Railways undertake various preventive measures. These include Deep Screening of ballast and De-stressing of Long Welded Rails (LWR)/ Continuous Welded Rails (CWR) following the prescribed procedures.

2.2.2.1 Deep Screening of ballast

It is essential that track is well drained for which screening of ballast should be carried out periodically[49]. Due to presence of bad formation, ballast attrition, excessive rain fall and dropping of ashes and ore, ballast getting choked up, the track drainage is impaired. In such situations, it becomes necessary to screen the entire ballast right up to the formation level /sub-ballast level. Further, thorough screening restores the resiliency and elasticity of the ballast bed, resulting in improved running quality of track. Such screening is called 'deep screening', as distinguished from the shallow screening, which is done, during overhauling. The work of deep screening should be carried out continuously from one end of the

[49]Para 238 of Indian Railways P-Way Manual

section to the other. Deep screening should be carried out by providing full ballast cushion prior to Complete Track Renewal (CTR) and Through Sleeper Renewal (TSR), where the caking of ballast has resulted in unsatisfactory riding, before converting existing track, fish plated or Short welded Rail (SWR) into LWR or CWR; or before introduction of machine maintenance, unless the ballast was screened in recent past. The entire track must be deep screened at least once in ten years.

The activities of deep screening of ballast over selected sections of five Zonal Railways were reviewed and it was observed that

- Over selected sections of NCR deep screening of ballast was carried out manually on contractual basis and mechanically with the help of Track machines. Over the selected sections (total length 228.28 kms) of NCR, deep screening was not done in 214 locations covering 65 kms (28.47 *per cent*) though it was due since the 1995 to 2016. The range of delay in deep screening was one year to 22 years over these 214 locations. Further, in 18 locations covering 4.98 kms, the deep screening was overdue for more than 10 years; in four locations (between Shikohabad-Tundla, Panki-Etawah, Govindpuri-Panki and Kanpur-Govindpuri sections) covering 1.35 km, deep screening was overdue for more than 20 years. The main reasons for delay in deep screening was attributed to non-availability of block, delay in approval of proposal, shortage of contractual labour and use of manual method of deep screening, etc.
- In SWR, over the selected section (total length 242.07 kms), deep screening was not done in 86 locations covering 51.51 kms (21.28 *per cent*) though it was overdue for a period ranging from three to 66 months. The reasons for not carrying out deep screening was stated as not included in the annual plan, delay in execution of works, sanction of Through Fitting Renewals (TFR) works in the subsequent immediate period, etc. In Heavy Traffic Sections, Deep Screening was done by machines.
- In SR out of three selected section (124.59 kms), in two sections[50] covering 100.43 kms, deep screening of ballast was not done in 5.18 kms, which were due during 2010-11 and 2011-12 respectively and carried out during 2016-17 after a delay of five years.
- All the deep screening work in selected HDN and Non-HDN routes was done mechanically during 2016-17. In selected non-HDN route of ECR (total length 211 kms), the deep screening was done only in 0.924 kms as against the 62.218 kms due in 2016-17 leaving shortfall of 98.5 *per cent*. The reasons for shortfall were non-availability of Ballast Cleaning Machine due to shifting of

[50]SSE/P Way/AVD -Down Slow EMU Line and SSE/P Way/TRL – Down slow EMU line

base of machines to other locations; machine remained under maintenance, non-availability of blocks, etc. In selected HDN routes, deep screening of 228.57 kms was due but only 37.14 kms was planned and done during 2016-17. The reason for non-inclusion of all the due portion of deep screening of track in annual programme of 2016-17 was not found on record. For HDN sections in ECR, as on 31 March 2017, deep screening was overdue at 63 locations ranging from one to nine years. The main reasons for delay in deep screening were non-availability of block, delay in approval of proposal, etc.

- In SER, in all the selected sections (total length 396.20 kms), deep screening of ballast was not carried out regularly. In 16 locations covering 78.87 kms deep screening was overdue. In some sub-sections of seven sections (Kharagpur-Tata, Mecheda-Panskura, Jharsuguda-Rourkela, Rourkla-Bondamunda, Panskura-Haldia, Santragachi-Tikiapara and Tikiapara-Howrah), last deep screening was done more than 10 to 16 years back. However, the deep screening work in these sub-sections was not done in 2016-17. The reasons for the same were non-sanctioning of work, non-finalization of tender, non-availability of block, shifting of machine, non-availability of sleepers, etc.

Annexure I

During Exit Conference (30 August 2017) Railway Board agreed with the audit observations and stated that non-availability of blocks is the main reasons for overdue deep screening of ballast. Audit is of the view that availability of blocks is within the control of Indian Railways and the same should be provided for track maintenance works.

Thus, there were significant arrears in deep screening work, which impacts the resiliency and elasticity of the ballast bed with consequent impact on running quality of tracks.

2.2.2.2 De-stressing of LWR/CWR

The safety of LWR track is vitally affected by locked up thermal stresses, which can result in rail buckling or rail fractures. De-stressing is a technique to avert rail track problems in LWR or CWR. When installing a new rail, or before the onset of hot weather, the rail is pulled or stretched by hydraulic tensors[51] or heated along its entire length to an equivalent length to that the rail would be at the stress free temperature. As per rules[52] de-stressing is undertaken with or without rail tensors to secure stress free conditions in the LWR/CWR at the desired/specified rail

[51] A rail tensor is a hydraulic or mechanical device use for stretching the rail physically to keep rail free from thermal stress
[52] Para 1.9 of Manual of Instructions on LWR

temperature. Railway Board further instructed (21 February 2012) that track works should not be undertaken manually on A B C & D special routes without the approval of Additional Member/Civil Engineering.

As per rules[53], de-stressing shall be undertaken whenever the abnormal behaviour of LWR/CWR gets manifested in the form of gap between Switch Expansion Joint (SEJ) beyond limits, after Through Fittings Renewal (TFR), deep screening /mechanized cleaning of ballast, lowering/lifting of track, major realignment of curves, sleeper renewal other than casual renewals, rehabilitation of bridges and formation causing disturbance to track, after restoration of track following an unusual occurrence and if number of locations where temporary repairs have been done exceed three per km.

