

## Safety

There were 106\* consequential train accidents in 2015-16 as compared to 131\* in 2014-15. Train accidents per million train kilometres, an important index of safety, is 0.10 in 2015-16 as compared to 0.11 in 2014-15.

Comparative position of train accidents during last the five years is as under:

Year	Colli- sions	Derail- ments	Level Crossing Accidents	Fire in trains	Misc. accidents	Total*	Train accidents per million train Kms.
2011-12	09	55	61	04	02	131	0.12
2012-13	06	48	58	08	-	120	0.11
2013-14	04	52	51	07	03	118	0.10
2014-15	05	60	56	06	04	131	0.11
2015-16	03	64	35	00	04	106	0.10

\*excludes Konkan Railway.

### Casualties and Compensation:

The number of passengers injured or killed in train accidents and compensation paid in the last five years are given below:-

Year	No. of passengers		Casualties per million* Passengers carried	Compensation paid# (₹ in Lakhs)
	Killed	Injured		
2011-12	100	586	0.08	498.00
2012-13	60	248	0.04	319.63
2013-14	42	94	0.02	149.22
2014-15	118	324	0.05	127.00
2015-16	40	126	0.02	263.00 (Approx.)

\* excludes Konkan Railway

# Compensation paid during a year relates to the cases settled and not to accidents/ casualties during that year.

### Causes of Train Accidents:

Out of 106 train accidents which occurred on IR during 2015-16, 92(86.79%) were due to human failure, including 54 (50.94%) due to the

failure of railway staff and 38(35.85%) due to failure of other than railway staff. Most of the accidents due to failure of other than railway staff have occurred at unmanned level crossings where the liability is primarily that of road users. 2(1.84%) accidents were caused due to 'equipment failure', 1(0.94%) due to sabotage, 9(8.49%) on account of incidental factors and causes of 1(0.94%) accidents could not be established and 1(0.94%) accident was due to the combination of factor.

### Damage to Railway property

The cost of damage to railway property and duration of interruption to through communication caused by consequential train accidents during 2014-15 and 2015-16 were as under:

Year	Cost of damage		Interruption to through communication (Hours)
	Rolling stock Inclusive of engines (₹ in lakh)	Permanent way (₹ in lakh)	
2014-15	6,313.06	894.45	946.27
<b>2015-16</b>	<b>5089.42</b>	<b>834.33</b>	<b>923.05</b>

Note: The above figures exclude Konkan Railway.

### Measures to improve safety

- **Safety Action Plans-** were continually executed to reduce accidents caused by human errors. A multi-pronged approach with focus on introduction of newer technologies, mechanization of maintenance, early detection of flaws, etc. to reduce human dependence in the first place, alongwith upgrading the skills of the human resources were the prime drivers for accident prevention.
- **Periodical safety audits-** of different Divisions by multi-disciplinary teams of Zonal Railways as well as inter-railway safety audits were conducted on regular basis. During 2015-16, 84 internal safety audits and 32 inter-railway safety audits were carried out.
- **Training facilities-** for drivers, guards and staff connected with train operation have been upgraded. Disaster Management Modules have also been upgraded. During 2015-16, 95,015 safety category employees attended refresher training.

### Measures to avoid collisions

To increase Efficiency and to enhance Safety in train operations, Advanced Signaling System with Panel/Route Relay/Electronic Interlocking (PI/RRI/

EI) along with Multi Aspect Colour Light Signals have been progressively provided at 5,393 stations i.e. about 86% of Broad Gauge stations of Indian Railways, replacing outdated Multi Cabin Mechanical Signaling system involving a large number of human interfaces. Route Relay Interlocking/Electronic Interlocking at 13 major stations namely Majeri, Malda Town, Sultangarh, Tuglakabad, Badarpur, Lumding, Ernakulam, Hatia, Katrasgarh, Etawah, Naini, Hanumangarh, Itarsi, Panel Interlocking at 151 Stations and Electronic Interlocking at 155 stations have been provided during the year 2015-16.

