Chapter 5 – Signal and Telecommunication

The Signalling Department is responsible for Safe Train operations and maximizing the utilization of fixed and moving assets such as train rakes, locos and tracks etc. The Telecommunication Department caters for safety related and operational communication needs of the Indian Railway network.

The S&T Organization is headed by Member-Electrical and is assisted by Additional Member (Signal) and Additional Member (Telecommunication). At Zonal, level the organization is headed by Chief Signal & Telecommunication Engineer (CSTE) who is assisted by Chief Signal Engineer, Chief Communication Engineer, CSTE (Planning), CSTE(Projects) and CSTE(Construction).

The total expenditure of the Department during the year 2010-11 was ₹3,679.86 crore. During the year, apart from regular audit of vouchers and tenders etc., 237 offices of Signal & Telecommunication Department were inspected.

This chapter incorporates a study on safety works viz. provision of Anti Collision Device (ACD) and Train Protection and Warning System (TPWS) over Indian Railways. The study revealed that despite lapse of about a decade since the trails of the ACD began, the system had not been a proven success. The TPWS system tried in Southern Railway had also not met with success.

Safety works on Indian Railways – Anti Collision Device (ACD) and Train Protection and Warning System (TPWS)

Executive Summary

The Ministry of Railways (Railway Board) adopted a Corporate Safety Plan (2003-2013) laying down a comprehensive strategy for implementation of safety related works. The performance of pilot project for installation of ACD over Northeast Frontier Railway (NFR) was reported to Parliament (Report No. 26 of 2008-09 tabled on 24 July 2009). Railway Board in their reply had stated that ACD was successfully implemented on trial basis on Northeast Frontier Railway and would be extended to three other Railways. The present study assessed Railway's performance in provisions of Anti Collision Device(ACD) and Train Protection and Warning System (TPWS) up to June 2011.

Audit observed that though Railway Board had conducted trials with ACD in 2001 and sanctioned a pilot project in Katihar – Guwahati-Ledo/Dibrugarh section (1736 Rkm) of Northeast Frontier for installation and commissioning of the safety equipment, the trials conducted so far had not indicated satisfactory results. The ACDs were prone to generation of spurious information and were not applying automatic breaks indicating presence of another train on the approach section. Thus despite incurrence of expenditure of ₹158.67 crore, and inducting several modifications, the reliability of the system was not certain and robust.

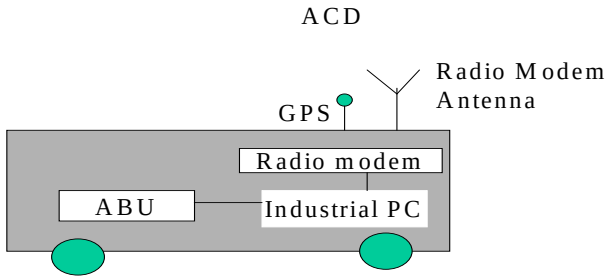
Similarly despite commissioning of the TPWS in Southern Railway in May 2009 at a cost of ₹49.49 crore, the trial reports indicated various failures of the equipment requiring modifications in the software. The performance efficiency recorded during trials was between 77 to 90 per cent as against the acceptable level of 99.9 per cent. The TPWS work commenced (2005) in North Central Railway had not yet been completed despite incurrence of expenditure of ₹41.54 crore.

5.1 Introduction

With human failure accounting for nearly 86 per cent of the train accidents (half of them by Railway staff), the Indian Railways have recognized the necessity of accident prevention strategies through adoption of upgraded technologies and signaling and telecommunication. The Vision 2020 brought out by the Ministry of Railways had affirmed safety as a critical Mission Area and targeted zero tolerance for accidents through a combination of technological and HR intervention. Under the Corporate Safety Plan (2003-2013) Indian Railways has inducted modern safety devices such as Block Proving Axle Counters (BPAC), GPS based Fog Safe Device, Auxiliary Warning System (AWS), Vigilance Control Device (VCD), etc. In addition, XI Five Year Plan has considered anti-collision devices that are under trial in the IR since 2000-01 as a part of planned technological up-gradation to achieve reduced human dependence.