The activity of de-stressing of LWR/CWR was examined in the selected sections of five Zonal Railways. It was observed that

- In NCR, need based de-stressing was carried out without using rail tensors. Further, in Tundla – Shikohabad section, the work of de-stressing was overdue in two locations of main line section between Sarai Bhopat and Shikohabad which became due after use of Ballast Cleaning Machine (BCM) in one location and in other location, de-stressing was done on high temperature early due to which extra stresses were developed in LWR. Proposal for de–stressing was sent (July 2016) to Divisional offices by the ADEN / Firozabad but the same was yet to be approved by the Divisional office till the date of audit (June 2017).
- During the check of records maintained in SSE offices of selected sections of SER, it was noticed that
    - In four sections (Kharagpur-Tata, Mecheda-Panskura, Jharsuguda-Rourkela, Muri-Barkakana), though special track maintenance was done during 2004 to 2015, the de-stressing work was not done in these sections after maintenance work of Deep Screening and Complete Track Renewal works.
    - In Kharagpur-Tata, under SSE, Jhargram, de-stressing was done in 2009, but due to absence of any record, it could not be ascertained whether further de-stressing was done.
    - In Santragachi-Tikiapara and Jharsuguda-Rourkela sections under SSE, Santragachi and Rajganpur, de-stressing was done during 2003 and 2004 respectively, no further de-stressing was done. Even in Santragachi-Tikiapara, de-stressing was done in one LWR in 2007 and four LWR in 2010. No further de-stressing was done in this section till date.

[53]Para 6.4.1 of Manual of Instructions on LWR

- In SR, SWR and ECR, the de-stressing of rails was carried out in the sections checked.

During Exit Conference (30 August 2017), Railway Board stated that main constraint is non-availability of required block. It was mentioned that Rail tensors are used while de-stressing of rails only when the required temperature is below the prescribed threshold. As the time required for de-stressing using rail tensors is more and usually longer maintenance blocks are not available, manual de-stressing is resorted to. They further stated that arrear on account of de-stressing gets accumulated, if the blocks are not provided when the de-stressing temperature is available.

Thus, delay in de-stressing in selected sections after special maintenance work, may have a bearing on the safety as thermal stress gets locked up in the LWR which may result in buckling or fractures. Railways need to provide required time of block for de-stressing work to avoid cases of rail fractures/buckling.

2.2.2.3 Contractual works for track maintenance

Proposal for contractual works in connection with the repair and maintenance of permanent way is initiated by the PWI (Permanent Way Inspector) office and sent to division for approval. This could involve multiple activities of regular and periodical maintenance in the section to be undertaken through outsourcing.

During the review of records related to contractual works such as change of damaged track due to derailment, deep screening of ballast, turnout renewal, de-stressing of track on main line, etc. for track maintenance over selected sections of five Zonal Railways, the following was observed

- Review of tender document and contract agreements in NCR and SER showed that in all the selected sections, the clause for employment of skilled staff by contractor was not incorporated in the agreement. However, in ECR, the same was incorporated and certificate for the purpose was collected from the contractors.
- In SER, as per the special conditions of contracts, the contractor is supposed to engage Supervisors and send them for training to a railway training centre and bear the cost of training payable to the railways. It was observed that the contractors were not sending their supervisors for training for acquiring required skill set. There was no penalty clause in the contract for not adhering to this specific condition of contract.

During Exit Conference (30 August 2017), Railway Board stated that normally there is a clause in the contract for skilled supervision. Audit stated that in respect of maintenance by departmental staff, there is a requirement of the concerned

staff being trained and skilled. Similar requirement, however, is not there in respect of maintenance being done through contractors.

Thus, Railways need to ensure incorporation of a clause for deployment of skilled labours under the supervision of trained personnel and provision for penalty in case of non-compliance, for ensuring quality of work done by the contractors.

2.2.3 Corrective actions based on condition monitoring

Using the detective and preventive methodologies discussed above, Railways monitor various track parameters and take necessary corrective actions. These parameters include rail fracture, weld failure and other defects in rails, crossings, sleepers, etc.

2.2.3.1 Rail fractures and weld failures

The life of rails, sleepers, and fastenings gets adversely affected due to the extra stresses created by the impact of moving loads on the rail joint. The rail ends particularly get battered and hogged and chances of rail fracture at joints are considerably high due to fatigue stresses in the rail ends. ***Rail fractures*** occur when a small crack turns into a larger one and they occur in the season when there is a significant difference between the maximum and minimum temperatures in the day, since those cause the tracks to expand and contract. Poor maintenance and fitting could also be the cause of a small crack that over time could lead to a separation of rails. This results in a break in the tracks, which causes the bogie to go off the rails, affecting all the coaches behind it. The Ultrasonic Flaw Detection Manual[54] identifies the most common cause of rail failure as the fatigue fracture, which is due to imperfections present in the material or due to crack formation during service.

Figure 4: Rail fracture

(a) Process of welding of rail joints

Rails are produced in fixed lengths and need to be joined end to end to make a continuous surface on which trains may run. For joining of the rails welding of ends of two rails is carried out. A ***weld failure*** could be a result of poor quality of welding. As envisaged in the Corporate Safety Plan (2003-13) and Vision 2020 of

[54]Chapter 1 of Revised USFD Manual

Indian Railways, to improve the quality of welds and enhance safety, the population of Alumino Thermite Welds was to be gradually reduced and replaced by Flash Butt (FB) welds with the help of mobile flash butt welding plants. The advantages of FB welds over an Alumino Thermite weld are as follows:

Table 10 – FB welds versus Alumino Thermite welds

	FB weld	AT weld
Principles of welding	Welding is done by passing a 35,000A electric current between two rails ends.	Welding is done by initiating an exothermic chemical reaction between iron oxide and aluminium
Quality of welding	Excellent	Good
Strength of welding	Good in fatigue	Weak in fatigue
Time required for welding	About 3-6 minutes	10-12 minutes for SKV[55] and 30-45 minutes for conventional
Place of welding	Welding normally done in workshop, but can be done on-site using mobile plant	Welding done onsite
Cost of welding	₹ 400-600 per weld	₹ 700-1200 per weld
Tolerance	Very high	Normal
Control on the quality of welding	Quality can be controlled with the help of a welding recorder	Quality control is possible only by working diligently and no monitoring is possible.

Slow progress in induction of mobile flash butt welding was attributed to mobile flash butt welding plants being bulky requiring more space and long spells of traffic blocks.

