



भारत सरकार  
रेल मंत्रालय  
रेलवे बोर्ड

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**सिगनल इंजीनियरी नियमावली**  
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GOVERNMENT OF INDIA  
MINISTRY OF RAILWAYS  
(RAILWAY BOARD)

**INDIAN RAILWAYS**  
**SIGNAL ENGINEERING MANUAL**

**VERSION 3.0**

**JUNE 2021**





# Indian Railways Signal Engineering Manual (IRSEM)



## Issue History

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1	Version 1.0	1955
2	Version 2.0	
	Part I	1988
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3	Version 3.0	June 2021

सुनीत शर्मा  
SUNEET SHARMA



### Message

अध्यक्ष एवं मुख्य कार्यकारी अधिकारी,  
रेलवे बोर्ड  
पदेन प्रमुख सचिव, भारत सरकार  
रेल मंत्रालय

CHAIRMAN & CHIEF EXECUTIVE OFFICER,  
RAILWAY BOARD  
EX OFFICIO PRINCIPAL SECRETARY  
GOVERNMENT OF INDIA  
MINISTRY OF RAILWAYS

24<sup>th</sup> February, 2021

Indian Railways (IR) is playing a key role in the development of the country by providing a safe, financially viable and environmentally sustainable transport for both goods and passengers. In the difficult times of Covid-19 pandemic, Indian Railway men worked 24X7 and ensured uninterrupted supply chains across the country. IR is rightly called the **“Engine of Economic Growth”** of the country.

IR is steadily working towards modernizing its network and assets, increasing capacities and improving safety of train operations. Road map of modernization and capacity augmentation has been laid down in National Rail Plan (NRP) and Vision 2024 documents. With all these initiatives, it is envisaged to increase the modal share of rail in freight from present level of 27% to 45%.

Modernization of signalling infrastructure is a prime focus area to improve safety and enhance capacities. Several initiatives have been launched by IR in this direction including provision of modern Electronic Interlocking (EI) system, Automatic Signalling, Centralized Traffic Control (CTC) and indigenously developed Train Collision Avoidance system (TCAS). These initiatives are also furthering the cause of **“AatmaNirbhar Bharat”**.

With induction of modern signalling equipment and systems, regular revision of Signal Engineering Manual (SEM) becomes important. I am happy to note that Signalling & Telecom Department has revised the Signal Engineering Manual for guidance of all Signalling Engineers.

I convey my best wishes to the IRSEM expert committee and all the Signal Engineers and am sure that this revised Signal Engineering Manual will lead to improved reliability of signalling assets, safety & efficiency of train operations.

  
(Suneet Sharma)



सत्यमेव जयते



**PRADEEP KUMAR**

सदस्य इन्फ्रास्ट्रक्चर, रेलवे बोर्ड  
एवं पदेन सचिव, भारत सरकार  
रेल मंत्रालय, रेल भवन  
नई दिल्ली-110001  
**MEMBER INFRASTRUCTURE, RAILWAY BOARD**  
&  
**EX-OFFICIO SECRETARY**  
**GOVERNMENT OF INDIA**  
**MINISTRY OF RAILWAYS**  
**RAIL BHAWAN, NEW DELHI-110001**



### **FOREWORD**

Indian Railway (IR) Signal Engineering Manual has first been published in January 1955. Revised volumes were last issued in 1988 (Part 1) & 2001 (Part 2). Since then several Technological advancements have taken place in Signalling to meet growing needs of Operation, Maintenance & Safety, which necessitated a thorough revision.

To meet out the expectations of increasing mobility, safety and ease of train operations, Indian Railway Signalling up gradation works are taken up. These include elimination of Mechanical Signalling and provision of Electronic Interlocking, Automatic Signalling, Centralized Traffic Control (CTC), Train Management System (TMS) and indigenously developed Automatic Train Protection System named Train Collision Avoidance System (TCAS) to fulfil 'Atma Nirbhar Bharat' vision of IR. In the field of maintenance, use of modern technologies like Artificial Intelligence (AI) is being introduced for Remote Diagnostic & Predictive Maintenance. Field assets shall be gradually fitted with modern sensing devices. This shall bring a new approach towards maintenance of assets, making it more productive and efficient. All these signalling systems have been included in present version of IRSEM. The contents of IRSEM are reorganized grouping similar topics in one chapter. Drawings and maintenance schedule have been added for guidance of all.

Current revision of IRSEM Vol-1 & Vol-2 is the culmination of dedicated, painstaking & yearlong efforts by the Convener & Revision Committee members from IRISSET, RDSO, Sub-committee on Maintenance, Signal Standard Committee & PCSTEs of Zonal Railways through Online Collaborative tools & Video conferencing methods.

I sincerely hope that this revised Signal Engineering Manual (SEM) will enable Officers & staff to bring more uniformity, greater safety, efficient & cost effective maintenance and facilitate modernization of signaling on Indian Railways and also enable Railway's Motto of "Safety, Security & Punctuality".

With Best Wishes

**New Delhi**  
**February, 2021**

  
(Pradeep Kumar)



भारत सरकार  
रेल मंत्रालय, (रेलवे बोर्ड)  
रेल भवन, नई दिल्ली-110001  
GOVERNMENT OF INDIA  
MINISTRY OF RAILWAYS  
(RAILWAY BOARD)  
RAIL BHAVAN, NEW DELHI-110001

## P R E F A C E

After First issue of Signal Engineering Manual in 1955, and later revision in 1988 & 2001, several technological advancements have taken place in Railway Signalling. Indian Railways have been gradually inducting modern technologies such as Electronic Interlocking, Dataloggers, BPAC, MSDAC, TMS/CTC & ATP systems. While the Mechanical Signaling Systems shall be phased out in the next few years, the migration towards Predictive/Condition Based Monitoring using IoT, Artificial Intelligence and Cloud Analytics, shall significantly enhance reliability of the Signalling assets.

The revision of Signal Engineering Manual is thus a much needed necessity in successful adaptation of modern Signalling Systems on Indian Railways. I am glad that along with revision, a number of new topics on above modern Technologies have also been added. It is commendable that the whole exercise of revision, was done through online tools & video conferences.

In this manual, Most of the Technical clauses can be complied by all. Certain Clauses may have to be complied over a period of time. All are expected to keep principles of Uniformity, Reliability, Availability, Maintainability & Safety in mind at all times. Let us keep Railways Motto of Safety, Security & Punctuality always foremost in mind.

I compliment the Members of Signal Revision Committee and all PCSTEs for their sincere efforts and hard work in carrying out the meticulous revision of Signal Engineering Manual, 2020 edition.

  
(Rajeev Sharma)  
Additional Member (Signal)  
Railway Board

New Delhi.  
Date : 25<sup>th</sup> September, 2020



## *From Convener & Editor's Desk*

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Chalamalasetty Mohan, IRSSE  
Additional Director General  
IRISET, Secunderabad



I am privileged & honoured to be the convener for current revision of Indian Railway's Signal Engineering Manual. In this revision, factors such as clarity, uniformity in para numbering & consistency in presentation, bridging gaps, keeping together content in one & same chapter etc. are given high priority.

Obsolete contents such as -Two aspect, MLQ Signalling etc. have been deleted and current topics on Dataloggers, IOT systems, Electronic Interlocking, Digital Axle Counters, BPAC, IBS, ETCS, TPWS, TMS, IRATP (Train Collision Avoidance System-TCAS) , concepts on Reliability, Availability, Maintainability, Safety (RAMS), High Speed Rail Signalling, Communication Based Train Control (CBTC), Glossary of Technical Terms etc. have been added. New annexures (including check lists) have been added and all existing annexures have been updated as per current needs. References from other codal provisions such as GR, ACTM, P-way Manual etc. are also given at relevant paras or as annexures for ease of referencing.

Maintenance Schedules & Drawings for Guidance are given in separate booklets as Appendix I, II.

In this onerous task of revision, many Signal Engineers have contributed significantly directly or indirectly. Their contribution is hereby acknowledged with gratitude. I hope that this Signal Engineering Manual along with Appendix I, II will be useful for all signal Engineers.

(Ch. Mohan)

Secunderabad  
Date: 23-06-2021

## Acknowledgements

The contribution of under mentioned officers & staff for revision of Signal Engineering Manual is hereby acknowledged with gratitude.

### 1. SEM Revision Committee:

Sri R.K.Jain, Sr.ED/Tele/RDSO, Secretary,  
Sri R. Baskaran, Ex. PCSTE/SR, Member,  
Sri Arun Kumar, PCSTE/NCR, Member,  
Sri Rajesh Kumar, PCSTE/ECR, Member

**2. Co-opted Members:** Sri Sameer Dixit, PCSTE/NFR, Sri Shyam Verma, CSE/WCR (Chapter 8,9), Sri A.B. Saran, CSTE/CORE/ALD (Chapter 20,22) Sri D.V. Meena, CSTE/Proj/WR, Sri V.K. Chaudhary, ADRM /Katihar (Ex CSE/NFR), Sri Rajesh Kumar Pandey, DRM/DDU (MGS) (Ex CSE/NER)

**3. Sub Committees on Maintenance Schedules & Drawings:** Sri Rajeev Kumar Gangele, CSE/SCR, Sri Vinod Kumar Agarwal, ED/Railtel/Western Region, Sri S. Nageshwara Rao, GM/S&T/K-RIDE (Ex CSE/SWR), Sri Niraj Yadav, CSE/NCR, Sri Praveen Kumar, CSE/SER, Sri Dinesh Kumar Kalame, Director/S&T/CAMTECH, Sri Sanjay Chilwarwar, ADRM/NJP (Ex CSTE/plg/NFR), Sri Sandeep Chauhan, ADRM/AII/NWR

**4. Railway Board:** Sri Pradeep Kumar, Member Infrastructure, Sri Rajiv Sharma, Ex AM/Sig, Sri T.P.Agarwal, ED/Safety, Sri Arjun Singh Tomar, ED (Signal)

**5. IRISET:** Sri S.K. Goel, DG, Sri K.V.Reddy, Sr Professor/Sig (Review), Sri K. Uma Maheswara Rao, Asst Professor (Appendix-II), Sri M. Raj Kumar, Lecturer (Chapter 19 & Appendix-I), Sri P. Srinivasulu, Lecturer (Chapter 21), Sri G.V.Rao (Appendix-II), Sri P Ramakrishna (Appendix-I), Instructors, Sri P.V. Ravi, SSE/Design & his team (Drawings & Documentation support). Many other Officers , Instructors & staff of IRISET

**6. RDSO:** Sri D.B. Singh, ED/Signal (Coord), Sri Ajay Verma, ED/Signal, Sri Hariom Kushwaha, ED/Signal, Sri G. Pavan Kumar, ED/Tele, Shri Rajneesh Gupta, ED/Signal, Shri M.M. Waris, Director, Shri Awadesh Yadav, Jt. Director

**7.S.C.Railway:** Sri S.Ramachandra Murthy, Dy.CSTE/SCR (Chapter7), Sri D.V.Satyanarayana, ASTE/C/HQ (Chapter 7 & Cable Drawings ), Sri V.S.S Ganesh Kumar, ASTE/Proj/SC (Chapter 3, 19, 21)