5.1.1 Anti Collision Device (ACD)

Anti Collision Device (ACD) also called "Raksha Kavach" is a train collision prevention system developed by Konkan Railway Corporation (a Public Sector Undertaking of Ministry of Railways). First proto-type of ACD was demonstrated by KRCL in December, 1999. The ACD is an intelligent micro-processor based equipment. It consists of a central processing unit, a global positioning system and a digital modem for communication with other ACDs. When installed on locomotives, brake vans and at stations and level crossing gates, these ACDs network among themselves to prevent accident like conditions.



Hardware
486 Industrial PC,
Data Radio
GPS
Automatic braking Unit

Software/function
Operating system- DOS
Radio protocol- CSMA/CD
Latitude/ Longitude/speed/direction from true north
Normal braking and emergency braking

There are two types of ACD equipments viz. mobile ACDs for locomotives and brake vans and stationary ACDs for stations and level crossing gates.

LOCO ACD ABU

Goods Guard ACD

Gate ACD MLCG

All the ACDs interact with each other and exchange information when they are within their radio zones up to three kilometers. While approaching a station, loco ACD gives station approach warning to the driver. In the event of not acknowledging this warning, the speed of the train is regulated automatically. While entering the station area, if loco ACD detects a train on the main line the system automatically regulates the speed. In the mid section, loco ACDs remain in look out position to detect the presence of other trains in a radius of three kilometers. In case, another train is approaching on the same track, the ACDs apply brakes in both the trains to bring them to a stop thereby reducing possibility of head-on collisions. When a train is approaching a level crossing gate, visual and audio warning is initiated by the ACD systems for the road users.

5.1.2 Train Protection and Warning System (TPWS)

The Train Protection & Warning System (TPWS), a variant of Auxiliary Warning System (AWS), is a train protection system prevalent in European Countries especially in UK Rail Network. It automatically activates brakes on any train that passes a signal at danger or is over-speeding. The purpose of the TPWS is to reduce the number and minimise the consequences of Signals Passed At Danger (SPADs) by providing the facilities of Over-speed Sensor and Train Stop. The main purpose of an Over-speed Sensor is to demand a brake application on a train that approaches a signal at danger at such a speed that has high probability of a SPAD occurring. Over-speed Sensors are also used at locations not associated with signals, e.g. at permanent speed restrictions and buffer stops. The purpose of a Train Stop is to demand a brake application on a train which passes a signal at danger without authority.

5.2 Background for Audit

The Ministry of Railways (Railway Board) adopted a Corporate Safety Plan (2003-2013) laying down a comprehensive strategy for implementation of safety related works. In 2004, Railway Board informed the Standing Committee on Railways that a number of steps were being taken to induct safety related technologies such as introduction of ACD and TPWS. Railway

Board also committed that the ACDs would be installed on entire Broad Gauge system by 2013.

The performance of pilot project for installation of ACD over Northeast Frontier Railway (NFR) was reported to Parliament (Report No. 26 of 2008-09 tabled on 24 July 2009). Railway Board in their reply had stated that ACD was successfully implemented on trial basis on Northeast Frontier Railway and would be extended to three other Railways. In the 'White Paper on India Railways' presented to Parliament (2009), Railway Board had indicated that based on the experience over NFR, revised specifications for ACD were framed and KRCL was asked to develop ACD with revised specifications for trial on the three Railways. Subsequently, the Minister of Railways in her Budget speech made in Parliament on 25 February 2011, had also declared that trials with an improved version of ACD had met with success and the same would be commissioned on three more Zonal Railways - Southern Railway, South Central Railway and South Western Railway."

5.3 Audit objectives

This study was thus, conducted as a sequel, in the light of assurances given to the Parliament to make an assessment with regard to progress achieved in trials of -

- Anti Collision Device (ACD) over Northeast Frontier Railway and its extension to other Zones.
- Train Protection and Warning Systems (TPWS) over Southern Railway and its expansion to other Zones.