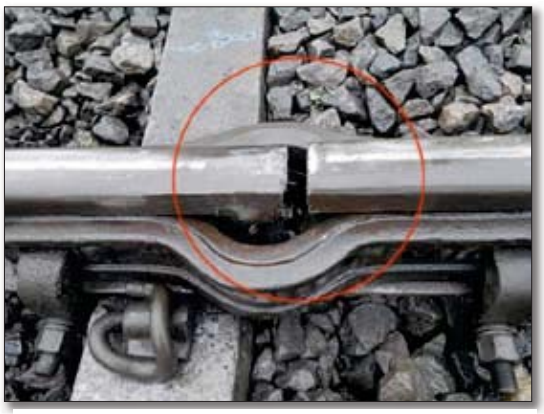

Figure 5: Weld failure

In April 2014, Railway Board instructed[56] that all the tenders of Alumino Thermite Welding were to be only with single shot crucible[57] after 1 April 2015. The use of multi-shot in Alumino Thermite welding after 1 April 2015 was to be discontinued and permitted only as an exception. Railway Board further instructed[58] (March 2015) that one weld in every division will be got executed by Chief Track Engineers (CTEs) in their

[55] SKV is the short form of the German phrase Schweiss-Verfahranmit Kurzvorwarmung meaning the short preheat welding method. The technique is therefore also termed SPW (short preheat welding).
[56] Railway Board's letter no .Track/21/2007/0110/AT Welding dated 2 April 2014
[57] Single shot crucible is an improved AT welding technology in which a portion of welding material is directly set on top of the mould without any hardware.
[58] Railway Board letter no .Track/21/2002/090S/7IVol.II dated 18 March 2015

presence, observing all instructions of checklist of Alumino Thermite Welding. Similarly, initial testing of one new weld per division was to be got executed by CTEs in their presence observing all instructions of checklist of Ultrasonic Flaw Detection testing and report sent to Railway Board. In case of the work being done by a contractor, provisions exist for re-welding of failed welds free of cost by the contractor within the guarantee period. For failure beyond a prescribed criteria, a penalty is to be paid by the contractor.

Audit examined relevant records pertaining to the rail fracture/ weld failure over the selected sections of five Zonal Railways. The details are given below:

Table11 – Rail fractures and weld failures in selected sections during 2015-16 and 2016-17

Zonal Railway	Accidents due to rail fractures/ weld failures	Number of rail fractures		Number of Alumino Thermite weld failures		Number of Flash Butt weld failures		Reasons
		2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	
SWR	01	30	95	89	220	05	12	One accident occurred in 2015-16 due to rail fracture. No casualties were reported.
SR	Nil	11	12	4	4	4	1	Liner seat corrosion and corrosion at weld area
ECR	5	39	34	9	11	6	5	Sudden rail fracture
SER	0	10	9	2	3	1	2	--
NCR	01	15	19	31	35	10	11	Final report of investigation still awaited.
Total	**07**	**105**	**169**	**135**	**273**	**26**	**31**	

From the above table, it can be seen that

- Seven accidents occurred in the selected 37 sections over five Zonal Railways due to rail fracture/ weld failure during the past two years.
- In SWR and SR, number of rail fractures increased as compared to the previous year. Further, number of Flash Butt weld failures was much less than that of Alumino Thermite weld failures.
- In SWR, the reasons of sudden increase in rail/weld failures in 2016-17 were attributed to change in the method of reporting[59] since October 2016.

[59]From October 2016 onwards all incidents of weld/rail fractures are being reported to Railway Board. Earlier, rail/weld fractures only of a serious nature were reported to Railway Board.

Further, Flash Butt Welding was yet to be taken up in a big way and hence, no comparative study could be made between Flash Butt Welding and Alumino Thermite Welding works/failures.

(b) Flash Butt welding versus Alumino Thermite welding

A comparison of defects in the Alumino Thermite weld population and Flash Butt weld population was done in selected sections of five Zonal Railways. It was observed that percentage defects in Alumino Thermite weld were much higher than FB weld as can be seen from the table below:

Table 12 – Weld failures in selected sections of NCR during 2016-17

ADEN / SSE	AT weld population	Defective weld in USFD testing	Percentage	FB Weld population	Defective weld in USFD testing	Percentage
			NCR			
ADEN – Etawah	4953	1323	26.71	15747	67	0.43
ADEN - Kanpur	6999	1844	26.35	12746	132	1.01
ADEN - Chunar	6785	957	14.10	5393	26	0.41
ADEN - Firozabad	21490	1105	5.14	18261	71	0.39
SSE - Naini	543	99	18.23	1524	15	0.98
SSE - Allahabad	514	153	30.93	175	7	4
SSE - Dadri	1965	121	6.16	4183	3	0.07
Total	**43,249**	**5,602**	**12.95**	**58,029**	**321**	**0.55**
			SER			
ADEN/PKU	*5437*	*58*	*1.07*	*12176*	*38*	*0.31*
ADEN/JGM	*12931*	*111*	*0.86*	*12978*	*44*	*0.34*
ADEN/Satragachi	*11724*	*142*	*1.21*	*2329*	*06*	*0.26*
ADEN/BLS	*18327*	*246*	*1.34*	*14343*	*22*	*0.15*
ADEN/TMZ	*16929*	*62*	*0.37*	*10894*	*36*	*0.33*
ADEN/Kharagpur	*10723*	*52*	*0.48*	*10083*	*57*	*0.57*
TOTAL	**76,071**	**671**	**0.88**	**62,803**	**203**	**0.32**
			SWR			
AEN - Bellary	7590	1679	*22.12*	222	02	*0.90*
AEN - Gadag	6619	1302	*19.67*	-	-	*0.00*
AEN - Central	6398	1586	*24.79*	-	-	*0.00*
AEN - Belagavi	9133	1801	*19.72*	523	04	*0.76*
AEN - Castlerock	4949	780	*15.76*	1441	14	*0.97*
TOTAL	**34,689**	**7,148**	**20.61**	**2,186**	**20**	**0.91**

- In NCR, Alumino Thermite welding was not initiated with single shot crucible**.** However, in some cases use of single shot crucible was noticed only after January 2017.
- In SER, Alumino Thermite welding with single shot crucible was started after April 2017 instead of April 2015 i.e. after a lapse of two years by SSE/Rourkela and SSE/Kolaghat under Jharsuguda – Rourkela and Mecheda – Panskura sections respectively.

- In SWR, Alumino Thermite welding was done with single shot crucible with effect from 1 April 2015.

- In ECR, Alumino Thermite welding with single shot crucible was started in non-HDN route with effect from October 2016 after delay of 18 month and in HDN route with effect from June 2016 after delay of 14 month. The reason was attributed to delay in supply of material.

- In SR, Alumino Thermite welding was not being done with single shot crucible and instead done by auto thimble (pre-fabricated piece). During March 2017, a contract has been awarded for Alumino Thermite welding with single shot crucible in the Chennai Central-Arrakonam section.