**8. Other Officials :** Sri Akhil Agarwal, Retd DG S&T/Rly Bd (Review of Chapter 7), Sri V.N.M Rao, CSTE/Proj/SCR (TPWS,TCAS), Sri Anshul Gupta, GM/NFR (Ex PED/Sig (Predictive Maintenance Systems), Sri P.V. Ramana, Dean/IRISET (Drawing numbering scheme), Sri B Sambireddy, Retd CSTE/Proj/ECOR (Dataloggers), Sri Mani Venkat Kumar, GM/Metro/Kochi ex. Professor/ Sig-2/IRISET (Annexures on Relays, CBTC), Sri Vishwanth Reddy, Sr.DSTE/BZA/SCR (Annexures & Drawings on Automatic Signalling & IB signalling on OFC), Sri Raja Goundan, Retd GM/ICF (Annexure G1 - RAMS), Sri Alok Katiyar, GM/High Speed Corporation (Annexure G2: High Speed signalling in Mumbai-Ahmedabad), Sri D. Srinivasu, Sr.DSTE/MYS/SWR (Pre-commissioning Check List), Sri E. Srinivas (IRSSE), CRS/S&T/Bangalore (Chapter 9 -Review), Smt Savitha Gedam, CSE II /WR (High Rise OHE)

9. All PCSTE`s of Zonal Railways & many others who contributed directly /Indirectly.

**Convener  
SEM Revision**

## Introduction to Signal Engineering Manual (Version 3.0)

- | S.no | Description   |
|------|---|
| 1.   | Signal Engineering Manual Version 3.0 is organised as one Main Volume, Appendix I, and Appendix II.   |
| 2.   | Numbering Convention of this Manual is given below.<br>(a) <b>Para numbering:</b> Each Para has a three segment number as: Chapter no. Section No. Para no. (For Example: 21.1.4).<br>Further sub-divisions are given as (c) (ii) and explained below<br><br>21- Chapter:<br>1- Section number in Chapter 21:<br>4 - Para number in section 1: (Indications on Control Panel)<br>(c) - Sub para: (Signal Indications)<br>(ii)- Sub sub para: ( Indications that stop..)<br>➤ Sub sub sub para: (Failure of green ..)<br>(b) <b>Annexure Numbering:</b> Annexures are given at the end of chapter and are numbered as Annexure: 19-A2, where 19 stands for Chapter number, A for Annexure and 2 indicates that it is second Annexure for that Chapter. General Annexures are given at the end of Manual are for information and are numbered as Annexure G1, G2 etc<br>(c) <b>Drawing Numbering:</b> Except embedded small drawings (which are in concerned page itself) all other drawings are given in Appendix-II. Numbering Scheme is given at S.No-4. |
| 3.   | <b>Appendix I:</b> Has Maintenance Schedules. They are given numbering such as; Annexure: 13-MS2, where 13 stands for Chapter number, MS stands for Maintenance schedule and 2 indicates that it is second schedule for that Chapter.   |
| 4.   | <b>Appendix II:</b> Has Signalling Drawings for Guidance. They are given numbering such as; Drg no: 19-D3, where 19 stands for Chapter Number, D stands for Drawing and 3 stands for third drawing for that chapter.  |
| 5.   | Wherever certain stipulations are not feasible/currently exist, they may be adopted gradually in due course, whenever the signalling assets are due for replacement or whenever any major Interlocking alterations are being taken up.  |
| 6.   | The information given in Signal Engineering Manual, Appendix I & II is Intellectual Property of Indian Railways and is only for official use of Indian Railway Signal Engineers. Copying /Reproduction by others in any form for other purposes without explicit & written approval of Signalling Directorate of Railway Board /New Delhi is strictly prohibited.   |
| 7.   | May give your feedback for improvements by e mail to: <a href="mailto:edsignal@rb.railnet.gov.in">edsignal@rb.railnet.gov.in</a><br><i>Disclaimer :- (1) Any Example/scheme given in Signal Engineering Manual, Appendix I &amp; II showing any equipment or usage of any acronym is only for Technical &amp; conceptual information of signal Engineers &amp; Technicians and does not endorse any particular make/Brand.</i><br><i>(2) References to other sources such as - GR, ACTM, SOD, Engineering Code, Finance Code, Payment of wages act, Hours of Employment are given at appropriate paras for ready referencing. However their accuracy/ latest updates shall be checked by the reader.</i>  |

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**Note: Maintenance Schedules are given in Appendix I.**

**Drawings are given in Appendix II.**

# **Chapter 1: Organisation of the Signal & Telecommunication Department**

## **Section 1: Signal and Telecommunication Department - An Overview**

- 1.1.1 The efficient upkeep of Signal and Telecommunication assets of the Railways is the responsibility of the Open Line Organisation of the Signal and Telecommunication Department.

Major construction activities of the Railways may be under the administrative control of a Chief Signal and Telecommunication Engineer (Construction) reporting directly to the General Manager of an Open Line or under administrative control of a General Manager (Construction)/Chief Administrative Officer (Construction).

### **1.1.2 Structure of Open Line Organisation**

- (a) The Principal Chief Signal and Telecommunication Engineer (PCSTE) is the Administrative and Principal Head of the Signal and Telecommunication Department and is responsible to the General Manager for the efficient and economical working of the Department.
- (b) The Principal Chief Signal and Telecommunication Engineer may be assisted in his work by one or more heads of the department (HODs).
- (c) These HODs are designated as per their area of work such as; Chief Signal Engineer, Chief Communication Engineer, Chief Signal and Telecommunication Engineer/Planning etc.

They are incharge of their respective areas of control. Their work is, however, coordinated by the Principal Chief Signal and Telecommunication Engineer who is responsible to the General Manager of the Railway.

- (d) Heads of the Department (HODs) in turn, may be assisted at the Headquarters by a team of Officers of the level of Deputy Chief Signal and Telecommunication Engineers, Senior/Executive Signal and Telecommunication Engineers and Assistant/Assistant Executive Signal and Telecommunication Engineers as required. HODs shall provide necessary direction and control for the efficient discharge of their duties.
- (e) The Principal Chief Signal and Telecommunication Engineer will lay down the duties of each of the Officers of the Headquarters and Divisions.
- (f) The expression "Chief Signal and Telecommunication Engineer" wherever used in this Manual implies HODs as mentioned in [Para 1.1.2\(c\)](#) and Chief Signal and Telecommunication Engineer (Construction) unless the contrary is clear from the context.
- (g) The Principal Chief Signal and Telecommunication Engineer shall be over all in charge of staff cadre - Gazetted and non-Gazetted.

### 1.1.3 Construction Organisation/Project Organisation/RE Organisation

- (a) The expression “Chief Signal and Telecommunication Engineer (Construction)” wherever used in this Manual shall also include CSTE/Projects, CSTE/Works, CSTE/CORE or any other post in Indian Railways in equivalent or higher grade (SAG/HAG) created for execution of works. The Chief Signal and Telecommunication Engineer (Construction) shall provide necessary direction and control for the efficient and cost effective execution of all works under his charge.
- (b) The Chief Signal and Telecommunication Engineer (Construction) may be assisted at the Headquarters by a team of officers of the level of Deputy Chief Signal and Telecommunication Engineer/Engineers, Senior Signal and Telecommunication Engineers, Assistant Signal and Telecommunication Engineers as required.
- (c) The Chief Signal and Telecommunication Engineer (Construction) shall maintain liaison with the Open Line Organisation and shall follow the general policies and procedure laid down for the execution of works. In cases where a different policy or procedure becomes necessary to be followed, he shall do so after due consultation with the Open Line Organisation to adopt an accepted policy or procedure.
- (d) The Chief Signal and Telecommunication Engineer (Construction) shall exercise necessary budgetary control within the allotment of funds at his disposal and shall co-ordinate with Head of Construction Organisation for compilation of budget at every budgetary stage.
- (e) The Chief Signal and Telecommunication Engineer (Construction) shall co-ordinate with the Principal Chief Signal and Telecommunication Engineer with regards to the placement of personnel for the various assignments under his charge keeping in view the overall career development of such personnel.
- (f) In the case of certain major joint projects for Survey, or construction, the Signal and Telecommunication unit may be constituted as a self-contained unit under the administrative control of the head of the Project.
- (g) In such cases, the Head of the Signal and Telecommunication Unit shall be responsible for co-ordination with the Principal Chief Signal and Telecommunication Engineer as mentioned in paragraphs 1.1.3 (c) and 1.1.3 (e).

*Note: These instructions for construction organisation with suitable modification will apply to the other Heads of the department (HODs) in Signal & Telecom departments when entrusted with specific execution of works.*

#### 1.1.4 Divisional Officers

- (a) A Signal and Telecommunication Engineer of appropriate grade is incharge of the Signal and Telecommunication Branch on each Division. He will be responsible to the Divisional Railway Manager for the maintenance as well as correct functioning of the installations under his charge. In case more than one officer in the highest grade are available on a division, senior most officer may be nominated as Incharge of S&T Department in the Division.
- (b) He is under the technical control of the Principal Chief Signal and Telecommunication Engineer to whom he is responsible for all technical matters. He may be assisted by a team of officers of the same grade or in lower grades. The Principal Chief Signal and Telecommunication Engineer will lay down the duties of the various officers of the Signal and Telecommunication Branch on the Division.

The term "Senior Divisional Signal and Telecommunication Engineer" includes Senior Divisional Signal and Telecommunication Engineer in Junior Administrative Grade/Selection Grade and Divisional Signal and Telecommunication Engineer (Senior Scale) holding charge of S&T in a division.

#### 1.1.5 Extra Divisional Organisation:

- (a) The following are the extra Divisional Organisations of the Signal and Telecommunication Department on the Railways:
  - Signal and Telecommunication Workshops;
  - Signal and Telecommunication Training School/Centre;
  - Field Units of Construction Organisation including Project /Works/CORE;
  - Any other unit designated by the Railway.
- (b) Each of these Organisations is under the control of an officer of appropriate grade who is responsible for its efficient functioning to the Principal Chief Signal and Telecommunication Engineer/Chief Signal and Telecommunication Engineers (Construction) directly or through an officer of the Headquarters Office in the appropriate grade. The controlling officer may be assisted by a team of officers in various grades as required.

### Section 2: Officers

- 1.2.1 **Strength of Officers:** Strength of officers in the Headquarters Office of Principal Chief Signal and Telecommunication Engineer, Chief Signal and Telecommunication Engineer (Construction), Divisional offices and in extra divisional organisations shall generally be in accordance with the extant guidelines of Railway Board.
- 1.2.2 **Officer`s Designation and Abbreviations:** The typical designations along with their abbreviation of various posts of S&T officers and staff are given below. There may be other designations for S&T officers and staff of equivalent level depending on their nature of duty/place of posting etc.

Post	Designation
(a) Principal Chief Signal and Telecommunication Engineer Zonal Railway/CORE/Metro	PCSTE
(b) Chief Signal Engineer	CSE
(c) Chief Telecommunication Engineer	CCE
(d) Chief Signal and Telecommunication Engineer/Construction	CSTE/C
(e) Chief Signal and Telecommunication Engineer/projects	CSTE/P
(f) Chief Signal and Telecommunication Engineer/Planning	CSTE/Plg
(g) Chief Signal and Telecommunication Engineer/Design & Drawing	CSTE/D&D
(h) Chief Signal and Telecommunication Engineer/Works	CSTE/W
(i) Chief Signal and Telecommunication Engineer/Headquarters	CSTE/HQ
(j) Chief Workshop Manager	CWM
(k) Deputy Chief Signal and Telecommunication Engineer	Dy. CSTE
(l) Senior Divisional Signal and Telecommunication Engineer	Sr. DSTE
(m) Divisional/Executive/Senior Signal and Telecommunication Engineer	DSTE/ESTE/ SSTE
(n) Assistant Divisional/Assistant Signal and Telecommunication Engineer	ADSTE/ASTE

### Section 3: Technical Staff

1.3.1 **Technical Staff:** The following are the technical staff of the Signal and Telecommunication Department for the purpose of this Manual.