5.4 Audit methodology

Audit reviewed in depth the relevant records of trials of installation and commissioning of ACD over NFR and TPWS over Southern Railway. In addition, records of other Zonal Railways where provision for ACD and TPWS were sanctioned were also examined. The period covered the entire duration of trials and commissioning till 30th June 2011.

5.5 Installation of Anti Collision Device

5.5.1 Trials of ACD in Indian Railways

To start with, Indian Railway first conducted field trials of ACD developed by Konkan Railway Corporation Limited on Northeast Frontier Railway in 2000/2001 on a limited scale and a pilot project to provide ACD in Katihar – Guwahati-Ledo/Dibrugarh section (1736 Rkm) of Northeast Frontier Railway (NFR) was included in the Works Programme of 2000-01 at an anticipated cost of ₹50 crore subsequently revised to ₹96.36 crore. After some rectification by KRCL in the ACDs, extended field trials were conducted during August 2002 to January 2003 on Jallandhar – Amritsar section of Northern Railway to test proof the device in a working railway system and thereafter first set of specifications was finalized by Research Design & Standard Organisation (RDSO).

5.5.2 Installation of ACD over Northeast Frontier Railway (NFR)

The work of provision of ACD was undertaken by KRCL after signing the Memorandum of Understanding with the Indian Railway. Field surveys on NF Railway were completed in September 2003 and work started in January 2004. Final Working agreement for erection and commissioning of 1018 stationary and Mobile ACDs in Katihar-New Jalpaiguri-Guwahati section of NFR was signed in 17 September 2004 (modified in May 2007 to include New Jalpaiguri – Samukatala Road 141 Kms section). The first Site Acceptance Test (SAT-I) of Anti Collision Device (ACD) system deployed in Katihar-New Jalpaiguri-Guwahati section was conducted by a Joint team of KRCL, RDSO and NFR during the period 31 July 2005 to 17 August 2005. As the trials had brought out spurious detection of abnormal situations causing unwarranted applications of train brakes, mismatch of information amongst different ACDs installed in the loco, guard van, at stations and level crossings, the work was stopped on the direction of Ministry of Railway in May 2006 pending evaluation of performance parameters by multi disciplinary team (MDT), transfer of design documents to RDSO as well as verification of selection of technology partner by KRCL.

5.6 Audit findings

5.6.1 Acceptance of the System

Audit observed that the multidisciplinary team constituted by the Board in November 2006 which included experts from ISRO and a scientist of reputed institute was unable to carry out evaluation of the system as the design documents, despite repeated requests, were never made available by KRCL who owned the system design.

Item	**Parameters approved by RB**	**Upper limit proposed by KRCL**	**Performance during SAT-I per loco day (Locos 95 , Loco days 377)**	**Performance during SAT-II**	**Comments/ observation**
Wrong TID (% of total decisions	0	0.25	0.27	0.14 (0.15 per loco day)	The availability of correct TID and communication availability of at least 99.99% each as per FRS should be ensured.
TID-FS for loco ACD (% of total decisions)	Performance and effects on train operations to be observed by MDT and comments given	0.25	2.00 per loco per day	0.78 (0.85 per loco day)	
TID-FS braking		0.25 loco day	1.84 per loco day	0.17 per loco day	
TID assignment failure resulting in TID-FS		0.1 per station loco day	0.08 per LD	5.5% of loco movement through TID assigning station	
Spurious parting/ Jumbling		0.1 per LD	0.42	0.08 per LD (after accounting for dropping/ picking, shunting of terminating/ originating load	
Loco ACD restrarts		0.1 per LD	1.7	0.35 per LD	
Spurious fauling cases		0.1 per LD	0.37 per LD	User Domain	
No communication	As per Functional Requirement	0.25 per LD	7.0 per loco day	StationaryACD-1.08/LD Loco ACD 0.12 /LD Guard ACD 1.17/LD	