**To avoid collisions technological aids are briefly enumerated below:**

- **Complete Track Circuiting:** Complete Track Circuiting has been done upto 99.82% on A, B and C routes. Fouling Mark to Fouling Mark track circuiting on 'A', 'B' 'C', 'D Special' and 'E Special' routes, where permissible speed is more than 75 kilometres per hour has been completed.
- **Block Proving Axle Counter (BPAC):-** To enhance safety, automatic verification of complete arrival of train, Block Proving Axle Counter (BPAC) is being provided at stations having centralized operation of points and signals.
- **Automatic Block Signalling:** For augmenting Line Capacity and reduce headway on existing High Density Routes on Indian Railways, Signalling provides a low cost option by provision of Automatic Block Signalling. As on 31.03.2016, Automatic Block Signalling has been provided on 2,752 Route Kms.
- **Train Protection and Warning System (TPWS):** Train Protection and Warning System (TPWS) based on European technology ETCS L-1 is a proven ATP System to avoid train accidents/ collisions on account of human error of Signal Passing At Danger (SPAD) or over-speeding. As a pilot project, TPWS has been provided on Chennai-Gummidipundi Suburban Section of Southern Railway (50 RKms). In another pilot project on Hazrat Nizamuddin – Agra Section of Northern/North Central Railway (200 RKms), commercial trials with 35 locomotives in nominated trains have been completed. Gatiman Express running at 160 Kmph on Delhi-Agra section has been equipped with TPWS. TPWS has also been provided on Dum Dum-Kavi Subhash section of Kolkata Metro (25 RKMs) and introduced in commercial service on all the EMU rakes. Work for provision of track side equipments of TPWS on Basin Bridge-Arakonam Section (67 RKms) of Southern Railway is under progress.

Based on experience gained, TPWS has been approved for 3,330 Route Kilometers (RKMs) covering Automatic Signalling Sections of Indian Railways (IR). In first phase the implementation of TPWS works has been taken up on 1,244 RKms, automatic Signalling sections on Zonal Railways where EMU services ply with onboard equipments on EMUs rakes only. Further, Railways have been advised for implementation of the balance sanctioned work of TPWS on 2,086 Rkms on HDN-1/HDN-2/HDN-3 Routes.

### **Train Collision Avoidance System (TCAS)**

- TCAS is being developed indigenously by RDSO for Collision Prevention as well as Protection against Signal Passing At Danger (SPAD) by loco pilot. RDSO has finalized the Specification after successful proof of concept trials. Extended field trials with multi-vendor, interoperability features are being conducted by RDSO on 250 km section on South Central Railway. After completion of field works in the pilot section (250 Rkm), extended field trials on 2 pair of trains have commenced on 15.02.16. System's performance under field conditions is being monitored and corrective action being taken based on regular analysis of trial results by RDSO. Operational deployment of TCAS on Railways on Absolute Block Signalling sections will be considered after conclusion of the extended field trials successfully and safety validation of system to Safety Integrity Level-4 (SIL-4) by an Independent Safety Assessor (ISA).
- **Train Management System (TMS)** TMS helps in real-time monitoring of trains in the control room. The arrival status of local trains is displayed on indicators installed on platforms in the form of a countdown (in minutes) to the train's arrival on the platform accompanied by automatic announcements on platforms. TMS has been provided on Mumbai suburban section of Western and Central Railway. TMS work is near completion on Howrah Division of Eastern Railway.
- **Accidents at Level Crossings** have been a major area of concern. Indian Railways have provided interlocking with Signals at 10,776 Level Crossing Gates to enhance the safety at Level Crossings. Initiative has been taken to Interlock Level Crossing gate with Train Vehicle Units of 20,000 and above.