- In NCR and ECR, initial testing of one new weld executed in presence of CTEs was not done**.**

- In NCR, welding work was carried out departmentally and by the staff of contractor**.** No case of contractors' failure and imposition of penalty as per contract *ibid* were noticed in NCR, ECR and SWR.

During Exit Conference (30 August 2017), Railway Board stated that they use Alumino Thermite welds only for repair work. It was also stated that while flash butt welding is better methodology for welding of rails, it is techno-economically not feasible for welding in all cases. As such, flash butt welding is being used in joining rails in depots and Alumino Thermite weld judiciously used for repair work only. At present there are seven flash butt welding plants in Indian Railways, renewal of which has been planned. However, Audit observed that railways have taken a policy view for gradually reducing the population of Alumino Thermite Welds and replace them by Flash Butt (FB) welds with the help of mobile flash butt welding plants. Railway Board has also issued various instructions over the years for reducing the number of AT welds and using mobile flash butt welding plants instead to enhance the quality of welds and safety of tracks. However, progress made in this regard was not satisfactory.

Railway Board further stated that 70 *per cent* of rails procured from SAIL are 13/26 m and 30 *per cent* rails are 130 m which are joined to make LWR. It was added that it is planned to have 70 *per cent* rails of 130 m which will need lesser number of field welds.

Railway Board also stated that availability of block of minimum 75 minutes is essential for good quality Alumino Thermite welding, which is usually not made

available. Audit is of the view that Railways need to ensure availability of required block time for ensuring quality of Alumino Thermite welds.

To improve the quality of welds and enhancing safety, the population of Alumino Thermite Welds was to be gradually reduced and replaced by Flash Butt welds with the help of mobile flash butt welding plants. Railways need to take action and enhance the use of mobile flash butt welding plants.

2.2.3.2 Monitoring of track where enhanced loading (CC+8+2t /25 t axle load) is permitted

(a) Conditions to be followed where operation of wagons with enhanced loading was permitted

Anticipating that enhanced axle load will have more adverse effect on track, the operation of CC+8+2t wagons with load in excess of carrying capacity by eight tonnes with tolerance of two tonnes was permitted with a set of strict conditions. Instructions were issued from the apex level on 10 August 2006. The salient points are given below:

- Wheel impact load detectors (WILD) were to be installed at all selected locations within one year
- Weighbridges were to be installed and it was to be ensured that all weighbridges were maintained and functional. No overloading was to be permitted. Drastic penal action was to be taken against defaulters.
- Wagons were to be well maintained and additional springs were to be provided during Routine Overhauling/Periodical Overhauling.

RDSO further prescribed requirements for operation of CC+8+2t /25 t axle load that *inter alia* included:

1. The track was to be of a minimum standard of 60 kg rail (90UTS), with 1660 sleeper density and minimum depth of ballast cushion of 300 mm below sleeper. Maximum permissible speed was to be restricted to 70 kmph in loaded condition and 100 kmph in empty condition. For track with a minimum standard of 52 kg rail (90UTS), sleeper with M+7 density and minimum depth of ballast cushion of 250mm below sleeper, the maximum permissible speed was to be restricted to 50 kmph in loaded condition and 100 kmph in empty condition.

2. The welds were to be protected by joggled fish plates as per laid down provisions[60]and maintenance of Rails and Rail joints was to be ensured[61]. In

[60] Para 6.4 and Para 8.14 of Ultrasonic Flaw Detection Manual and Para 6.3 of AT welding manual and other policy instruction of Railway Board.
[61] Para 250 and 251 of Indian Railway P-way Manual

addition, wherever condition warranted on account of corrosion on rail/weld collar, wear on rail, cupping of welds, etc., necessary precautions were to be taken for fish plating/joggled fish plating.

3. USFD testing was to be carried out at a frequency, one grade higher than the specified frequency in the USFD manual. On section with GMT more than 60, the existing stipulated frequency of once in one and a half month as per USFD Manual was to be continued.

4. Only weighed raked were to be moved on the section after unloading/ correction of over loaded wagons. In case unloading/correction is not possible then speed of rakes was to be restricted as applicable for CC+8+2 tonne loaded rakes as mentioned in unified JPO issued by Railway Board[62].

5. Zonal Railway were to set up a regular rail grinding regime which is considered necessary, to check development of rolling contact fatigue defects in rail due to 25T axle load operations.

(b) Adherence to Railway Board guidelines regarding checks and controls before running heavier loads on sections

In NCR, operation of 22.9t BOXNHL wagon was introduced through Railway Board sanction in December 2009. In the selected sections of NCR, no assurance could be derived about compliance to these conditions with regards to weighment and availability of minimum depth of ballast cushion for running of 25t axle load. In ECR CC+8+2 loading was introduced in Patna-Mughalsarai-Gomoh sections in 2008 and in SER, out of six selected HDN sections, four sections were identified for CC+8+2/25 ton Axle load. No assurance could be derived in ECR and SER about availability of minimum depth of cushion for running of 25t axle load due to non-maintenance of records in the selected sections. In SWR ballast cushion of 300 mm was seen maintained over the selected sections. In SR sleeper density of M+8 and ballast cushion of 300 mm was maintained in the selected sections.

Railway Board/RDSO issued a number of control and monitoring measures to be strictly followed in the sections where enhanced loading was permitted. This included rehabilitation of distressed bridges and installation of Bridge Load Monitoring System, installation of weighbridges and ensuring weighment, use of USFD testing for monitoring track, replacement of rails by 90R rail in the whole section, monitoring rail and weld defects, etc. The compliance of these instructions was checked in the selected sections, where enhanced loading of CC+8+2/CC+6+2/CC+4+2 was permitted.

[62] Railway Board letter no. 2007/CE/II/TS/8 dated 2.4.2009

(i) In NCR, it was observed that all the nine sections (Allahabad division) were notified for running of CC+8+2 rakes. However,

- Damages were reported in 14 bridges in Ghaziabad-Mughalsarai section , but yet to be rectified (March 2017),
- Location-wise stock of USFD tested rails was not made in selected sections for use,
- New welds were not tested by USFD within 30 days of welding,
- 52 kg rails still existed on few portions of these sections (67.754 kms) where enhanced loading was permitted, due to which speed restrictions had been imposed; and
- Only one weighbridge at GMC was available in Allahabad Division, which was installed in December 2011.

(ii) In ECR, Patna-Mugalsarai and Mugalsarai-Gomoh sections were notified for running CC+8+2 rakes. However, Bridge load monitoring system was not installed and USFD testing was not being done as per prescribed frequency. In Patna-Mughalsarai section, no weighbridge was installed to check overloading of rakes.