Low communication	Specification	0.25 per LD	2.5 /LD	StationaryACD-0.04/LD Loco ACD 0.01 /LD Guard ACD 0.19/LD	
Battery low event	Such cases should be avoided	Depends on maintenance	0.47 (excl. Guard ACD	0.66/LD incl. guard ACD and 0.31 excl. guard ACD	

Audit further observed that second Site Acceptance Test (SAT-II) of the pilot project of ACD system was conducted by RDSO and NFR as directed by the Railway Board during 9 March 2007 to 29 March 2007 using a modified version of Station and Loco ACDs for deriving inputs from track circuits for corrections of track identification (TID). The Site Acceptance Test II Report prepared by RDSO and NFR revealed that as compared to SAT I there were improvements in ten parameters: however, there were five areas namely, track assignment failure, TID- failsafe cases in guard ACD, low battery events, spurious messages regarding head on collision, assurance on reliability and availability of parameters that were considered not comparable and needed evaluation by the MDT. Table below summarize the report highlights.

In quite a few areas, the Railway Board was not able to establish its own safety parameters for want of expert evaluation by the MDT. As pointed out already, the MDT evaluation was pending as the system design documents were not transferred by KRCL.

The SAT II report also emphasized that as per the Functional Requirement Specification (FRS) the modified ACD would function as a GPS based safety shield against collisions and would use inputs from existing signaling system of the Railways only to supplement its working and not be dependent on it. Audit noticed that -

- The deviation count theory based on which the original version of the ACD system was modeled was no longer applicable as the functional requirements specifications(FRS) were modified to draw inputs from track circuits(signaling system) and thus had become dependent on signalling system in a big way. Since the information from signalling system was not processed in a failsafe manner, the reliability of ACD on information derived from existing system would not be useful to avert collision.
- ACD was not only dependent on signalling system but its decisions based on inputs received from signalling had overriding priority over other decisions of ACD including KRCL's patented Deviation Count Theory (DCT)[13]. This was reflected in the correction of TID at stations.
- The ACD was not in a position to judge whether the inputs derived from the signalling systems were dependable i.e. whether the

[13] **Deviation Count Theory** is a technique by which both loco and guard ACDs automatically deduce, using input from GPS receiver, the change in their Track IDs when they negotiate a point zone already pre-fed as data in the deviation count table of that station. Accuracy & efficacy on Points on a curve, Ladder points, Diamonds & Slips to be spelt out clearly by supplier.

signalling inputs were derived under the condition of unsafe interference, disconnection or non-interlocking of signalling gears. Wrong Track Identification (TID) can be assumed by Loco and Guard ACD under abnormal working, for example, there were 9 cases of wrong TID at Kendukana station when wiring of dead points and crossings zone points was disturbed due to shifting of relay room during Electronic Interlocking work.

- In case of non-interlocked working or failure of track circuit, correct TID assignment would not be possible and thus prevention of accident of the nature that had occurred at Gaisal would not be possible.

5.6.2 Limitation of Site Acceptance Test –II

The above assessments were subject to certain limitations recognized in the report such as –

- Design details of ACD were not shared or handed over by KRCL to RDSO / NFR leading to the qualification that all the design deficiencies had not come out during the SAT-II that required constant monitoring of the system not only for rectification but also for unusual performance of ACD.
- Besides certification of design by the verifier and validator i.e. Electronic Test and Development Centre (ETDC) and agency carrying out the test were necessary to establish the suitability of ACD.
- Significantly, the SAT II Report had indicated that performance of the system was likely to be considerably impacted when all the trains in the sections were equipped with loco and guard ACDs and all the level crossings covered.

During the SAT –II, the position of defective ACDs was as per Table below:

Type of ACD	Installed	Switched off	Decommissioned (removed from the data file of Loco ACD	Working	Defective percentage
Station ACD	172	4	0	168	2.32
MLCG ACD	61	4	7	50	18.03
Repeater ACD	139	27	37	75	46.04
UMLC ACD	51	9	12	30	41.17
Total	423	44	56	323	23.64

The above table indicated that during SAT-II, 23.64 per cent ACDs were either defective or decommissioned.