- (a) Senior Section Engineer (SSE) (Signal), Junior Engineer (JE) (Signal) and artisan staff under their charge.
- (b) Senior Section Engineer/(Design & Drawing) (SSE/D&D), Junior Engineer/(JE/D&D) and staff; and
- (c) Senior Section Engineer (SSE), Junior Engineer (JE) and artisan staff of Signal and Telecommunication Workshop.

1.3.2 The Signal supervisors, are designated as;

Post	Designation
Senior Section Engineer Incharge Signal:	SSE/(Signal)/Incharge
Sectional Senior Section Engineer Signal:	Sectional SSE(Signal)
Junior Engineer Signal:	JE (Signal)
Senior Section Engineer/Junior Engineer-Head quarter	SSE/JE (HQ)
Senior Section Engineer/Stores	SSE (Stores)

1.3.3 The duties and responsibilities of Senior Section Engineer/Sectional and Junior Engineer would be same, unless specifically mentioned and is clear from the context.

- (a) The Sectional SSE/JE (Signal) is directly responsible for installation and maintenance of his section.
- (b) The SSE (Signal)/Incharge supervises the work of one or more Sectional Senior Section Engineers and Junior Engineer (Signals) and are responsible to the Assistant/Divisional Signal and Telecommunication Engineer in appropriate grade.
- (c) Some Technical Supervisors (i.e. SSEs/JEs) are - headquartered in the Office of the Principal Chief Signal and Telecommunication Engineer/Chief Signal and Telecommunication Engineer (Construction), Dy Chief Signal and Telecommunication/Sr. Divisional Signal and Telecommunication Engineer and assist in discharging his technical duties.

*Note: (i) If the divisional officer is in Selection grade/JA grade, the prefix senior (Sr) is added to DSTE.*

*(ii) Dy. Chief Signal and Telecommunication Engineer/Construction may be designated as Dy. Chief Signal and Telecommunication Engineer/Project/Work/RE as per executing unit as applicable.*

1.3.4 **Staff under SSE/JE Signal**

- (a) Each Sectional SSE/JE (Signal) shall be assisted by one or more Signal Technicians and maintenance gangs.
- (b) Each SSE(Signal)/(Incharge), Sectional SSE/JE(Signal) shall be provided with one or more special gang/gangs consisting of Signal Technicians, Artisan staff and Assistants for attending to maintenance requirements that may be considered normally beyond the scope of maintenance by Technician of particular station.
- (c) Each SSE(Signal)/(Incharge) shall be provided with necessary manpower assistance for management and security of office and stores. Pick up van, utility vehicle, Material handling machines, Material trolleys etc. as per requirement shall be provided at stores. Online network connectivity also to be provided to Stores.

- (d) Each Sectional SSE/JE (Signal) may be provided with trolley/motor trolley/utility vehicle. Where trolley is provided adequate number of trolley men/Helpers shall also be provided.
- (e) Each Sectional SSE/JE (Signal) shall be assisted by appropriate staff as provided for a SSE (Signal)/(Incharge).

#### **1.3.5 Strength of staff**

- (a) The strength of SSE/JE, Signal Technicians, Sectional gangs and office staff shall be generally in accordance with an approved yard stick of the Railway Board.
- (b) Where such a yard stick is not available, the Principal Chief Signal and Telecommunication Engineer shall frame a suitable one with due consideration to the standard of signalling, type of installation, size of yards, density of train services and general importance of the section.

#### **1.3.6 Drawing Office Organisation**

- (a) Senior Section Engineer (Design and Drawing): SSE(D&D)
- (b) Junior Engineer (Design and Drawing ): JE(D&D)

#### **1.3.7 Responsibility of drawing Office**

- (a) Drawing and design office of Zonal Railway for open line & Construction organisation is generally situated at Zonal HQ. This will be handled by JAG/SG officer who may be assisted by Sr. Scale/Jr. Scale officers & SSE's/JEs D&D.
- (b) This office is primarily responsible for preparation and checking of various designs and documents such as Signal Interlocking Plan, Control Table, Panel/VDU Diagram, Wiring Diagrams, Application logic Circuits, Interface circuits, Installation drawings, Earthing diagrams etc., as per latest policies and guidelines of Railway Board and Zonal Railway HQ office.
- (c) Organisation for Design and Drawing with Division and other field units of Construction, Project etc. shall be manned by JE/SSE (Signal) who will be designated as JE/SSE (D&D).
- (d) A similar but smaller drawing office may be established in field units viz., Sr.DSTE/Dy.CSTE's for their needs, such as Location drawings, Cable Layout Plan, Cable Core distribution Plan, Track Circuit Bonding Plans, Traction Bonding Plan etc.

#### **1.3.8 Other Staff**

- (a) Signal Technician/Signal Maintainer (SM)/Technician(Signal)
- (b) Assistant (S&T) Or Helper



## **Chapter 2: Duties of Signal and Telecommunication Engineers**

### **Section 1: Duties of Signal and Telecommunication Engineers inCharge of Maintenance or Construction**

#### **2.1.1 Duties of Signal and Telecommunication Engineer in charge of Maintenance or Construction**

The Sr.DSTE/Dy.CSTE(C)/Incharge of Maintenance or Construction is generally responsible for:

- (a) The installation and maintenance of all Signalling and Telecommunication equipments under his charge in a satisfactory and safe condition.
- (b) Observance of the rules and procedures laid down in the General and Subsidiary Rules, Rules for opening of a Railway, the Signal Engineering Manual, the Telecommunication Manual, relevant Rule books and Manuals and Orders and Circulars issued by Railway Board, Guidelines issued by RDSO and Circulars issued by the Principal Chief Signal and Telecommunication Engineer from time-to-time and ensuring that all staff under his charge are acquainted with relevant Rules and working methods and efficiently perform their allotted duties.
- (c) Preparation of plans, drawings, diagrams, estimates and tender schedules and safe execution of works as per prescribed norms.
- (d) Ensuring that all inspection notes of higher authorities receive prompt action and submit compliance report.
- (e) Co-ordination with Engineering, other branches and other organisations like CORE, PSUs etc. in case of combined works; obtaining sanction of Commissioner of Railway Safety/PCSTE for new signalling works or alterations and additions to the existing signalling installations, either separately for purely signalling works or jointly with other departmental officers in the case of combined works.
- (f) Obtaining all necessary approvals/sanctions from RDSO/any other competent authority as per requirement.
- (g) Co-ordination with concerned departments in case of accidents for speedy restoration of traffic and for investigation into the causes of accidents.
- (h) Co-ordination with officers and staff of other departments in all other matters to ensure smooth functioning of Signalling and Telecommunication system.
- (i) Preparation of Tender schedules for works, Annual Repair Contracts (ARC), Annual Maintenance Contracts (AMC) of equipments, management of contracts, Timely payments to the contractor, Timely renewals of ARC/AMC, ensuring that contractual agencies deploy qualified man power & quality of works.
- (j) Ensuring supply of approved quality materials and tools for the installation and maintenance of the equipment.

- (k) Control over expenditure in relation to budget allotments and sanctioned estimates.
- (l) Submission of proposals for Revenue and Works Budget and for periodic reviews.
- (m) Exercise of such powers as may be delegated to him/her in Establishment and other matters.
- (n) Ensuring strict discipline amongst his/her staff within the frame work of the Rules.
- (o) Dealing promptly with appeals and representations from and looking after the welfare of staff.
- (p) Issue of special and specific maintenance schedules for SSE(Signal)/Incharge, Sectional SSE/JE (Signal) and Technicians as and when necessary.

#### **2.1.2 Transfer of Charge**

- (a) Instructions on "Transfer of Charge" are contained in Chapter I of Indian Railway Code for Engineering Department.
- (b) Senior Divisional Signal and Telecommunication Engineer/Dy. Chief Signal and Telecommunication Engineers handing over and taking over charge of a Division or of a work shall carry out joint inspection of such works or important sections as necessary.
- (c) The "Transfer of Charge" statement shall be prepared in adequate number of copies, signed by both and one copy sent to the Principal Chief Signal and Telecommunication Engineer.

#### **2.1.3 Applicability to other Signal and Telecommunication Engineers:**

These instructions with suitable modifications will apply to the other Signal and Telecommunication Engineers such as DSTE/ASTE posted to a Division or extra Divisional units for executions of works.

### **Section 2: Additional Duties of Signal and Telecommunication Engineer Incharge of Maintenance**

#### **2.2.1 Sr DSTE is generally responsible for:**

- (a) Ensuring that no alteration to an installation is made, which is a deviation from the original approved plan diagram or specification, without the authority of the Principal Chief Signal and Telecommunication Engineer.
- (b) Sr.DSTE shall inspect 20% of Installations or any other percentage/number of installations in his Jurisdiction as decided by PCSTE of Zonal Railway once in a year and every section must be covered. He shall also ensure stipulated Inspections by a monthly report of inspections so made shall be submitted to the Headquarters Office.
- (c) Ensuring of Inspection of Signals within his jurisdiction from footplate of a locomotive or a driving cab both by day and by night in both Up and Down direction once in a year, at ASTE/DSTE level preferably jointly with officers of Mechanical/Electrical/Operating/ Engineering Departments.

- (d) Having in his possession the under mentioned drawings and registers as required when called upon to accompany the inspection of superior officers like Divisional Railway Manager, Principal Chief Signal and Telecommunication Engineer, General Manager, Commissioner of Railway Safety or an officer of the Railway Board etc.
- (i) Interlocking plans of the section;
  - (ii) Foot plate/station inspection details;
  - (iii) Previous inspection reports of the section by HODs/Principal Chief Signal and Telecommunication Engineer, General Manager, Commissioner of Railway Safety etc.
  - (iv) Any other books/papers/documents as per instructions issued by the Headquarters office of the Zonal Railway.
- (e) Inspection of office and stores of SSE (Signal) (Stores/Incharge once in a year. During the inspection a 10% check of some of the stores items, particularly those that are costly shall be made. Suitable measures for Proper storage of Materials shall be ensured to avoid deterioration/Damage/Pilferage/Fire accidents.
- (f) Ensure inspection of Signal and Telecommunication installations and foot plate inspections by the DSTE/ASTE/SSE/JE (Signals) under his/her control.
- (g) Analysing the Signalling incidences/Data logger exceptional reports, failures from the reports submitted by the Sectional SSE/JE (Signal) and taking remedial measures to eliminate recurrence of failures. The reports shall be examined in a meeting jointly with all SSE (Signal)/Incharge of the division once in 3 months to improve the standard of maintenance. He shall ensure Timely renewal of AMC/Service Contracts, where applicable.
- Note: Each Sr.Divisional Signal and Telecommunication Engineer must maintain a record showing the number of failures and number of trains detained every month over the jurisdiction of each JE/SSE.*
- (h) Drawing out a programme of System Integrity Test of PI/RR/I/EI installations, overhauling and/or testing of interlocking frames, interlocking key boxes, Station Master's slide control frames, block instruments, relays, cables, point and signal machines, etc. as per instructions contained in [Para No. 19.8.8](#).
  - (i) Reviewing the position with regard to supply of stores on the Division periodically.
  - (j) Planning replacements of worn out installations, as per codal life or on condition basis and additional signalling inputs necessary to improve the working and submission of proposals for the same.
  - (k)(i) Reviewing the staff position periodically to ensure that the staff strength including requirements of Rest Giver, Leave Reserve, Training Reserve and Night failure rectification gangs is neither in excess nor short.