### **Measures to Reduce Derailments**

- **Upgradation of Track Structure** consisting of pre-stressed Concrete (PSC) sleepers, 52 Kg/ 60 Kg high strength (90 Kg/ mm<sup>2</sup> ultimate tensile strength) rails on concrete sleepers, fanshaped layout on PSC sleepers,

Steel Channel Sleepers on girder bridges has been adopted on most of the routes.

- **Standardization of track structure with 60 Kg Rails and PSC Sleepers:** Track structure is being standardized with 60 kg rails and PSC sleepers on all the Broad Gauge routes, especially on high density routes to reduce fatigue of rails under higher axle-load traffic. New track construction and replacement of over-aged tracks is being done by PSC sleepers only.
- **Long welded rails:** For improving maintenance and better asset reliability, Railways are consistently eliminating fish plated joints on tracks by welding the joints to convert all single rails into long welded rails to the extent possible. During relaying/construction of new lines/gauge conversion also, long welded rails are laid on concrete sleepers to the extent possible. Mobile Flash Butt welding is being done on priority in construction projects and through weld renewal works. Mobile Butt welding plants are being arranged in Zonal railways for welding work of construction/Open line. Turnouts are also being improved systematically. Now Thick Web Switches are being used to improve asset reliability and to cope with higher axle load and increased volume of traffic. Now Weldable Cast Manganese Steel Crossings have been planned to be provided on identified routes in a phased manner to improve asset reliability and to cope with higher axle load and increased volume of traffic.
- **Flash Butt Welding :** There is progressive shifting to Flash Butt Welding which is superior in quality as compared to Alumino Thermic (AT) welding.
- **Ultrasonic testing of rails and welds:** Other measures taken in this direction include use of modern diagnostic aids like Digital Ultrasonic Rail Flaw Detectors (USFD), track recording cars, use of on-track machines for maintenances of track to higher standards controlling/reducing rails and weld failures and ensuring quality of rails during manufacture. Analogue type USFD machines have been replaced with digital type machines which have the facility of freezing scan and storing data during rail and weld testing. Vehicle Borne USFD Testing of Rails/Welds is also planned to test about 30400 Track km length on Rajdhani route which is capable of on line recording of data and run over run analysis, by which defect growth rate can be monitored and timely action taken to remove such defects before it actually fails.

- **Tie Tamping and Ballast Cleaning Machines:** There has been progressive use of Tie Tamping and ballast cleaning machines for track maintenance. Also, sophisticated Track Recording Cars, Oscillograph Cars and Portable Accelerometers are being used progressively.
- **Rail Grinding Machines:** Two Rail Grinding Machines are working on high density routes of Indian Railways for enhanced reliability of Rails.
- **Electronic monitoring of track geometry** is carried out to detect defects and plan maintenance.

## Coaches

- **Centre Buffer Coupler:** Progressive fitment of tight lock Center Buffer Couplers (CBC) in lieu of screw coupling on new manufacturing of ICF design coaches has been carried out with a view to prevent the coaches from climbing over each other in an unfortunate event of an accident. So far, 4,400 LHB coaches, 425 Hybrid Stainless Steel Coaches & 1,340 conventional ICF design coaches have been manufactured with CBC. Design of CBC has been upgraded to mitigate the problem of jerks during acceleration/ deceleration of trains.
- **Crashworthy features of Passengers Coaches:** To improve upon the standards of safety, a “crashworthy” ICF coach design, in conjunction with a Centre Buffer Coupler (CBC) , was evolved. Such a design enables absorption of significant amount of energy during the impact/collision. About 530 such crashworthy ICF design coaches have been manufactured so far. LHB AC Double Decker coaches introduced first time on Indian Railway have also been provided with enhanced crashworthy features. On similar lines, principal design for a crash worthy LHB coach shell has been manufactured and crash test for design validation on this coach has been completed at RDSO. Enhancing crashworthiness of coaches therefore remain continuous endeavour of Indian Railways which minimizes injury/loss of life in the event of collision when compared with ICF designed conventional coaches.
- **Progressive use of Air Springs:** For enhancing safety and reliability of passenger coaches, the suspension systems are being redesigned with air springs at secondary stage capable to maintain constant height at variable loads. Air springs have been developed and are being fitted on all the newly built EMU & DMU coaches for sub-urban trains. Air springs have now been developed for mainline coaches as well and have been fitted in limited number of coaches. In future, more coaches inducting LHB coaches have been planned for provision of Air spring.