5.6.3 Commissioning of ACDs

Thus although there remained unresolved issues, the Railway board as a follow up of SAT-II, Railway Board (25 June 2007) approved the appraisal of operational requirements delivered by ACD application of pilot project and directed NFR to treat the project as commissioned by taking over the assets. The ownership of ACDs was assigned as per Table below:

S.No.	ACDs installed at	Department
1.	Relay rooms, Equipment rooms at stations and Repeater Stations	S&T Department
2.	Loco Sheds , Locos and Loco Shed Bahar Line	Mechanical or Electrical to whom the loco belongs
3.	Station and Guard	Traffic
4.	Level crossing (Manned or Unmanned)	Engineering

Maintenance of ACDs and training, counseling of staff was to be undertaken by KRCL in co-ordination with S&T department of NFR. For maintenance of all ACDs an Annual Operation Maintenance Contract was entered into between KRCL and NFR. Railway Board while declaring the system as commissioned also directed the KRCL and NFR to complete the following items in a fixed time frame to make the application run in full scale.

- TID assignment malfunctioning cases should be plugged by KRCL at their cost.
- Provisioning of Loco ACDs must be completed so that at least 90 per cent of the trains running on the NFR (both passengers and Goods) are with ACDs.
- Portable goods guard ACD should be used whenever last vehicle was unwired
- KRCL should complete their commitment pertaining to third party certification for software and hardware validation.

Audit however noticed that KRCL had not taken adequate actions for compliance of the above requirements including third party certification as evident from the Report of the team of the Safety Directorate deputed by Railway Board in June 2009 to ascertain the effectiveness of ACD after a lapse of two years. Audit also observed that many of the deficiencies that were noticed during previous testing were continuing and commented upon by the Safety team as under:

- There was no system to detect whether the Loco and Guard ACDs were defective or not.
- No support was available to analyse the repeated cases of failure such as 'isolation of Automatic Braking Unit (ABU)', Normal Brake (NB) not OK.
- There was mismatch between the messages seen by the team at Station Master's console and the message reflected in the ACD AMSS. On 6 September 2009 while the console at Narangi station had recorded eight cases of low communication between 1400 hrs and 2100 hours, the maintenance report of AMMS submitted by KRCL showed no failure.
- As against the prescribed limit of zero, there were 58 cases of invalid/wrong Track identification (TID) in 15 days.
- The Safety team had observed that invalid/wrong TID, TID-FS, Automatic Braking Unit isolated and normal brake not OK could lead to

potentially unsafe conditions as driver may become complacent because of false sense of security provided by presence of ACDs.

5.6.4 Status of ACD as on 30.6.2011

The status of intallation of ACD in Katihar – Guwahati-Ledo/Dibrugarh section (1736 Rkm) of Northeast Frontier Railway (NFR) is depicted in Table Below.

S No.	Type of ACDs	Number of ACDs installed	Number of ACDs in Working Condition as on 30.6.11	Number of ACDs not working due to defects	Not working due to solar panel thefts
Stationary ACDs					
1	Stations	203	194	9	0
2	Manned level crossing Gates (MLCG)	78	59	0	19
3	UMLCG	61	24	0	37
4	Repeater Station	174	52	0	122
5	Loco Shed	12	12	0	0
6	Track Identification Number Assigning	10	9	1	0
7	RI/O Unit	14	14	0	
	TOTAL	552	364	10	178
Mobile ACDs					
1	Loco ACDs	550	522	28	0
2	SLR -Guard ACD	90	87	3	0
3	Goods Train Guard ACDs	145	139	6	0
	TOTAL	**785**	**748**	**37**	**0**
GRAND TOTAL		***1337***	***1112***	***47***	***178***

Out of a total of 552 stationary ACD installed at stations, level crossings both manned and unmanned, Repeater stations, TID assigning etc. 188 (34 per cent) were either defective or were not working on account of theft of solar panel provided for charging the batteries of the ACDs.