(iii) In SER, out of six selected HDN sections, four sections (Jharsuguda – Rourkela, Rourkela – Bondamunda, Tata-Kharagpur and Mecheda - Panskura) were identified for CC+8+2/25t Axle load. Bridge Load Monitoring System had not been installed in these sections.

(iv) In SR, three sections have been notified for running of CC+8+2 rakes. New welds were tested by USFD within 60 days instead of 30 days due to busy schedule of deployment of USFD machine over the division.

(v) In SWR, there is one section notified for running of CC+8+2 rakes. New welds were USFD tested after delay of one to six months. Though scanned images/peak pattern were saved for the test conducted by the private agencies, for departmental USFD team, these were saved only for welds and rails which required immediate removal/replacement.

Annexure 2

In this regard, review of report of RDSO regarding 'Effect on track due to operation of CC+8+2t/ 25t axle load' revealed an increasing trend of rail/weld defects in Mughalsarai-Ghaziabad section on quarter-to-quarter basis as detailed below:

Table 13- Rail / Weld failure and USFD testing details of Mughalsarai – Ghaziabad section (60 kg rail, PSC – 1660/kms)								
Quarter	Track length (Km)	Rail Defects (OBS + IMR)	Weld Defects (OBS+IMR)	Rail Failure	Weld Failure	No of welds tested	DFW	DFW per 100 weld
Oct 2015 to Dec 2015	1502.4	92	345	5	18	11682	889	7.6
Oct 2016 to Dec 2016	1502.4	141	304	5	19	9806	757	7.7
Jan 2016 to Mar 2016	1502.4	96	322	4	11	14570	706	4.8
Jan 2017 to Mar 2017	1502.4	189	341	10	19	7425	977	13.2
April 2016 to June 2016	1502.4	56	206	0	2	10910	849	7.8
July 2016 to Sep 2016	1502.4	74	168	3	5	8177	815	10

(OBS – observation of weld, DFW – Defective weld, IMR – Immediate rail removal)

A comparison of number of defective welds per 100 weld tested of various quarters during October to March, with the figures of the previous year's respective quarters, showed an increasing trend in Mughalsarai – Ghaziabad section. The actual rail and weld failures were also showing an increasing trend. The report of RDSO highlighted that

- Increased axle load wagons have adverse effect on rail and old Alumino Thermite weld.
- Defect generation in rail and welds is increasing due to heavy load on the track.
- Actual failures in rails and welds are also increasing.
- Rate of breakage of PSC sleepers, glued joints and fish plates and wear of switches & crossing were increasing.
- The implementation of Railway Board instructions regarding monitoring and detachment of defective wagons as per WILD alarms was severely lacking.
- Weighment of each rake and control on overloading is also not being monitored by NCR.
- At present in sections where 22.9 t /25t axle loads are running there is no rail grinding regime in operation to take the advantage of the technology.

(c) Non installation of Wheel Impact Load Detector (WILD) System

WILD (Wheel Impact Load Detector), is an unmanned intelligent trackside data acquisition system that measures the dynamic impact load of wheels on the track. It is a useful 'wayside detection system' for safety and asset reliability in train operations.

WILD system helps reduce the railway maintenance cost significantly by identifying the damage causing wheels for quick removal. Out of round wheels produce very high impact loads which result in normally imperceptible damage.

Such impact loads sustained over long term leads to premature failure of rails, wheels, bearings, etc. With rising axle-loads the severity of this type of damage increases.

Thus, WILD helps in reducing service failures and unplanned maintenance cost of rolling stock and tracks and catching the defects at an early stage and thereby instrumental in protecting rail infrastructure, avoid derailment and accidents. It replaces subjective human judgment, increases reliability of identification of defective wheel, has in-built automatic communication for prompt corrective action, detects overloaded wagons and helps in improvement in safety of vehicle and track.

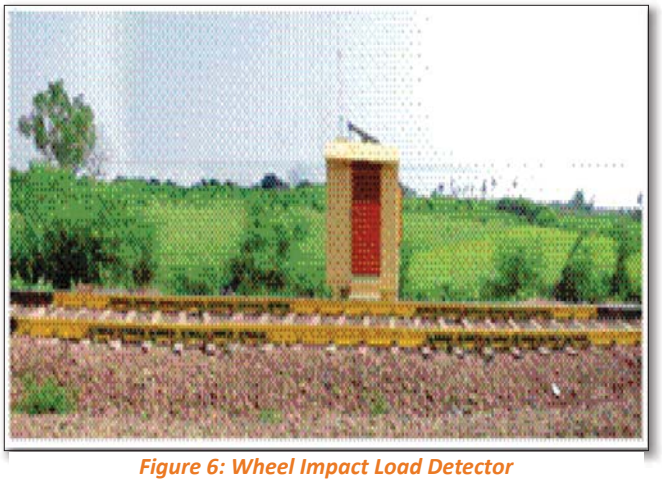

Figure 6: Wheel Impact Load Detector

Minister of Railways in August 2006 pointed out that WILD must be installed at all the selected locations (270 locations were identified over all Zonal Railways) within one year. Further, Railway Board in 2008-09 decided for procurement of WILD through development cell at Railway Board. In December 2015, RDSO advised all Zonal Railways to ensure installation and maintenance of adequate number of WILD instruments to record the impact of loading spectrum actually passing over the track. As against 270 locations identified, WILD had been installed at Mughalsarai (ECR), Bina and Itarsi (WCR) and Dongargarh (SECR). Audit observed that no WILD system had been installed in NCR, SER and SR. In SWR, WILD was installed in Hitnal station in August 2010, but not working since February 2017 due to ongoing doubling work in the section. It was further seen that the global tender for installation of WILD was yet to be finalised (March 2017).

RDSO in its report (11 May 2017) on 'Effect on track due to operation of CC+8+2t/25t axle load' stated that implementation status of Railway Board's instruction regarding weighment of each rake and control on overloading is not being monitored by Zonal Railways. The Report highlighted the following deficiencies:

1. In NCR, not even one *per cent* of the rakes running on the system were being passed through weighbridge installed at Jhansi and Kanpur Goods Marshalling

Yard (GMC). Between January 2016 and March 2017, of 7207 rakes of 22.9t axle load which passed through Allahabad- Kanpur Goods Marshalling Yard, only 20 rakes were weighed of which five were found overloaded and corrected.