- (ii) Redeploy staff or process for additional maintenance staff (where required) before new works or additions/alterations to existing installations involving increased workload are commissioned.
- (l) Ensure that staff adopt safe working Practices & Arrange for Periodical Technical briefings and update them of Latest Procedures/Circulars.  
Ensure that all stations have been provided with approved drawings, ensure maintenance of Registers.
- (m) Ensuring sending periodical returns to Headquarters Office as well as replies to letters from Headquarters within the time specified.
- (n) Ensuring provision of tool kit and protection kit to maintenance staff.

2.2.2 The stipulations in Section '2' will also apply to a Dy. Chief Signal and Telecommunication Engineer (Construction/Project/Works), who is entrusted with the maintenance of any installation as for the time being.

### **Section 3: Additional Duties of Dy CSTE Incharge of Construction/RE/Project/Works**

#### **2.3.1 Dy. CSTE Incharge is responsible for**

- (a) The accuracy, quality and progress of the works entrusted to him and for ensuring that "each work is efficiently organised and so programmed that it progresses speedily and is completed within the time specified". If a work is to be executed through a contractual agency, he shall define Tender Schedules accurately as per actual requirements at site, without any ambiguity, incorporate Special conditions where ever required and ensure quality execution confirming to laid down Quality standards.
- (b) Ensuring that all works are carried out strictly in accordance with the approved plans, Typical drawings issued by PCSTE, standard drawings, specifications and conforming to the provisions of Manuals. Deviations, if any, shall have the prior approval of the PCSTE. The Signal and Telecommunication Engineer incharge of Construction is responsible for:
- (c) (i) Ensuring that traffic notices & Programme of Pre-NI and NI are issued in consultation with other Divisional officers before any existing installation is altered or any new installation is introduced which affects the safe working of any Signal, points or interlocking:  
(ii) Ensuring issue of temporary working instructions/Rules for working of traffic/Green Notice, where necessary.
- (d) Furnishing relevant information to the operating department to help them in the preparation of working Rules and temporary working instructions.
- (e) Arranging for obtaining the sanction of Commissioner of Railway Safety/PCSTE where required as per instructions in [Chapter 9 of SEM](#).

- (f) Advising Commissioner of Railway Safety & PCSTE by a message after bringing a new installation or modification to the existing installation into use and submission of a Safety Certificate as per instructions in [Para No. 9.2.5](#).
- (g) Submitting progress reports as per [Annexure: 2-A1](#) to Headquarters every month.
- (h) Periodical verification of the materials at site as per [Para No. 6.8.2](#).

*Note: (i) The rules in Section '3' will also apply to Sr. Divisional Signal and Telecommunication Engineer normally in charge of maintenance, who is entrusted with the execution of certain specific works.*

*(ii) Where ever "His/he" is mentioned in this chapter, it also applies to "Her/She"*



**Note:-** This Chapter has under mentioned [Annexures](#)

<b>S.No</b>	<b>Annexure No</b>	<b>Description</b>
1	<a href="#">2-A1</a>	Engineer's Progress Report

Para No. 2.3.1(f)

Annexure: 2-A1  
Form No.S&T.PR/2.1

## Engineer's Progress Report

**SIGNAL & TELECOMMUNICATION DEPARTMENT**

..... RAILWAY

.....Division/District

Monthly Progress Report for the month ending..... 20

S.No.	Name of work & IRPSM Id	Cost and Allocation	Estimate No. and date of sanction quoting authority	Date funds allotted quoting authority	Reference to commissioner Railway Safety/PCSTE Sanction	Percentage of material received up to end of the month	Name of Contractor & Date work started	Percentage of work done during the month	Total percentage of work done up to the end of last month	Remarks

Signature .....

Name .....

Designation .....

Mobile No. ....

## **Chapter 3: Duties of Signal Supervisors and Technical Staff**

### **Section 1: Duties of Sectional SSE/JE(Signal)**

#### **3.1.1 Duties**

The duties of a Sectional SSE/JE(Signal) are detailed in various Chapters of this Manual, the most important being;

- (a) Safe & efficient maintenance of all signalling & interlocking equipment under his charge in accordance with the provisions of the Manuals, Rules and regulations in force and instructions issued from time to time. Proper documentation such as Drawings & Registers at stations shall also be done. (Recommended List is at [Annexure: 3:A5](#))
- (b) Assist the SSE(Signal)/Incharge in execution of works for the maintenance of equipment under his charge, additions and alterations to existing installations and new works in accordance with approved Signalling & Interlocking plans, interlocking tables, Control Tables, Route control charts and circuit diagrams under Open Line working conditions.
- (c) Taking prompt action in response to messages received through Test Room, Dataloggers, station staff.
- (d) Supervision of contractual works, Annual Maintenance Contracts (AMC) (if any).
- (e) Carrying out works in an emergency on his own initiative and responsibility. In such cases, intimation must be given to his SSE(Signal)/Incharge or Test room /fault control by a message on control or phone or suitable means of communication.

#### **3.1.2 Equipment Inspection**

- (a) The Sectional SSE/JE (Signal) shall report to SSE(Signal)/Incharge for his work and submit his inspection reports to the Divisional Signal and Telecommunication Engineer through the SSE(Signal)/Incharge.
- (b) The Sectional SSE/JE (Signal) shall carry out inspection and testing of all the equipments in his/her charge at intervals not exceeding one month in accordance with the detailed instructions contained in this Manual and Maintenance Schedule issued by PCSTE. Telecommunication equipments entrusted to his maintenance shall be inspected in accordance with instructions contained in the Telecommunication Manual.
- (c) While carrying out inspections, the Sectional SSE/JE (Signal) shall take the Technician (Signal) of the section with him/her whenever possible.
- (d) Special attention shall be paid during inspections to the work of each Technician (Signal) in respect of adjustments, cleaning and lubricating of moving parts of all points and signal equipment to ensure that they work smoothly. Any fault detected shall be arranged to be rectified at the earliest, after taking disconnection from ASM on duty for the defective gear, where required.

- (e) The inspection shall be thorough with reference to the prescribed Schedule of Maintenance and purposeful to ensure that equipments function satisfactorily, safely and with minimum liability to failures.
- (f) The Interlocking Plan, Cabin Diagrams, Working Rules etc. shall be inspected to see that they are up-to-date. Any discrepancy noticed shall be brought to the notice of the SSE(Signal)/Incharge.
- (g) A record shall be made in the Signal Failure and Inspection Book at each station during monthly inspection.
- (h) All interlocked points and crossings must be jointly inspected by SSE(Signal)/Sectional Incharge with SSE(Pway)/Incharge and Sectional SSE/JE (Signal) with SSE/JE(Pway) alternately and duration between two joint inspections shall not exceed 3 months.
- (i) Signal Staff should attend the failure only after giving disconnection memo (where required) for gear at fault and duly taking acknowledgement from operating staff at the station.

*Note: Stipulations of [Para 3.1.2](#) is also applicable to all Sectional SSE/JE (Signal) & Technician (Signal).*

### **3.1.3 Foot-plate Inspections**

- (a) The SSE(Signal)/Incharge, Sectional SSE/JE(Signal) shall carry out foot-plate inspection of all signals by day and night in both Up and Down directions over his entire jurisdiction as given below;
  - (i) Once in three months for SSE (Signal)/Incharge,
  - (ii) Once a month for Sectional SSE/JE (Signal).
- (b) During the inspection he shall take special notice of the following;
 

All signals shall have adequate visibility as specified in [para No. 7.1.11](#) preferably from the Loco pilot side of the foot-plate. No fixed light is interfering with the sighting of the Signals. If the visibility of a signal is affected by growing tree branches or other structure or other obstructions, the matter shall be noted for corrective action. Cases requiring special attention, such as trees in private lands shall be referred to Sr. Divisional Engineering through Sr. DSTE with full particulars of the topography of the area for his information, necessary action. In other cases the supervisors shall arrange to remove the obstructions as early as possible by P-Way Staff as per IR P-Way Manual.
- (c) Anything which may endanger safety or interfere with signalling gears, the same shall be brought to the notice of the concerned department. If immediate action is necessary for reasons of safety, information to be conveyed to the Station Master and control room.
- (d) Any abnormality in working of signals shall be brought to the notice of Station Master concerned.



- (e) In Token Block Working Territory, a suitable light is displayed at the token delivery and pickup area for the Loco Pilot to clearly drop the incoming token and pick up the outgoing token.
- (f) All Warning Boards and other boards maintained by Signal department are in good condition.

#### 3.1.4 **Attending to Failures/Incidences**

- (a) The Sectional SSE/JE(Signal) shall monitor daily all failures on his section. During his periodical inspection he shall check up the cause indicated as well as repairs carried out to ensure that similar faults do not recur. In case of failures of a serious nature, the investigation shall be carried out immediately, and the SSE(Signal)/Incharge advised.
- (b) Each Sectional SSE/JE(Signal), shall at the end of every month, summarise the failure reports received from each Technician(Signal) and submit monthly '**Cause wise Analysis Of Signal Incidences**' as per [Annexure: 3-A6](#) with his remarks to the Sr. Divisional Signal and Telecommunication Engineer in duplicate. Failures pertaining to other departments shall be promptly brought to the notice of the concerned departments.
- (c) SSE(Signal)/Incharge, Sectional SSE/JE(Signal) shall monitor Datalogger exception reports on daily basis and take corrective actions. Where required, he shall take assistance from Data Logger Management Centre (DLMC) in Divisional headquarters.

#### 3.1.5 **Competency in Rules and Technical Work:** Sectional SSE/JE (Signal) shall be;

- (a) Fully conversant with the rules and regulations, instructions, procedures and practices of installation, operation and maintenance of all installations under his charge.
- (b) Competent to carry out under open line working conditions
  - (i) Additions and alterations to existing installations and circuits.
  - (ii) New installations.
  - (iii) Installation, adjustment, maintenance and testing of Relay/Electronic Interlocking equipments, Point Machines, Train Detection devices, LC gates & carrying out alterations whenever required.
- (c) The Sectional SSE/JE(Signal) shall ensure that only competent staff are permitted to work on or make adjustments to any of the signalling gears which are connected with the safety of trains. The supervisors shall further ensure that these instructions are clearly understood by all the staff concerned. Wherever contractual staff are deployed their technical competency and awareness on safety matters, shall be checked before they are allowed to work. Contractual staff shall not be allowed to work in Relay Room, Point Mechanisms, Cables or any vital circuits independently, unless unaccompanied by Railway Staff in a working Installation.

- (d) The Sectional SSE/JE(Signal) shall ensure proper training to subordinate staff for trouble shooting of the equipment under the charge.

### **3.1.6 Reports of Technician(Signal)**

- (a) The Sectional SSE/JE(Signal) shall ensure that the Technicians are regular in their maintenance programme and their reports as per [Annexure: 3-A9](#) are correctly maintained.
- (b) Technician (Signal)'s programmes shall be prepared in terms of the days of the week. The programme shall be so prepared that it is convenient to the Technician (Signal) and provides for maximum possible time at every station with due regard to the rostered hours of the duty. Any leftover maintenance works during a week (on account of failures and other exigencies) shall be liquidated in the following week.