Besides 37 mobile ACDs out of 785 provided in the locomotives and Guard Vans were also lying defective resulting in reduced ACD cover. The total cost of these defective ACDs worked out to ₹12.86 crore approximately.

5.6.5 Cost of installation and maintenance

The total expenditure incurred on supply and installation of ACD as well as annual operation and maintenance incurred up to 30 June 2011 was ₹158.67 crore out of which the annual maintenance costs accounted for ₹66.08 crore.

5.6.6 Inadequate ACD coverage

Actual ACD coverage on an average per month (June 2011) was seen to be 33 per cent on Passenger trains and 43 per cent on Goods trains i.e. four years after the commissioning. Since the ACD coverage was not available to two-third of the passengers trains and more than fifty per cent of freight carrying trains, the risk of averting collision was more or less the same even after incurrence of expenditure of ₹158.67 crore.

5.6.7 Non-compliance of provision of operational and maintenance contract

Audit scrutiny of operational and comprehensive maintenance activities revealed that

- As per clause 11.6 KRCL was to report to the NFR on monthly basis the summary of ACD unusual positions, contracted up time of ACDs and analysis of unusual of all field and train bound ACDs vis-à-vis action taken by KRCL to eliminate the reporting of false cases. No action in this regard was being carried out by KRCL as found on record with no assurance on the performance of the system.
- Clause 12.3.2 provided that on completion of physical work by KRCL and submission of bill based on self certification NFR would release 75 per cent of billed amount to KRCL. Balance 25 per cent (clause 12.3.3) of the billed amount would be released by NFR after verification of bills, including receipt of compliance of deficiencies noticed. Audit noticed that during the period 2010-11 and 2011-12 (upto second quarter), NFR had made 75 per cent advance payments of ₹14.06 crore to KRCL on self certification of the work of repair and maintenance done without details of the work of maintenance carried out.

5.6.8 Extension of the system to other Zones

In regard to the declaration by the Minister for Railways during Budget speech (2010-11 and 2011-12) that further commissioning of the ACD was being extended to Southern, South Central, South Western, Eastern, East Central, East Coast and South Eastern Railways. Audit reviewed the progress of installation and commissioning of the works in these zones and found that there was negligible progress (Table below).

Anti Collision Device (ACD) work over Zonal Railways as on June 2011

(₹. in crore)

Railway	Name of the work	latest anticipated cost	Actual expenditure	Status
Southern	Emakulum-Shoranum-Palghat-Errode-Chennai and Bangalore-Jolarpettai-Chennai- Anti Collision Device	75.24	0.05	No work commenced

South Central	Vasco-Madgaon-Londa-Hubli-Guntakal-Renigunta-Anti Collision Device	52.00	0.11	No work commenced
East Central	Anti Collision Device on all broad gauge A.B & D-Special Routes (1736 rkm)	104.20		No expenditure incurred so far.
Northern	Jalandhar - Amritsar - Anti Collision Device	15.73	0.16	Railway Board had stopped the work In May 2006 and as such survey was yet to be conducted
Western	Churchgate-Mumbai Central & Dahanu Road - Gholved - Field trial of Anti Collision Device (A&C routes)	4.67	Nil	Western Railway had proposed to cancel the work of field trials. Decision of the Railway Board awaited.

5.6.9 Conclusion

Audit scrutiny thus revealed that the indigenously developed ACD, based on KRCL's patented deviation count theory was modified for extensive trials in NFR and the system became dependent on the efficiency of the existing signalling system. The continuing deficiencies on various safety counts had not been fully evaluated by RDSO/Railway Board with reference to the system design that needed to be addressed on priority for satisfactory resolution for enhancing safety.