- **Proliferation of LHB coaches for improving Safety:** LHB type coaches have interior crashworthy and anti climbing features. There is plan for complete switchover to production of LHB type coaches in future. Hitherto these coaches were inducted into premier services such as Rajdhani, Shatabdi and Durantoos but now these are also being inducted into Mail & Express trains as well.
- **Provision of Automatic entrance doors and Bi directional swing doors in coaches:** Provision of Automatic entrance doors have been planned on coaches to prevent accidental falling of passengers from running trains. One air-conditioned EMU (Electric Multiple Unit ) rake with Automatic doors, similar to Metro coaches for Mumbai, Western Railway has been manufactured at Integral Coach Factory (ICF) Chennai. ICF has turned out coaches for Kolkata Metro with Automatic door closure mechanism. Automatic entrance doors have been provided in the design of coaches of one Linke Hofmann Busch(LHB) rake with a higher speed potential of up to 200 kmph. Besides, for faster evacuation in case of emergency, AC compartment doors have been made with Bi-directional swing and fitment started in newly manufactured coaches. Retro fitment is also being done in all AC coaches in a progressive manner.

### **Measures taken to prevent Fire in Trains**

- **Improving Fire Retardancy in Coaches:-** Coaches are being provided with fire retardant furnishing materials such as Fire retardant curtains, partition paneling, roof ceiling, flooring, seat and berths along with cushioning material and seat covers, Windows and UIC Vestibules etc. The specifications of these items are being upgraded from time to time as a part of continual improvement. In the recent past, another parameter called 'Heat Release Rate ( HRR)' has been added in the material specification of all major interior furnishing materials used in coaches as per latest European norms.
- **Introduction of Automatic Fire and Smoke Detection System:** A pilot project for field trial with Automatic Fire and Smoke Detection system was taken up in one rake of New Delhi- Bhubaneswar Rajdhani. Besides, one LHB rake in New Delhi –Jammu Tawi Rajdhani train and one rake of LHB AC Double Decker rake running between Kacheguda-Tirupati/Guntakal of South Central Railway have been provided with Automatic Fire and Smoke Detection system. In the latest specification Air brake system has been interfaced with Fire and Smoke detection system for stoppage of trains in emergency situations. Provision on 2750

coaches (around 110 rakes) has been further sanctioned by IR. Besides, AC coaches trial on Non AC coaches has also been planned.

- **Provision of Fire Extinguishers:** Dry chemical powder type fire extinguishers are being provided in all mainline trains. These are portable fire extinguishers and easy to use by on board staff or passengers in case of emergency. Fire extinguishers are being provided in all Air-conditioned coaches, Second class- cum-guard and luggage van, Pantry cars and train locomotives. In other Non-AC passenger coaches, trial fitment has been done on 100 coaches.
- **Provision of Water mist type Fire Suppression in pantry cars and power cars:** Power cars and Pantry cars are relatively more prone to fire and therefore Fire suppression system based on water-mist technology is being tried out on limited numbers of coaches before large scale proliferation.
- **Inspection of Electrical & LPG Fittings in Pantry Cars:** Detailed instructions have been issued to zonal railways for observance of safe practices in handling of pantry cars and for ensuring periodical inspection of electrical and LPG fittings in the pantry cars.
- **Publicity Campaigns:** Intensive publicity campaigns to prevent the travelling public from carrying inflammable goods are regularly undertaken.