2. Operation of 22.9t BOXNHL wagon was introduced in NCR through Railway Board sanction in 2009. Ghaziabad-Mughalsarai route (Track length 1502.4 Km) was under CC+8+2 routes and line capacity utilisation was more than 100 *per cent.* However, WILD instrument has still not been installed over NCR. Hence, impact of heavy loading, flat wheel and overloading on track could not be ascertained for quick remedial action.
3. Analysis of the RDSO report for the WILD at Mugalsarai showed that during January 2016 to March 2017, of the 7857516 wheel passed through WILD, 27183 maintenance alarms were generated, of which 221 were critical. However, only seven wagons were detached. Even the wagons producing alarm up to 51t were allowed to run.
4. The Report also showed an increasing trend of rail and weld defects in most of the sections operating 22.9t/25t axle load.

During Exit Conference (30 August 2017), Railway Board stated that at present out of 270 locations identified, WILD has been installed in 15 locations, of which, two are no longer functional. It was stated that a JPO has been issued at Railway Board level to follow laid down procedures for monitoring through WILD, which needs to be followed properly. It was also stated that the impact load and sometimes due to overloading on already stressed rails also cause sudden rail failures.

Railway Board further stated that all critical alarms generated are crucial and action need to be taken on each and every critical alarm. Not taking action and detaching wagons where critical alarms are generated leads to severe damage to tracks/rails and entail high risk of accident/derailment.

Thus, necessary measures such as installing weighbridges to ensure weighment and control overloading, laying of higher strength rails, were also not implemented. Running goods trains with enhanced load without ensuring the check and control mechanism in place could lead to poor track condition, which could impact the safety of running trains. Eleven years after the issue of instructions, WILD system was not installed at most of the identified locations. In a few locations like Mughalsarai where WILD was installed, corrective action was not being taken on the basis of the information/data generated from WILD as Railway Administration ignored most of the critical alarms.

2.2.3.3 Monitoring through Track Management System (TMS)

With a view to maximize the benefits of material, equipment and manpower inputs made to track and to optimize the life and utilisation of assets, Track Management System (TMS) application software has been developed.

TMS provides benefits in the form of prioritization of works, need based deployment of Gang and Machine, overall economy in Track Maintenance, monitoring of overdue inspections, listing of features needing attention, optimization of maintenance inputs, easy management of entire infrastructure with centralized option, reduced IT maintenance and personnel costs and seamless transfer of data for users moving from one location to other by virtue of centralized database. TMS has various modules, viz. Asset, Inspection, Planning, Work, Stores, Report, Innovations, Miscellaneous, Rail and weld fracture, Track monitoring by machines, Monitoring by machines & USFD testing, Engineering control-caution orders and traffic blocks, Track renewal and deep screening, Ballast supply and insertion, Patrolling and accidents reporting.

Audit examined the implementation of TMS over the selected Zonal Railways. In this regard, read only access of TMS was not provided by Railway authorities to Audit at Divisional and Zonal level. Thus, details of functioning of TMS application and its optimum utilization in decision making by divisional and Zonal offices could not be ascertained in Audit. Limited access to the TMS reports was given to audit at sectional level. Audit observations on the basis of analysis of these reports are detailed below:

- TMS was working over Allahabad Division since 2014-15. 115 TMS connections were provided to ADEN and SSE (P-Way) over Allahabad Division. Check of reports generated through TMS revealed that
    - Asset, store, caution orders, traffic block, ballast supply and insertion and accident reporting modules were not working in TMS.
    - Monitoring of TMS at ADEN & SSE level is a regular activity and must be done on day to day basis . However, compliance of inspections was not entered in TMS. Consequently backlog of compliance was being reflected on TMS .
    - Data of bridge inspection, training of staff, periodical medical examination and refresher courses was not updated in TMS.
    - Check of reports of Track Machine module of TMS revealed that details of track machine deployed in different sections were updated in TMS regularly.

- In SER, updation of data in TMS was not regular as internet connection was poor. However, manual records viz. Gap register, Points & Crossings Register, Curve Register, etc. were being maintained side by side along with TMS.
- In ECR, information/data in respect of track maintenance viz. inspection programme of SSE/ P. Way, AEN of the concerned section, Inspection details asset register of LWR, detail of machine maintenance were fed in the TMS from the year 2015-16 onwards. It was further noticed that ECR was not uploading the reports of inspection done at SSE/P-way level and compliance thereof at all the levels in the system in all the cases rather uploading was done selectively.

  Scrutiny of inspection reports of SSE/P. Way, AEN & DEN generated from TMS of both selected HDN and Non-HDN routes revealed that action taken and compliance of general remarks/findings of inspection conducted by concerned officers/officials were not incorporated in the TMS. In absence of action taken and compliance of Inspection Reports, it could not be assessed whether timely action was taken.
- In SWR, implementation of TMS in eight selected SSE (P-way) and five AEN Offices was checked.
  - There were delays in feeding data in TMS by P-way officials.
  - Alerts issued by TMS were not attended to/taken care of.
  - In SSE (P-way), Hubli (East), though inspections - LWR, points & crossings, curves, Level Crossings, etc., were conducted, details of the same were not fed in TMS from April to September 2016.
- In SR, in regard to track maintenance part of TMS, except Stores Module, all other Modules relating to track maintenance have been implemented. Track Machines programme is uploaded in the TMS for monitoring by officials, of adhering to the planned maintenance schedule using track machines, TMS is used by the concerned officials.
- Store module viz. receipt, issue and balance of material and excess/shortage of material, etc. were not maintained in the TMS of both selected HDN and non- HDN routes in all Zonal Railways - NCR, SER, ECR, SWR and SR.

During Exit Conference (30 August 2017), Railway Board stated that at present module for bridge inspection is not inbuilt in the TMS and is being prepared separately. Only master data of bridges has been uploaded in TMS. During discussions Audit suggested providing access of TMS to all departments for better coordination of maintenance activities, to which Railway Board responded that

access to TMS was on a 'need to know' and 'need to use' basis. However, reports could be made available as and when required to officials of other departments.

Thus, TMS was not being used effectively in monitoring track maintenance activities. There is a need for complete development of bridge inspection module in TMS, implementation of all modules of TMS in all Zonal Railway formations, completeness of data entry, real time updation of data into TMS and utilization of information in TMS for monitoring, decision making and undertaking track maintenance activities.

2.3 Impact due to deficiencies in track maintenance

Deficiencies in maintenance of track result in imposition of speed restriction on various sections, and can also lead to derailments/ accidents.