5.7 Provision of Train Protection and Warning System

5.7.1 Introduction of TPWS as pilot projects

Indian Railways had installed Auxiliary Warning System that provided advance information of upcoming signal aspects to the motorman via a display panel in the driving cab of the EMU on Western and Central Railway's suburban sections and the system had worked satisfactorily over the years. In June 1998, Railway Board deliberated new developments in the field of AWS replacing analogue version that had now become obsolete and considered the trial offer received from International Union of Railways [Union Internationale des Chemins de fer (UIC)] for provision of European Train Control System (ETCS). The work of provision of ETCS was included in the works programme (1999-2000) at a cost of ₹48.98 crore. The UIC was to conduct trials on Delhi – Mathura section with 30 Electric and five Diesel Locomotives. The UIC had, however, shown their inability to conduct trials as the specifications of ETCS level II were under formulation and the provision of funds was not firmed up. Railway Board decided (2003), to install a modified system of Train Potection Warning System (equivalent to ETCS level-I) at a cost of ₹53.54 crore in 50 Route KM of Chennai –Gummidipundi section of Southern Railway (SR). The system was to be developed indigenously by RDSO. Another pilot project to provide indigenously developed TPWS over Delhi –Mathura Section of North Central Railway (NCR) was sanctioned (January 2004).

5.7.1.1 Provision of TPWS in Southern Railway

The TPWS was designed to aid the Motorman of an EMU/MEMU train by automatically initiating service brakes and emergency brakes in case of over speeding or disregarding the signal aspects, providing various information like permitted speed, actual speed, over speed audible warning, target distance, target speed, modes and level information on a screen called DMI (Driver Machine Interface) placed at a convenient position in front of the motorman.

The detailed estimate for provision of the TPWS in Chennai –Gummidipundi section of the SR was sanctioned by Railway Board in August 2005 at a cost of ₹53.54 crore. The work was taken up for 50 route kilometers (Chennai - Gummidipundi). The contract for installation and supply of the complete TPWS system was awarded to M/s. Union Switch & Signals Ltd., Bangalore at a total cost of ₹46.77 crore during February 2005 to be completed by August 2006. The contract provided, among other things,

- Provision of 'on board' equipments in 82 Motor Coaches (MCs)
- Track mounted and wayside equipment for 50 RKMs (Chennai - Gummidipundi).

After completion of track side work, Commissioner of Railway Safety, Bangalore inspected the provision of TPWS on 17 October 2007 and sanctioned the commissioning of TPWS during January 2008 and trials were commenced immediately. The installation of TPWS on-board equipment in the motor coaches was completed in May 2009 at a total cost of ₹49.49 crore.

5.7.2 Audit findings

Though the trials were conducted through a period of more than two years, the reliability of the system fell short of prescribed standard of 99.9 per cent. There were failures of the following nature despite modifications to software.

- Simplified Driver Machine Interface (SDMI) blanking
- SDMI Audio port failure
- Balise Transmission Module (BTM) error
- Train Interface Unit (TIU) failure
- Speed bouncing on SDMI
- System failure during booting
- System failure in sleep mode
- Brake not releasing
- Braking during run without reason
- System failure during run

Further analysis of the reports of trials conducted revealed that the reliability of the system had not been established as was indicated in the trial reports detailed below:

- Out of 5608 trials conducted during the period from 25.02.11 to 26.05.11, there were 868 failures. Of this, there were 566 on-board failures, 255 trackside failures and 47 other types of failures such as linkage error, data overflow, etc. The performance efficiency of the system ranged from 77 to 90 percent as against 99.9 per cent as prescribed in Para 7.1 of contract.
- As on 17.07.2011, out of 81 motor coaches (excluding one MC involved in accident), the TPWS system was out of order in 11 MCs for the period ranging from one to four months.
- There were 958 cases of isolation during the period between 25 February 2011 and 26 May 2011 (a situation when train bound equipment is disconnected from communicating with track side equipment) of TPWS. Out of this, 277 isolation incidents were reported by Motormen while the trains were in the section provided with TPWS system. In addition, 1491 cases of isolation/defects were noticed in the maintenance depots during night examination of rakes.
- In spite of providing latest version of European Vital Computer (EVC) on board software and Balise Transmission Module (BTM) software, there were 138 cases of on board failure during the period 3 June 2011 to 13 July 2011, wherein the system went to 'system failure mode' and came to 'healthy mode' simply by repeated booting of the system. Though this clearly pointed out to likely problems in hardware leading to computer not being able to establish communication with its associated equipment such as BTM, Simplified Driver Machine Interface (SDMI), Odometeric Card for measuring speed and distance and Emergency Brake feedback system, the same was not investigated.