## **Section 2: Additional Duties of SSE(Signal)/Incharge**

- 3.2.1 The additional duties of SSE(Signal)/Incharge, assisted by one or more Sectional SSE/JE (Signal), are detailed in various Chapters, the most essential being:

- (a) Exercising supervision over the work done by the Sectional SSE/JE (Signal) and maintenance staff in accordance with instructions contained in this Manual.
- (b) Maintenance of Transport vehicles/pickup vans, stores, Ledgers, passing of stores bills for materials received, disposal of surplus/scrap.
- (c) Testing, overhauling and carrying out alterations to the existing signal and interlocking installations in accordance with approved plans and instructions.
- (d) Testing any telecommunication equipment specifically entrusted to his maintenance in accordance with instructions in the Telecommunication Manual or other executive instructions.
- (e) Carrying out works in an emergency on his own initiative and responsibility. In such an emergency, intimation shall be given to his controlling officer by a message on control or phone.
- (f) Monitoring of Annual Maintenance Contracts (if any) of the equipment & their timely renewal (as needed). Supervision of contractual works, Timely filling of Measurement Books.
- (g) Providing assistance to the Sectional SSE/JE(Signal) to attend to works which are normally beyond the scope of the maintenance staff under the Sectional SSE/JE(Signal).
- (h) Arrange Training for staff, deputing them for Refresher courses.

- (i) The SSE(Signal)/Incharge shall see that the fire-fighting appliances at various locations under his charge are kept in a condition fit for immediate use. He shall also see that the staff under him are conversant with the method of operation. He shall arrange actual trials periodically to test appliances for fitness and the staff in the knowledge of the working of the fire-fighting appliances and the method of their operation. The appliances shall be recharged immediately after they have been used.
- (j) In his work, the SSE(Signal)/Incharge shall be responsible to the Sr. DSTE/DSTE/ASTE.
- (k) Each SSE(Signal)/Incharge shall submit an annual return in duplicate of all equipments in service on his section to the Sr.DSTE in prescribed forms.

### **3.2.2 Inspections**

- (a) The SSE(Signal)/Incharge shall carry out all the inspections prescribed in [Para 3.1.2 and 3.1.3](#) over his entire jurisdiction at intervals not exceeding three months.
- (b) He shall carry out the quarterly foot-plate inspection preferably jointly with the SSE/Loco, and Traffic Inspector by day and by night.
- (c) Joint Certificate of Foot-Plate Inspection at the end of every quarter in Form No. S&T/FP ([Annexure: 3-A2](#)) shall be submitted to the Sr. DSTE/DSTE/ASTE. A copy of the relevant portion of the joint report of Foot-Plate Inspection shall be sent to the station concerned for the reference of inspecting officers and also for necessary action, if any, by the Station Master.
- (d) He shall also check for condition of building and structures in which equipments are housed; proper lighting/ventilation/Air-conditioning arrangements (where existing) and take appropriate action.
- (e) Exception report for a period from last visit to present day visit shall be taken from Datalogger and action shall be taken against each item to avoid recurrence.
- (f) He shall be a member of Signal Sighting Committee to ensure proper visibility of newly erected Signals/shifted Signals.
- (g) A record shall be made in the Signal Failure and Inspection Book at each station during quarterly inspection.

### **3.2.3 Section Gang and Maintenance Work**

- (a) Each SSE(Signal)/Incharge shall maintain a register in which all works that are beyond the capacity of the Technician(Signal) shall be entered. Execution of such works in the order of their importance shall be entrusted to the section gang.
- (b) The SSE(Signal)/Incharge shall prepare a programme of work for the section gang. The programme shall be so prepared as to reduce travelling time to a minimum and allow the gang to return to Headquarters on rest days.

- (c) It is desirable that when the section gang is deputed for a number of days, a pickup van equipped with all materials and tools for the work is also provided.

### **Section 3: Inspection Certificates**

#### **3.3.1 Inspection and Testing Certificates**

- (a) Each SSE(Signal)/Incharge shall submit an Inspection and Testing Certificate monthly for each station/installation inspected by him during the month as per [Annexure: 3-A3](#) to the Sr.DSTE indicating the condition of gear inspected. Brief remarks shall be given in regard to any assistance required in regard to labour or stores or any other important matter.
- (b) The Certificate of Inspection and Testing is an important document and it forms a record of the nature of inspections carried out and the condition of the gear reported upon from time-to-time. SSE(Signal)/Incharge, Sectional SSE/JE(Signal) shall, therefore, make a careful record of all the inspections and the repairs, special or ordinary required on the section. The report shall not be used for representing their general difficulties.
- (c) The report on each foot-plate inspection must be promptly submitted to the Sr. DSTE as per [Annexure: 3-A2](#) every month.
- (d) At the end of each quarter, the SSE(Signal)/Incharge shall certify as per [Annexure: 3-A1](#) that all existing signals on his section have proper visibility and have been jointly inspected by a committee consisting of (i) SSE(Signal) (ii) SSE(Loco)/ and (iii) Traffic supervisors. They shall also highlight deficiencies noticed, action proposed to be taken, indicating assistance required (if any). Such jointly signed certificate shall be kept on record in the office of the Sr. DSTE.
- (e) The inspection, testing (including testing of cables) and overhauling certificates, shall be filled in progressively at the stations immediately an inspection or testing or overhauling has been done and not left to be completed at the Headquarters station.
- (f) Each SSE(Signal)/Incharge, Sectional SSE/JE(Signal) shall send a separate certificate that all the stations under his charge have been inspected as per [para 3.1.2, 3.1.3](#). If all the stations have not been inspected, the names of stations left out and the reasons why these could not be inspected shall be furnished.
- (g) Periodicity of inspection of signalling Installations is once in a month Sectional SSE/JE (Signal) and once in a quarter for SSE (Signal) incharge.

## **Section 4: Accidents**

- 3.4.1 SSE(Signal)/Incharge, Sectional SSE/JE(Signal) and Technicians(Signal) are responsible for supervision of labour and shall take all precautions to ensure safety of staff and equipment, prevent accidents to the staff or damage to apparatus and see that-
- (a) Instructions contained in Zonal/Divisional Disaster Management Plan as well as those issued from time-to-time are observed.
  - (b) Use is made of the safety appliances provided such as Helmets, Retro reflective Jackets, Safety shoes, belts, pulley blocks etc.
  - (c) That all ropes, lifting tackles and staging used for erection of signals, etc. are adequate and in good condition.
  - (d) That staff working on the line are vigilant and where necessary employ look out men.
  - (e) All accidents are promptly reported.
- 3.4.2 The rules for ensuring safety are contained in General Rule 2.11. The procedures to be followed in regard to accidents are contained in Chapter VI of General Rules and in the Accident Manual. Each Supervisor shall be well acquainted with the rules concerned. A few salient points in regard to SSE/JE(Signal) are listed in [Annexure: 3-A4](#).

## **Section 5: General Responsibilities and Duties**

### **3.5.1 Tools and Plant**

Each SSE(Signal)/Incharge shall be responsible for the issue of proper tools and other equipments to the Technicians (Signal) and artisans under him and for ensuring that these are kept by them in proper working order. Unserviceable and defective tools shall be replaced.

### **3.5.2 Books of Reference and Acquaintance with Rules**

- (a) Each SSE(Signal)/Incharge, Sectional SSE/JE (Signal) shall have in his possession when on duty an latest copy of the following books of reference:
- (i) General and Subsidiary Rules.
  - (ii) Signal Engineering Manuals, along with Appendix I, II.
  - (iii) Schedule of Standard Dimensions.
  - (iv) Current Working Time Tables.
  - (v) Maintenance Manuals for Special equipment under his charge.
  - (vi) Telecommunication Manual.
  - (vii) Accident Manual.
  - (viii) Block Working Manual.

- (ix) AC Traction Manual (in RE area).
  - (x) Station working rules.
  - (xi) Compendium of Technical Circulars and joint Procedures orders & Typical Drawings.
- (b) Each SSE(Signal)/incharge shall be well acquainted with all the rules concerned in these publications and circulars issued from time to time which concern his work and duties. These books shall always be kept updated with all the addenda and corrigenda slips issued from time to time. He shall ensure that all staff under his charge are well acquainted with these rules and regulations to the extent applicable to them.

### **3.5.3 Accompanying Important Inspections**

- (a) Each SSE(Signal) while accompanying an inspection such as that of General Manager or Commissioner of Railway Safety or Divisional Railway Manager or the Principal Chief Signal and Telecommunication Engineer or any other Signal and Telecommunication Engineer or any officer of the Railway Board, shall in addition to the books of reference mentioned in [para 3.5.2\(a\)](#), have the following in his possession;
- (i) Signaling Interlocking Plans, yard diagrams, interlocking tables and Control tables, Traction Bonding Diagram, Track circuit bonding plan, Cable Route Plans, Cable Core Plans.
  - (ii) Interface Circuits, Application Logic Circuits, Bit allocation Charts, track circuit bonding plan, Video Display Unit Diagram/Panel Diagram.
  - (iii) Location box details, wiring diagram.
  - (iv) Track circuit history card.
  - (v) OEM check lists of Signalling equipments such as Electronic Interlocking, Axle Counters, IPS, UFSBI etc.
  - (vi) Various registers at station – Asset Register, battery checking, cable insulation testing, Signal Incidences, joint Inspection register etc.
  - (vii) Plans of proposed and sanctioned works.
- (b) Point test gauges, Multi-meter, Train shunt resistance, insulation test equipment, Earth resistance measuring test equipment, Track circuit test equipment, Cable Fault Locator, Cable Route Locators, a portable telephone or any other equipment required to test the signalling gears in the section under inspection.
- (c) Other tools such as True RMS meter, Clamp meter, measuring tape, foot rule, sealing plier etc.
- (d) Any other items specified by Sr. Divisional Signal and Telecommunication Engineer/ Principal Chief Signal and Telecommunication Engineer.

#### **3.5.4 Establishment matters**

The SSE(Signal)/Incharge shall ensure that the Rules laid down in Establishment Code, Acts and Regulations and Local circulars issued from time-to-time regarding general service conditions, conduct, discipline, passes, leave, service Records, medical examinations, etc. are strictly complied with, records maintained and returns submitted as laid down. Certain salient points in regard to Payment of Wages Act, Workmen's Compensation Act and Hours of Employment Regulations are listed in [Annexure: 3-A13](#). These only list the broad features and a reference to the Act and Rules should be made while deciding cases.

#### **3.5.5 Muster Sheets**

- (a) The SSE(Signal)/Incharge shall arrange to have the blank muster sheets of staff top-initialed by the Signal and Telecommunication Engineer under whom he works and issue them to the staff in time. At the end of each wage period, the muster sheet shall be collected and fresh ones issued.
- (b) Each SSE(Signal)/Incharge shall inspect and initial the muster sheets of staff whenever he is in their section. The presence or absence of staff shall be noted on the spot. The time of inspection and the number of staff present should be recorded in the muster sheet in ink.

#### **3.5.6 Correspondence and Records**

The SSE(Signal)/Incharge shall keep his correspondence up to date. He is responsible to see that his office records, registers, stores ledgers and accounts are maintained correctly and stores ledgers (physical and/or Electronic) are posted up to date. Periodical returns shall be submitted within the dates as per the standing instructions.

#### **3.5.7 Relinquishment of charge**

- (a) When relinquishing charge of a section, the SSE(Signal)/Incharge or section SSE/JE(Signal) shall prepare a handing over charge statement in duplicate, which shall briefly contain the following:
  - (i) The section particulars with staff, their service and leave records.
  - (ii) Details of sanctioned and proposed works and their progress.
  - (iii) General Notes regarding painting, renewals and replacements, etc.
  - (iv) Overhauling and testing of interlocking frames, block instruments, point machines, signal machines, relays, etc.
  - (v) Notes regarding materials, stores, important notes and documents.
  - (vi) Position of stock sheets, Accounts notes, Audit and Accounts Inspection Reports, Completion reports.
  - (vii) The detailed status of the Scheduled Inspections, officers Inspections and compliance, other Organisations work's status and compliance of deficiencies.
  - (viii) Any other important matters.