### **Measures to Curb Accident at Unmanned Level Crossings:**

Various measures taken by Indian Railways to prevent accidents at level crossings, are as under:

- **Containing the proliferation of Level Crossings (LCs) at source:** A policy decision has been taken not to permit any new LC either on existing line or any new line/ gauge conversion to be commissioned henceforth. However, in exceptional cases, retention of unmanned LCs on new line or gauge conversion can be permitted with the approval of Railway Board.
- Ministry of Railways have decided to progressively eliminate all unmanned level crossings by:
  - (i) **Closure** – Closing unmanned level crossings having NIL/ Negligible Train Vehicle Unit (TVU).
  - (ii) **Merger** – Merger of unmanned level crossing gate to nearby manned or unmanned gates or subway or Road Under Bridge (RUB) or Road Over Bridge (ROB) by construction of diversion road.

(iii) **Provision of Subways/ RUBS**

(iv) **Manning** - The unmanned level crossings which cannot be eliminated by above means, will be progressively manned based on rail- road traffic volume, visibility conditions.

**(a) Level Crossing:** Level crossings are meant to facilitate the smooth running of traffic a in regulated manner governed by specific rules & conditions, Status of level crossings on IR as on 01.04.2016 is as under:

Total Number of level crossings	:	28,607
Number of manned level crossings	:	19,267 (67%)
Number of unmanned level crossings	:	9,340 (33%)

Indian Railways has decided to progressively eliminate the level crossings for the safety of Road users and train passengers. During the year 2015-16, 1,253 Nos. of unmanned level crossings and 390 Nos. of manned level crossings have been eliminated.

During the year 2016-17 (upto September, 2016), 505 Nos. of unmanned level crossings and 218 Nos. of manned level crossings have been eliminated.

**(b) Road Over/Under Bridges:** To improve safety of train operation and reduce inconvenience to road users, level crossings are being replaced by Road Over/Under Bridges/Subways (ROBs/RUBs) in a phased manner based on the quantum of traffic.

There are 2,117 of sanctioned works of ROBs/RUBs appearing in Pink Book 2016-17 which contains 1,592 ROBs and 6065 RUBs/Subways. These are at various stages of planning, estimation and execution.

During the year 2015-16, 194 ROBs and 830 RUBs/Subways have been constructed under cost sharing, railway cost/accommodation works, Deposit/BOT term and by NHAI over Indian Railway.

During the year 2016-17 (upto September, 2016), 64 ROBs and 404 RUBs/Subways have been constructed over Indian Railways.

**Major Achievements:** In the Budget 2016-17, 949 ROBs/RUBs and other Safety works have been sanctioned at a total cost of ₹14,091 crores. These works will result in elimination of 1,621 Level Crossings (LCs) including 973 unmanned LCs.

**(c) Bridge Inspection and Management System:** Modern Bridge Inspection techniques have been adopted, which includes testing by non-destructive testing equipments, under water inspections, monitoring the water level with the help of water level system etc. Bridge Management system is also being developed which will have the facility for uploading

of photographs, Bridge design data, inspection details etc.

**(d) Patrolling of Railway Tracks:** During adverse weather conditions patrolling of railway tracks including night patrolling is carried out at vulnerable locations regularly.

### **Administrative Measures**

- **Constant Review of Safety Performance at Board's apex level:** Safety performance is invariably reviewed as a first item on Agenda of Board Meeting at the apex level. All accidents are analyzed in detail so that remedial measures can be initiated.
- **Safety Review Meetings with Zonal Railways:** Chairman and Board Members have conducted Safety Review Meetings with General Managers and PHODs of zonal railways during their visits.
- **Intensive Footplate Night Inspections:** Intensive footplate inspections including night inspections have been conducted at the level of SAG and Branch officers and supervisors in the field.
- **Regular Safety Drives:** Safety drives have been launched from time to time, covering the lessons learnt from recent train accidents so as to prevent similar accidents in future.



*A view of Construction of ROB on North Western Railway*