Also analysis of failure as mentioned above was not submitted by the firm along with corrective steps taken, if any, for their redressal.

5.7.3 Provision of Train Protection and Warning System in North Central Railway

The tenders for work of Survey, Design, Supply, Installation and commissioning of Loco borne and line side equipment for TPWS in New Delhi – Agra Cantt sections of Northern and North Central Railways were invited in March 2004 and the work was awarded in June 2005 to M/S Union Switch & Signal Pvt. Ltd, Bangalore. The work was to be completed by June 2006. The detailed estimate for ₹60.44 crore was sanctioned in August 2005.

Audit observed that though the equipment to be installed on track and locos had been supplied by the contractor, the same were installed only on ten locomotives and along the track between Agra Cantt.-Mathura-Palwal and Tuglakabad. The work of provision of equipment in remaining locos had not been completed so far (June 2011) despite expenditure of ₹41.54 crore having been incurred. The reasons for delay in completion of the work were attributed to infringement caused by construction of third line between Palwal and Mathura as it required trenching, cable laying and track crossings with probable damage to equipment and various other factors such as frequent

modifications in equipment, on board system, odometery etc. to make the system suitable and adaptable on Indian Railways.

On the basis of recommendation of a high level committee constituted in October 2009, trials were conducted by fitting on-board equipment on one locomotive with features of traction cut off and E-70 interface on 16 coach train (January 2010) by the firm in association with NCR and RDSO. The trial Report was sent to Railway Board in January 2010 but its evaluation results were not available with NCR (June 2011).

5.7.4 Extension of the system to other Zones

While the results of TPWS trials over NCR were still under evaluation and those of Southern Railway were found below acceptable standards, audit found that Railway Board had sanctioned (2010-11) TPWS work on other zones (Table below).

List indicating Train Protection and Warning System (TPWS) work over Zonal Railways up to 30.6.2011

Railway	Name of the work	latest anticipated cost (₹. in crore)	Actual expenditure up to 2010-11 (₹. in crore)	Status
Eastern	Sealdah-Howrah-Khana-Train Protection System (142 kms)	139.00	0.01	Detailed estimate amounting to ₹147.36 crore sanctioned in November 2010. Tender called for but not yet opened.
South Eastern	Howrah-Kharagpur-Train Protection System (116 rkm)	135.57	0.10	No work has been taken up as yet.
Western	Virar-Vadodara - Train Protection System (340 rkm)	146	Nil	Detailed estimate sanctioned by RB in August 2010 at a cost of ₹.127.32 crore. Tenders floated but not finalized.
Southern	Basin Bridge–Arakkonam Junction Section (Slow Line)	25.73		Tender for the work floated in May 2011. Technical bid opened on 19.7.2011
North Central	Tundla-Kanpur-Track side equipment for train protection system (230 rkm) and onboard equipment on electric locos of Indian Railways (100 locos)	144.77	0.30	Tender notice issued and pre-bid conference held in March 2011. RDSO revised the specification of TPWS and qualification criteria also revised by Railway Board.

From the above it was observed that while tenders had been called for by Eastern, Western, Southern and North Central Railways (yet to be finalized), no action has so far been taken by South Eastern Railway.

5.7.5 Conclusion

The trials reports of Indigenously developed Train Protection and Warning System (TPWS) commissioned (May 2009) in Chennai _ Gummidipundi of Southern Railway with 81 on board equipments fittled in 81 Motor Coaches revealed that the system suffered from various software and hardware related problems which needed to be rectified. The work of pilot project (New Delhi – Agra Cantt) commenced six years ago was yet incomplete as the Railway had resorted to frequent changes in the design of the equipment to make it suitable to Indian conditions.

The matter was brought to the notice of Railway Board (January 2012); their reply had not been received.