- (b) The SSE(Signal)/Incharge taking over and handing over shall inspect all important works in progress, check the staff and their tools and plants and materials-at-site.
- (c) The relieving SSE(Signal)/Incharge shall examine all Office records and ledgers and initial them with date.
- (d) Handing over charge statement shall be jointly signed by the supervisors taking over and handing over and a copy submitted to the Sr. Divisional Signal and Telecommunication Engineer. Errors and discrepancies noted during handing over and taking over, shall be recorded on the statement for the information of the Sr. Divisional Signal and Telecommunication Engineer.

## **Section 6: Additional Instructions for SSE (Signal)/Incharge of Construction**

- 3.6.1 **Code Rules:** The rules for the execution of works are contained in [Chapter 9 of SEM](#) and Chapter XI of the Indian Railway Code for the Engineering Department.
- 3.6.2 **Applicability of Rules:** The instructions for SSE(Signal)/Incharge of construction will also apply to SSE(Signal)/Incharge of maintenance when executing works. Similarly the instructions for SSE(Signal)/Incharge of maintenance will apply to SSE(Signal)/Incharge of Construction when maintaining equipments at a station.
- 3.6.3 **Commencement/Execution of Works**
  - (a) The instructions contained in [Para No. 9.1.4](#) shall be observed.
  - (b) When the estimate for a new work is sanctioned, the SSE (Signal)/Incharge shall submit requisitions for the materials without delay and ensure that all the required materials are made available. No work shall be physically commenced until it is authorised by the concerned officer.
  - (c) No work affecting an existing signalling and interlocking system shall be commenced, unless all prior/pre non-interlocking works have been completed, so that the duration of non-interlocking/disconnection will be as short as possible.
  - (d) Location of signals (new or proposed for shifting) shall be jointly surveyed by a Signal Sighting Committee consisting of (i) SSE(Signal)/Incharge, (ii) SSE(Loco)/ and (iii) Traffic supervisors, keeping in view extant instructions and schedule of dimensions. Signal Sighting Committee reports shall be submitted as per [Annexure:19-A1](#) to the Dy.CSTE (Construction)/Sr.Divisional Signal and Telecommunication Engineer.
  - (e) Introduction of a new signal or alteration to an existing signal shall be taken on hand only after publication of the Traffic Notice.



#### **3.6.4 Progress Report of Works:**

The SSE(Signal)/Incharge of works shall submit a Progress Report, every month of all the works in his charge to the Dy.CSTE (Construction) as per [Annexure: 3-A7](#) which shall include;

- (a) The progress of work and probable date of completion;
- (b) Reference to requisitions or work orders against which supply has not been made; also details of items which are particularly required and on account of which works are being delayed;
- (c) Delays arising from other causes.

#### **3.6.5 Opening of works**

- (a) The SSE(Signal)/Incharge of works shall advise the Sr. DSTE/Dy.CSTE (Construction), when a work will be ready for opening, in order that the latter may arrange for fixing of a date and for the issue of the necessary notices.
- (b) When a new work or alteration to an existing work is about to be brought into service, the SSE(Signal)/Incharge shall ensure that approved plans, Control Table, circuit diagrams, CRS/PCSTE sanctions, required approvals, OEM test certificates of equipments, FAT/SAT Testing reports etc. are available before commissioning /opening ([Refer Annexure: 21-A2](#)). If there are minor alterations, the existing diagrams may be corrected and endorsement made by the SSE(Signal)/Incharge duly advising HQ for updating their records.

#### **3.6.6 Completion Certificate and Completion Report**

- (a) The SSE(Signal)/Incharge shall submit a Completion Certificate to the Sr.DSTE/Dy.CSTE (Construction) as per [Annexure:3-A8](#) immediately, after a new work/alteration to an existing installation has been brought into service.
- (b) The SSE(Signal)/Incharge of the works shall, immediately after the completion of a work submit a Completion Report to the officer Incharge which shall contain the following:
  - (i) List of all materials received from the stores and other sources with all particulars.
  - (ii) List of all materials used for the work.
  - (iii) List of materials released and returned to stores with particulars.
  - (iv) List of excess materials returned to stores with particulars.
  - (v) Details of contractor(s), who executed the works.
  - (vi) Special problems or difficulties experienced during the execution of the work (if any) and
  - (vii) Transfer unutilised materials from 'Works Registers' of that work to other works to get the credit for that work.

## **Section 7: Datalogger Management Centre (DLMC)**

### **3.7.1 At Divn HQ**

- (a) Data Logger Management Centre generally situated at Divisional Headquarters shall be extensively used for monitoring of signalling system in the entire division. SSE/JE(Signal)(HQ) shall continuously or regularly monitor Data Logger exception reports and inform concerned SSE(Signal)/Incharge, Sectional SSE/JE(Signal) for necessary action.
- (b) When a new station is commissioned or alterations are carried out in existing station, SSE(Signal)/Incharge shall ensure that all specified relays and gears are monitored by Datalogger at the station ensure its proper validation.
- (c) SSE(Signal)/Incharge/DLMC shall ensure that SMS alerts are generated for Safety related faults & Maintenance related faults.
- (d) SSE/JE(Signal)/DLMC shall ensure monitoring of Relay Room door opening, fire alarm, Power supply/Battery voltages, ELD and other specified gears through SMS alert generated by Data logger.
- (e) SSE/JE(Signal)/DLMC at divisional HQ shall ensure data availability and network connectivity continuously to zonal HQ/Railway Board.
- (f) SSE/JE(Signal)/DLMC at divisional HQ shall ensure Prompt and regular validation of Datalogger inputs in coordination with SSE(Signal)/Incharge of the Station/IB/LC.

## **Section 8: Duties of Technician(Signal)**

### **3.8.1 Duties of Technician (Signal)**

The duties of Technician(Signal) are detailed in various Chapters in this Manual, the most essential being:

- (a) Efficient maintenance and testing of all equipments under his charge such as Mechanical Signalling equipments, Electrical and Electronic Signalling equipments, Telecommunication equipments etc. so as to keep them properly maintained and in good working condition, in accordance with instructions contained in this Manual and such Circulars or Instructions, as may be issued from time to time.

*Note: The term Electrical/Electronic Signalling equipments includes all types of Block Instruments.*

- (b) Carrying out works and alterations to the existing installations under the instructions of the SSE/JE (Signal) or S&T officers.
- (c) Responding promptly to messages received through Datalogger or Test Room or Station staff.
- (d) Bringing to the notice of the SSE/JE (Signal) any emergency and situation that may be beyond his competence or control by a message on control or phone or other means of communication.

- (e) Ensuring that the safety appliances like safety belts, lifting tackles and staging etc. are in good condition in order to ensure his safety and that of staff working with him.
- (f) Deploying men for look out duties as and when necessary.
- (g) Before starting maintenance at station, exception report from last visit to present visit shall be taken from Datalogger (where PC or printer is available) to focus on preventive maintenance.

### **3.8.2 Attending to Signal Incidences**

- (a) The Technician (Signal) shall not disconnect or alter any connection in the interlocking circuits except with the approval of, and in the presence of his SSE/JE (Signal). Any action, which will vitiate safety, shall be done only after disconnection notice has been issued and accepted by operating staff.
- (b) A Technician (Signal) shall, however, attend to the signalling failures promptly to permit safe passage of trains till the arrival of the SSE/JE (Signal). If any unsafe failure/gear is noticed, he shall suspend signals/signaling gear/signaling as required and informed to SM concerned.
- (c) A Technician(Signal) shall also ensure that, once the signals have been suspended as per para 3.8.2(b) normal working shall not be restored until the failure/faulty gear has been attended to, tested and certified by the SSE/JE (Signal) and the Relay Room, Block Instrument have been closed, pad locked and sealed.

### **3.8.3 Maintenance Programs**

- (a) Each Technician(Signal), as far as possible, adhere to the programme laid down for him by his SSE/JE (Signal) and shall maintain a record of his visits as per [Annexure: 3-A9](#).
- (b) Technician(Signal) shall not normally leave any gear in disconnected condition and in unavoidable eventuality; a specific advice to ASM, duly acknowledged by him shall be obtained.
- (c) Each Technician(Signal) shall maintain and test all the equipments under his charge, as per maintenance schedule specified for various gears.
- (d) Each Technician(Signal) shall submit a fortnightly report of his maintenance activities to his Sectional SSE/JE (Signal) as per Annexure:3-A9.
- (e) Technician (Signal) before leaving his Headquartered Station, shall take permission from his sectional SSE/JE (Signal).

### **3.8.4 Disconnection of Equipment:** Each Technician(Signal) shall have in his possession a book of Disconnection Notices as per [Annexure:3-A10](#).

- (a) A Technician (Signal) who is in possession of a Competency Certificate cum Training History book ([Annexure: 3-A12](#)) only shall independently undertake works necessitating issues of Disconnection Notices.

- (b) Disconnection Notices need not be issued in situations as listed in [Annexure: 3-A11](#) provided suitable precautions are taken. In other situations, when it is necessary to disconnect any equipment in his charge for repairs, replacement or adjustment, the Technician(Signal) shall advise the Station Master on duty in writing as per [Annexure:3-A10](#) and obtain the latter's signature before work is started and after it has been completed.
- (c) When it is necessary to disconnect point equipment switches or signals for repairs, replacement or alteration, Warner/Distant and Stop Signals governing the lines in question shall be kept in the 'ON' position and made in-operative until the work is completed.
- (d) The Technician (Signal) must seal the equipment opened by him under his competence.
- (e) A Technician (Signal) shall possess valid Competency Certificate for handling Signalling equipments like Block instruments, EI, MSDAC etc. The Competency Certificates are issued to Technician (Signal)s by Training Centres after successful completion of the training.

#### **3.8.5 Attending to Failures/Incidences/Accidents:**

- (a) A Technician (Signal) shall attend to all failures in his section promptly proceeding by the first feasible means on receipt of information. Before taking up work, he shall first obtain failure report/message from SM/ASM in writing in accordance with provision of G.R.3.68 for each failure recorded in the signal failure register and then issue disconnection notice as per [para 3.8.2, 3.8.4](#). He shall make every endeavour to rectify the failures expeditiously and take all possible steps to prevent recurrence ensuring proper rectification method. If a gear has failed on the unsafe side and the SM/ASM has been unable to put the relevant signal to 'ON', the Technician(Signal) shall take steps to disconnect/disable the relevant signal and bring it to 'ON'.
- (b) All failures which are beyond his competence or control must be brought to the notice of the sectional SSE/JE (Signal) section by a message on control or phone or other means of communication.
- (c) Record of the date and time of rectification and the nature of the fault removed must be recorded in the Signal Incidence and Inspection Register provided at each interlocked station and same will be informed to SSE/JE(Signal) and signal control also.
- (d) On receipt of advice about any accident in his jurisdiction, the Technician shall proceed to the site of accident by first available means. He shall not interfere with any equipment on his own but shall act upon the orders given by the senior most officials at the site of accident.

#### **3.8.6 Miscellaneous Duties of Technicians (Signal):**

- (a) A Technician (Signal) shall be conversant with rules, regulations and instructions concerning his work contained in the following books of reference as well as other instructions issued from time to time.
  - (i) General and Subsidiary Rules;
  - (ii) Signal Engineering Manual;
  - (iii) Block Working Manual.