2.3.1 Speed restrictions

The impact of running trains causes heavy wear and tear of the track. It becomes necessary to rehabilitate or renew the track periodically to ensure that it continues to be safe and efficient. Retaining the over aged tracks in operation not only leads to an increased cost of maintenance but also affects the safety and fluidity of the movement of traffic. Due to delays in track maintenance, incidents of rail fractures may increase.

Zonal Railways impose speed restrictions on various sections due to poor track structure. Each speed restriction has a cost attached to it and prolonged imposition would also have a financial impact in addition to the operational impact. It is therefore necessary to ensure completion of works within a set time frame so that speed restrictions are removed at the earliest.

Audit revealed that

- In NCR, 34 PSRs which had been continuing since 2007 in the selected sections. The reasons for imposing PSRs included defects in track structure, less transition curve in the track, inadequate transition length between points & crossings, weak bridge structure, bad drainage system, poor visibility, large number points and crossings in track, unusual vibration sound during oscillation trail, etc.
- In SER, a total of 159 PSRs were imposed (Kharagpur - 102 and Chakradharpur - 57), out of which 28 PSRs (Kharagpur - 18 and Chakradharpur-10) were removed during the last three years in HDN routes.

- In ECR, scrutiny of working time table of Mughalsarai Division (for HDN Route) and Danapur Division (for Non- HDN routes) revealed that, there was no PSR on account of poor track structure.
- In SWR, a total of 119 PSRs were imposed from November 1993 to December 2008 on account of bad sub-soil and bunching of ballast, kinking welds on track, non-interlocked point, less lateral distance on bridges, points & crossings taking off on curves, insufficient super elevation of curve, yielding formation, vulnerable bridges, poor visibility of level crossings and steep degree of curve, etc.
- In SR, 15 PSRs were in place due to poor track structure like diamond crossing on wooden layouts and existence of Girder Bridge with wooden sleepers. Five PSRs were relaxed during 2016-17.

Thus, 294 speed restrictions had to be imposed in these five Zonal Railways because of track vulnerability.

2.3.2 Train Accidents

Audit reviewed the records of train accidents over the last three years over the selected five zones. The details of accidents occurred during the last three years (2014-15 to 2016-17) are mentioned below:

Table 14– Trains accidents during 2014-15 to 2016-17 in selected Zonal Railways

S. no	Date of accident	Train no. and Location	Brief description	Cause	Impact of the accidents
NCR					
1	25.05.2015	18101 Tata-Jammu Tawi Express (km-887/21 of Sirathu-Athsarai section	11 coaches derailed	Buckling of track	Damage assessment at ₹1.64 crore, causalities of three passengers, one passenger sustained grievous injury and six passenger suffered minor injuries.
2	07.12.2015	AMG special (Loop line point No.202B)	Three wagons derailed	Non-negotiation of curve of the point and center pivot defects in wagon	Damage assessment at ₹11 lakh, no casualties / no injury.
3	31.03.2016	ICDD special (km 1496/16 of Ootward-Ramgarh section)	Four wagons derailed	Track buckled in 'S' form with onset of temperature	Damage assessment at ₹10.10 lakh, no casualties / no injury.
4	30.09.2016	Goods KN-25 (Between DN Home and DN Starter of Barhan station)	Five wagons and 1 break van derailed	Track reading and wagon reading on higher side	Damage assessment at ₹23.10 lakh, no casualties / no injury.
SER					

Table 14– Trains accidents during 2014-15 to 2016-17 in selected Zonal Railways					
S. no	Date of accident	Train no. and Location	Brief description	Cause	Impact of the accidents
5	22.06.2014	53342 DN Muri-Dhanbad Passenger (Muri-Bokaro Steel City Section)	Train engine and five coaches derailed	Rail fracture of RHS tongue rail (5.09 m from toe)	There were no casualties. Though Engineering Department was held responsible, no individual Railway staff was held responsible.
6	03.12.2014	UP NBox E Spl (Ranchi-Muri section)	21 Nbox derailed	Rail facture under load	There was no casualty. Responsibility was fixed on one SSE/P-Way and one JE/P-Way and censure issued.
ECR					
7	20.12.2015	At Pasarha station of Kathiar – Barauni section, seven coaches of Train number 15707 Katihar – Amritsar Express derailed	7 coaches derailed	Breakage of RH tongue rail of RH switch of point	No impact quantified either in terms of loss due to accident or for casualties / injuries.
8	07.06.2015	UP Dadri Goods (coal) (Barkakana-Barwadih section) between Richughutu and Demu stations	Train engine and 19 wagons derailed	Rail Broken	Both up and down main line blocked
9	14.02.2017	53349 UP Barwadih Jn. to Dehri On Son Passenger (Dehri-on-son station in Garwa Road Jn.-Dehri-on-son section)	Train engine derailed	Defects in point	No impact quantified either in terms of loss due to accident or for casualties / injuries.
10	17.11.2016	53371 Koderma to Barka Kana Passenger (Mid-section/Koderma-Hazaribagh and Kurhagada)	Train engine derailed	Weld fracture	No impact quantified either in terms of loss due to accident or for casualties / injuries.
11	11.10.2016	18698 Patna Jn.-Saharsa Jn. Koshi Exp (Bakhtiyarpur – Danapur section)	Derailed at PF No. 10 at Patna Jn.	Rail Fracture	No impact quantified either in terms of loss due to accident or for casualties / injuries.
12	25.07.2016	13006, Amritsar Jn - Howrah Mail (Mid-section/DNR-BXR & BXR-BUE)	Train derailed	Defects in point	No impact quantified either in terms of loss due to accident or for casualties / injuries.
SWR					
13	13.02.2015	12677 UP Bengaluru-Ernakulam Jn. Express (Anekal Road-Hosur section)	Train engine and coaches (except 2nd coach and trailing loco) derailed.	Rail Fracture, under category Failure of Equipment- Rail Failure	No casualties/no injuries to Passengers reported. Damaged track material was replaced. Cost of damages was assessed at ₹ 1.11 crore.

Table 14– Trains accidents during 2014-15 to 2016-17 in selected Zonal Railways					
S. no	**Date of accident**	**Train no. and Location**	**Brief description**	**Cause**	**Impact of the accidents**
14	28.08.2015	18463 Bhubaneswar-Bengaluru Prashanti Express (OHE mast No SBC 1043 & 1048)	Train engine and two coaches derailed.	Track defect	No casualties/no injuries to passengers reported.
15	21.12.2015	11006 Puduchery to Dadar Express (Unakal station)	Train engine and two coaches derailed.	Failure of Equipment(P-way)	No casualties reported, 11 passengers injured. Cost of damages to track material was assessed at ` 35.62 lakh.
SR					
16	17.06.2015	12658 Bengaluru to Chennai, Chennai Mail (Basin Bridge Chennai-Arakkonam section)	While the train was passing through Basin Bridge station wheels of two coaches derailed	Deep flange in R-1 wheel of coach and track instability at diamond crossing on wooden layout.	No impact quantified either in terms of loss due to accident or for casualties / injuries.