- (b) A copy of those portions of each of the books mentioned in [Para 3.5.2\(a\)](#) as also all circulars and instructions concerning his work, shall be maintained by him for his reference and information. He shall keep them up to date in respect of Correction Slips issued from time to times.
- (c) A Technician (Signal) shall not permit any Helper or artisan staff to do any adjustment to the gear in use except under his personal supervision and he shall ensure that the staff under him clearly understand this rule.
- (d) **Maintenance of Muster Sheets etc.:** A Technician (Signal), when posted at station where his seniors are not posted/not available, then, he shall mark his own attendance and that of his staff on the muster sheets received from the SSE/JE (Signal) before starting his work. Erasing and over-writing is not permitted. Loss of muster sheet shall be brought to the notice of the SSE/JE (Signal) at the earliest.
- (e) A Technician (Signal) shall work to the duty rosters provided and see that the staff under him also works according to the roster.
- (f) **Materials and Tools and Plant:** A Technician (Signal) shall, where necessary, get his requirements of materials for maintenance and repair work from the SSE/JE (Signal), giving full particulars of station, location and the gears to be replaced. Released materials shall be returned to the SSE/JE(Signal) immediately. There shall absolutely be no wastage of any material.  
A Technician (Signal) shall always take his tools with him when on duty. All tools shall be kept in a condition fit for immediate use.
- (g) **Co-operation between Technicians:** Technician (Signal) shall co-operate in testing of all the signals. Technician (Signal) shall extend full co-operation to each other in their day-to-day work.

## **Section 9: Duties of Helpers/Assistants**

### **3.9.1 Duty list of Helpers/Assistants:-**

- (a) The general duties of Helpers/Assistants are as follows :
  - (i) Cleaning of Glued Joints/Block joints.
  - (ii) Cleaning of all S&T gears and their up keeping.
  - (iii) Painting of all S&T gears and their up keeping.
  - (iv) Cleaning of garbage/vegetation under Point rodding and surrounding of all signaling gears/locations.
  - (v) Cleaning of chair plates and maintaining their lubrication.
  - (vi) Reporting of any infringement of signal/Ladder etc.
  - (vii) Upkeep of Relay room, Power room, Battery room, Maintenance room, Store room etc.
  - (viii) Maintaining minimum essential tools with him for day to day works as per instructions of Technician/SSE/JE(Signal).

- (ix) Loading/unloading/Handling of T&P items and all materials as per instructions of Supervisor.
  - (x) Manning and protection of installations/S&T gears on need basis as guided by Supervisor.
  - (xi) Reporting of rubbing of stretcher bar with Stock Rail bottom (if any).
  - (xii) Assisting Supervisor/Technician during testing/Maintenance/Inspections, Carrying Tools & Plants for Maintenance/Failures.
  - (xiii) Handling/topping-up of Distilled water, Electrolyte, HSD oil and applying Petroleum Jelly, Lubricants etc. as per instructions of Technician/SSE/JE.
  - (xiv) Assisting Supervisor in documentation works.
  - (xv) Accompanying/Assisting Technician/SSE/JE and Higher officials in their day to day works.
- (b) Technical duties of Helper are as under
- (i) Removal of obstruction to points.
  - (ii) Removal of excess bars formation at insulation joints.
  - (iii) Be aware of working in RE area.
  - (iv) Check RE bonds, their intactness.
  - (v) Check water logging in track circuited areas.
  - (vi) Any other duty assigned by SSE/JE(Signal) or Technician



*Note: This Chapter has under mentioned Annexures*

<b>S.No</b>	<b>Annexure No</b>	<b>Description</b>
1	3-A1	Signal Visibility Certificate for Existing Signals
2	3-A2	Foot Plate Inspection of Signals
3	3-A3	Inspection and Testing Certificate
4	3-A4	Action in case of Accidents
5	3-A5	List of Drawings & Registers at a Station
6	3-A6	Cause Wise Analysis of Signal Incidences
7	3-A7	SSE/JE's (Signal) Progress Report
8	3-A8	SSE/JE's(Signal) Completion Certificate
9	3-A9	Technician's (Signal) Report
10	3-A10	Disconnection/Reconnection Notice
11	3-A11	Where Disconnection notice is not required
12	3-A12	Competency Certificate cum Training History book
13	3-A13	Hours of Employment Regulations, Workmen's Compensation Act, Payment of Wages Act. (Extracts of Manuals)

**Signal Visibility Certificate for Existing Signals**

.....RAILWAY

**SIGNAL & TELECOMMUNICATION DEPARTMENT**

Name of the station: ....., Section: ..... Division: ..... Signalling Plan No: .....

**Note: Minimum visibility in MACLS territory: Distant signal: 400 meters, Inner Distant/Stop signal: 200 meters.**

We, the undersigned members of the Signal Sighting Committee having met at ..... and sighted the visibility of the Signals noted, below, made following observations along with action proposed to be taken.

Signal No & Description	History of Complaints /SPAD at this signal	Obstruction by Tree Branches	Interference from Fixed Lights	Height of the normal aspect of the Signal above rail level	Implantation in meters of the Signal from the adjacent Left side track	Implantation in meters of the Signal from the adjacent Right side track	If infringing with SOD, is the distance marked in Red Paint	LH side/RH side	If on RH side, Reason for the same	If on RH side, Is Arrow provided (Yes/No)	Screen/Mesh /Caution Board provided if within 2 m of Live Conductor	Visibility of the existing Signal from loco pilot's point of view	Is Visibility Adequate	Action proposed to be taken to improve visibility (if any)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)

Signature .....	Signature .....	Signature .....
Name & Designation .....	Name & Designation .....	Name & Designation .....
Date .....	Date .....	Date .....

**Foot Plate Inspection of Signals**

.....RAILWAY

Name of Official conducting inspection	
Designation	
Division & Section	

S.No	Item	Details/Observations
<b>1</b>	<b>General items</b>	
	(a) Date	
	(b) Division, Section	
	(c) Train No, Load	
	(d) Engine No, Parent Shed/Depot	
	(e) Loco pilot Name	
	(f) Asst. Loco Pilot Name	
	(g) Guard's Name	
	(h) Availability of Detonators/Flags/Flasher	
	(i) Long/Short Hood Leading	
	(j) Speedometer/Pressure Gauges	
	(k) Portable Telephone/Walkie Talkie working	
	(l) Mobile Phone Switched Off during running	
	(m) Weather : Clear/Cloudy/Foggy	
	(n) ALP/LP calling out signals	
	(o) Vigilance Control Device/TCAS/TPWS/DMI working	
	(p) Loco Pilot Equipment (Spectacles)	
	(q) First Aid Box	
	(r) Headlight, Adequacy of lights in Loco cabins	
	(s) Competency and medical certificate of Loco Pilot/Asst. Loco Pilot/Guard	
	(t) Availability of Caution orders	
	(u) Loco trouble shooting guide	
	(v) Fire extinguishers	
	(w) Sanders working	
<b>2</b>	<b>Signalling items</b>	
	(a) Visibility of Signals : Good/Fair/Poor Fill up annexure for station wise Details	



S.No	Item	Details/Observations
	(b) Visibility of the Signal Number and Aspect, & Markers	
	(c) Presence Boards - Speed Boards, Stop Boards, SLB, BSLB etc.	
	(d) Observance of the any hanging parts/Accessories of Signal post	
	(e) Out of Plumb signals (if any)	
	(f) Visibility of the Signals in curves	
	(g) Any background light dominating the Signal aspects	
	(h) Signals out of use – Provided with two cross bars as per dimension 1 metre X 10 cms	
	(i) Loose packing at point zones	
	(j) Observance of any signal is dropping or improperly taken off	
	(k) Working of Aspect sequence	
	(l) Loco TCAS/TPWS/DMI	
	(m) Right Hand signal (if any), whether having arrow pointing towards the relevant line	
	(n) Loco pilot feedback (if any) on signals in the section	
<b>3</b>	<b>Train Running items</b>	
	(a) Exchange of signals with station, LC Gate staff, p way patrol man, Crossing Trains etc.	
	(b) Alertness of Gate Man, Station Staff, cabin staff etc.	
	(c) Delayed clearance of signal	
	(d) Whistling while approaching Level Crossing Gate	
	(e) Train passed via Loop line though Main line is free.	
	(f) Observance of Speed Restrictions and Caution Orders	
	(g) Looking back at the formation in curves	
	(h) Any signal in this section, is appearing in complaints in last 3 months from 'CREW BOOKING SYSTEM', if so, your observation today	
<b>4</b>	<b>Any other Remarks</b>	

**Annexure: 3-A2 (contd)**

Station wise signal visibility Details (Encl to Foot plate Inspection Report).

Signals		Station 1							Station 2							Station 3						
		D	ID	H	S	AS	IB	GS	D	ID	H	S	AS	IB	GS	D	ID	H	S	AS	IB	GS
Signal Lamp	Y																					
	G																					
	Y																					
	R																					
Visibility	Good																					
	Adequate																					
	Insufficient																					
	Reason (Code)																					
LED brightness	Excellent																					
	Very Good																					
	Good																					
	Out of focus																					
Interference from fixed light/Tree branches /other structures																						

\*Code      B-Background,      O-Obstruction,      T-Tree,      L-Light.

Important item of observation on Signalling and action proposed to be taken for rectification within own competency & Time frame there of	
Assistance required (if any) and by whom and purpose.	
Signature & Date	
Name, Mobile Number	

**Inspection and Testing Certificate**

.....RAILWAY  
SIGNAL & TELECOMMUNICATION DEPARTMENT

Month.....20

To,

The Sr DSTE,.....

Through.....

This is to certify that I have personally inspected and tested all the Signals and Telecommunication gears at the following stations/section on my jurisdiction. The details of inspection carried out are shown below-

Date	Station/ Location Visited	Nature of Inspection and Time Spent	Gear		Repairs done during the month	Repairs required	Remarks
			Type	Condition			

Signature .....

Designation.....

Date.....

### Action in case of Accidents

#### 1. Proceeding to Site of Accident:

1.1. On receipt of information of the occurrence of an accident, the SSE/JE/Signal shall proceed by the Quickest-available means to the scene of the accident, with staff and tools and portable control telephones and establish immediate communication with control.

1.2. He shall make a special note of the exact time of the accident, besides other important details. The SE/JE/Signal shall check his watch, if available with Guard's time, station time and control time, as the exact time of an accident is often an important clue in determining the cause of the accident.

**2. Action at Site.** If the Signal Supervisor is not the senior-most official present at the site of the accident he shall report to the senior-most official and render all possible assistance to him in taking action detailed in Paras 2.1 to 2.8 below. If however he is the senior-most official on the spot he shall himself initiate such action.

2.1. Check that the obstructed line including adjacent lines on a multiple line section is protected as per rules.

2.2. Arrange for medical aid to the injured taking the help of medical practitioners, if available.

2.3. After a rapid survey of the position, send brief particulars to the nearest SM to enable him to issue the all concerned message.

2.4. Record the statements of staff and take whatever steps may be necessary to record or preserve the evidence which subsequently may not be available. This shall be done by an officer or SSE/JE/Signal present at the site of the accident even if he is off duty. Evidence shall be collected and recorded with due care and attention and later submitted to the Enquiry committee.

2.5. Preserve all clues and record the character and relative position of markings to enable reconstruction of the scene of the accident. Where immediate repairs are necessary to pass trains, only such parts of the interlocking gear shall be disconnected as are necessary to carry out the repairs to the Track.

2.6. Scrutinise and initial jointly with the concerned officials noting time and date the Train Register Books or Train Message Books, Private Number Books, Caution Orders, S. & T./MR, S. & T./DN forms concerned and any other relevant records. Secure and seal immediately the records directly connected with the cause of the accident.