In the selected five Zonal Railways, during 2014-15 to 2016-17, sixteen accidents/derailments took place due to deficient track maintenance. The reasons were rail fracture, weld fracture, track defects, defects in points, track buckling, etc.

Figure 7: Train no. 12987, Ajmer-Sealdah Express derailed in Kanpur on 28.12.16

This included the following three train accidents that occurred during 2016-17 over NCR for which causes of accidents were under investigation.

Table 15 – Accidents where final investigation report is awaited				
S. no	**Date of accident**	**Location**	**Train no.**	**Brief description**
1	20.11.2016	Pokhrayan – Malasa(PHN-MLS) section in Kanpur	19321 Indore - Rajendra Nagar Patna Express	14 coaches derailed. 150 passengers died and more than 200 injured
2	28.12.2016	Kanpur Central – Rura Section	12987 Sealdah – Ajmer Express	15 coach derailed and 50 passengers were injured
3	30.03.2017	Kulpahar- Mahoba	12189 Jabalpur – H. Nizamuddin-Mahakaushal Express	Eight coaches derailed

Audit carried out detailed analysis of position of track maintenance in the sections, where the major accidents took place. Some important findings in respect of four accidents are tabulated below:

Table 16 – Important findings of four major accidents	
1. Accident of Train no. 19321, Indore - Rajendra Nagar Patna Express on 20 November 2016	
Spot of Accident	Between Pokhrayan - Malasa station section, Pole no. 1290/2 – 1290/16, SSE/Juhi, Jhansi Division, NCR, Section Ait – Bhimsen
Loss of life/ railway property	Death of 150 passengers Estimated loss of C&W – ₹ 6 crore
Cause of accident as per supervisor's joint note	Rail failure due to old flaw in rail
Report of the Commissioner of Railway Safety (CRS)	Preliminary Report of CRS which should be given within one month of the accident and Final report of CRS enquiry which is due within six months of the accident is awaited.
Audit findings regarding track maintenance activities of the section	
• USFD was done on 18 October 2016 i.e. about one month before the accident. At that time, no major deficiencies were reported. • 13 rail/weld failures took place between May 2016 and March 2017. Spot of failures were not inspected by ADEN, Kanpur. • Track recording by TRC was to be done in six month. Last TRC was done on 5 March 2016. No TRC carried out in 2016-17. • Deep screening was overdue in main line section at 10 locations for length of 16264 meter from one to 19 years. • Out of 196 staff on roll, 32 staff were absent from the duty without any intimation to office establishment between 01 April 2016 to 31 March 2017 for more than 15 days. 15 Track maintainers were posted in the section of SSE, Juhi without imparting initial training of track maintenance.	
2. Accident of Train no. 12987, Ajmer Sealdah Express on 28 December 2016	
Spot of Accident	Near KM-1061/26 UP Line of Maitha-Rura under jurisdiction of SSE – II, Kanpur, Allahabad Division, NCR
Loss of life/ railway property	16 coaches derailed, 50 persons were injured and estimated loss of ₹ 4.67 crore occurred due to damages to assets
Cause of accident as per supervisor's joint note	Rail fracture
Report of the Commissioner of Railway Safety (CRS)	Preliminary Report of CRS which should be given within one month of the accident and Final report of CRS enquiry which is due within six months of the accident is awaited.
Audit findings regarding track maintenance activities of the section	
• Four rail/weld failure took place during 2016-17. Spot of failures were not inspected by ADEN, Kanpur. • TRC was to be done in six month. During 2016-17, only TRC was done in December 2016 • Deep screening was overdue in main line section at 41 locations for length of 34.46 km due from three to four years. • As of April 2017, against the sanctioned strength of 488 track maintainers only 288 were on roll of which, 14 were deployed in other than track maintenance work.	
3. Accident of Train no. 12189,Jablapur – Nizamuddin Mahakaushal Express on 30 March 2017	

Table 16 – Important findings of four major accidents	
Spot of Accident	Between Mahoba and Kulpahar Stations under Manikpur- Jhansi Section, jurisdiction of SSE/Mahoba
Loss of life/ railway property	Estimated loss of ₹ 25.6 lakh on account of damaged track. Eight rearmost Coaches of the Train derailed and 10 passengers injured.
Cause of accident as per supervisors joint note	Fracture near rail joints.
Report of the Commissioner of Railway Safety (CRS)	Not made available to Audit.
Audit findings regarding track maintenance activities of the section	
• As per USFD test, 276 defective welds and 76 defective rails existed at different locations. Welding of most of defective welds was done in 2002 and 2003 i.e. welds are old and prone to frequent weld failures. • TRC was not done as per frequency prescribed. During 2016-17, only TRC was done in July 2016. • Out of 127 track maintainers on roll, 20 track maintainers were deployed in other than track maintenance work.	
4. Derailment of Train no. 18101, Tata-Jammu Tawi Express on 25 March 2015	
Spot of Accident	Near KM-887/21 in Sirathu- Athsarai Section (Main Section Allahabad-Kanpur) under jurisdiction of SSE, Khaga
Loss of life/ railway property	11 coaches derailed, cost of damage ₹1.64 crore Death of 10 passengers
Cause of accident	Buckling of Track
Report of the Commissioner of Railway Safety (CRS)	Report of CRS finalised on 26.05.2015 and as per enquiry report of CRS derailment of Train caused by buckling of track. Responsibility fixed against three railway staffs.
Audit findings regarding track maintenance activities of the section	
• Under-utilisation of track maintenance machines in Allahabad Division was 23.40 to 81.61 *per cent*. • TRC was to be done once in three months. During 2016-17, only two TRC done in July 2016 and December 2016. • Deep screening was overdue at seven location for length of 25 km between two to five years. De-stressing was required to be done on seven locations. However, due to non-maintenance of record and not providing the access to TMS report to Audit, could not be ascertained whether de-stressing was done or not. • Out of 242 track maintainers on roll, 41 track maintainers were absent between May 2014 to May 2015.	

Detailed observations in respect of five major accidents are given in **Appendix II.**