2.7. Devote special care and attention in the collection and recording of evidence as prescribed and in submitting the evidence with all details to the Enquiry Committee.

Note: The object of recording all available data at site and presenting the evidence at the enquiry is to ascertain the cause of the accident with a view to prevent its recurrence and, where the cause is due to negligence, to fix responsibility.

2.8. Report the position at site of the accident to the Control Office and to the Sr. DSTE by the quickest possible means.

**3. Special action by SSE/JE/Signal** - The SSE/JE(Signal) shall pay special attention to the following:

3.1. He shall record the following details which shall be attested by officials of other Departments concerned who are present at the site of the accident:

Datalogger Off Line simulations Reports & Video format file of Offline play back to be sent to Sr.DSTE immediately.

Position of Points, Signs any activity of outside interference, Digging, position of levers/Knobs, VDU display, SM control slides, indication of various points, track circuits, Axle Counters, routes, slot indicators, etc. position of block instrument handles and indications, if any, aspects of the concerned signals, reading of the counters where provided and conditions of seals of appliances which are normally kept sealed and any other detail relevant to the accident . some of which are given in Para 4.0 below. He shall record video/Photo evidences at site.

3.2. The Signal Supervisor shall along with the other officials at site seal up affected interlocking gear such as lever frames, cabins, relay rooms, signal location boxes etc. immediately after an accident has occurred so that these equipments are not interfered with, until necessary tests have been carried out. The seals shall not be removed until authorised by senior-most official present at site after conducting necessary tests and recording all necessary facts.

3.3. Furnish a full report to Sr. DSTE by the quickest possible means.

3.4. After getting permission to restore signalling, every effort shall be made to complete the restoration as expeditiously as possible.

4.0 Few Guidelines on site related measurements are given below.

However latest information /Data shall be verified from concerned Manuals/Instructions.

<b>Classification Of Accidents</b> (Ref: Railway Board letter No: 2000/ Safety (A&R)/19/20 dated 13.12.2000).			
Sl. No.	Category	Class	Type
I	Train accidents	Class A (A1 – A4)	All types of collisions
		Class B (B1 – B6)	Cases of fire and blasts
		Class C (C1 – C8)	LC gate accidents
		Class D (D1 – D5)	All types of derailments
		Class E (E1 – E2)	Collision on obstruction or passing over obstruction but safe
II	Yard accidents	Class A5	All above related cases with concerned classes in yard, but Train is not involved
		Class B7	
		Class C9	

<b>Classification Of Accidents</b> (Ref: Railway Board letter No: 2000/ Safety (A&R)/19/20 dated 13.12.2000).			
Sl. No.	Category	Class	Type
		Class D6	
III	Indicative accidents	Class F (F1 – F4)	Averted collisions cases
		Class G (G1 – G4)	Cases of breach of block rules
		Class H (H1 – H2)	Signal passing at danger (SPAD cases)
IV	Equipment failures	Class J (J1 – J10)	C&W, Loco failures
		Class K (K1 – K7)	Engg. department failures
		Class L (L1– L4)	Electric department failures
		Class M (M1– M7)	S&T department failures
V	Abnormal incidents	Class N (N1– N3)	Intentionally damages to Rail, train, stations
		Class P (P1 – P3)	Human run over cases
		Class Q (Q1 – Q6)	Natural human death, murder, suicide, theft, fire, blasts in railway area
		Class R (R1– R5)	Cattle run over cases, Other natural incidents

### Rail Wear and Tear

Sl. No.	VERTICAL WEAR	LATERAL WEAR
1	8 mm for 60 Kg	8 mm for 60 Kg
2	5 mm for 52 Kg & 90 R	6 mm for 52 Kg & 90 R

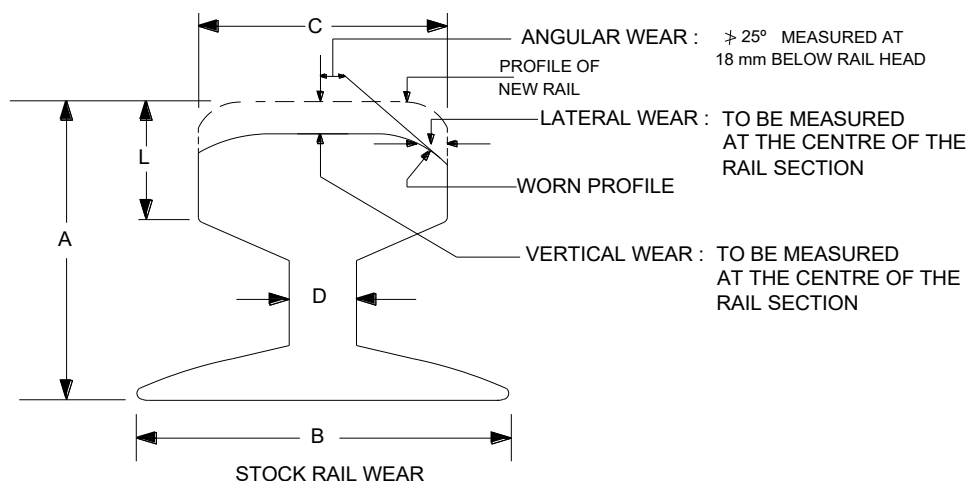


Fig No: 4F1

Rail Section	A	B	C	D	L
52 KG's	156	136	67	15.5	38.82
60 KG's	172	150	74.3	16.5	37.5
90 R	112.83	136.5	66.68	13.89	32.53

#### 4.1 A Tongue Rail Is Classified As Worn Out When

- Chipped/cracked over small lengths totaling to 200 mm within 1000 mm from the toe. Chipped length is the portion where tongue rail has worn out for a depth of more than 10mm over a continuous length of 10 mm.
- Developed a knife edged tip — thickness of tip less than 2 mm over a length of more than 100mm anywhere up to a distance of 1000 mm from its toe.
- Badly twisted, does not house properly and cause a gap of more than 5 mm at the toe.
- Vertical wear which is measured at a point where tongue and stock rails are at the same level. Vertical wear allowed is 8mm for 60 kg. Lateral wear is 8 mm for 60 kg.
- Burred stock rail to be replaced.
- Tongue rails should bear evenly on all the slide chairs.
- All sleepers should be packed properly.
- When the tongue rail is in closed position, it must bear evenly against distance studs or blocks.
- Wear on switches can be reduced by lubrication of the gauge face of the tongue rail.
- On wooden sleeper layout assembly, the slide chairs should be fixed to the timbers by plate screws. Round spikes not to be used for this purpose.

#### 4.2 Measurement And Reading – Track And Vehicle

- Track Readings At Accident Site.** Gauge should be checked at the following locations in case of points and crossings.
  - 305 mm (1 foot) in advance of nose of tongue rail.
  - 152 mm inside nose of tongue rail for straight and turn out.
  - At middle of tongue rail for straight & turnout.
  - At heel of tongue rail for straight & turnout.

**Note:** Gauge should be correct at all locations except at toe. At toe, for PSC layouts up to 3 mm tight gauge is allowed.

- Gauge at Crossings**
  - 610 (2 feet) in advance of nose of crossing on straight & T/Out
  - 152 mm behind the nose of crossing on straight & T/Out
  - 76 mm behind the nose of crossing on straight & T/Out.

The gauge should be correct.

- Check rail (Wing Rail) Clearance on Crossings:

- BG 44 to 48 mm
- MG 41 to 44 mm

Ensure checkrail clearance should be between the values mentioned above.

- Measure vertical wear of stock and tongue rails.

Maximum permissible vertical wear on wing rails or nose of crossings: 10 mm

Rail	Section	BG	MG
S/Rail (wing rail also)	60Kg	13 mm	---
	52 Kg	8 mm	---
	90 R	5 mm	6 mm
T/Rail 1	60 Kg.	8 mm	---
2	52 Kg/90R	5 mm	---

(v) Measure Lateral Wear of stock and Tongue Rail

S/Rail	8 mm/10 mm max	for A, B/Other routes in straight line
	6 mm/8 mm max	for A, B/Other route in curve
T/Rail	60Kg - 8 mm max	-----
	52Kg/90R - 6 mm max	-----

Measure both wears on T/rail at a point with 13 mm head width and at the point where T/Rail and S/Rail are at the same level

(vi) Check for angular wear of Stock Rail

(vii) Check for clipping of T/Rail within 100 mm (1 Metre ) from toe

(viii) Check for knife-edge of T/Rail within 1 m from toe. If the thickness of the T/Rail is less than 2 mm continuous for 100 mm (10 Cms) anywhere within 1 meter from ATS then it is knife edged.

(ix) Measure track readings (Gauge, Cross level, Versine etc) jointly.

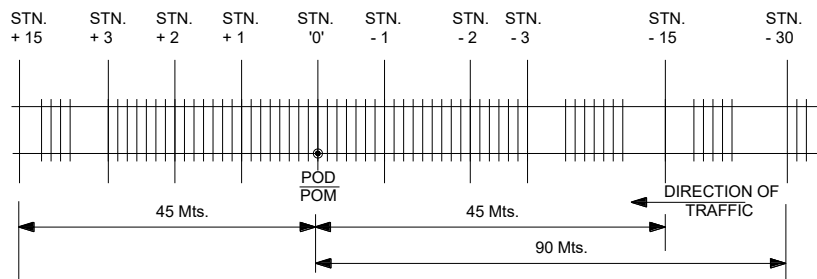


Fig No : 4F2

- Identify and mark Point of Drop (POD)/Point of Mount (POM) as Station 'O'. In case both POD/POM are available then take whichever is first to come (moving in the direction of the train) as Station. 'O'
- Mark 15 Stations 3 m apart in rear of POM/POD up to 45 Metres. Station ahead are marked +1, +2 etc, and rear are marked -1, -2, etc.  
**(Note: In case of any doubt of POM/POD, mark another 15 stations in rear from the suspected POD/POM at 3 Metres up to 90 Metres . i.e. total 30 stations in rear because clues for the cause of the accident are available mostly in rear portion.)**
- Take the reading at every sleeper up to 3 stations (i.e. up to 9 Mts.) on both sides of POD/POM.
- Measure the gauge, cross-level and versine jointly
  - The versine difference between the standard value and the recorded value at every point shall not be more than  $\pm 4$  mm.
  - The difference between any two recorded values shall not be more than  $\pm 3$  mm



- If the versine difference is not within the limits of  $\pm 4$  mm between std value and any recorded value and/or within  $\pm 3$  mm between any two reading then the track curvature is defective.

**Note:** A crossover point is a track in curvature, but without any super elevation. Hence all the parameters need to be maintained correctly.

**4.3 Track Twist:** It is an important parameter having crucial impact on safety. The rate of change of cross-levels is called 'twist'. Cross-level means difference of level of rails. Cross-levels are measured on left rail as seen in the direction of train involved in derailment.

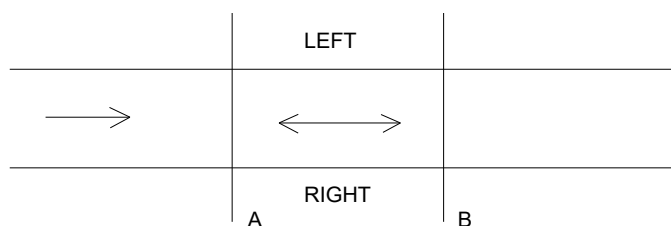


Fig No: 4F3

Track Twist =  $\frac{\text{Algebraic difference of Cross Level at A \& B in}}{\text{Distance between A \& B}}$

Example: Cross level at 'A' = +5 mm (Left rail is higher than right rail by 5 mm)

Cross level at 'B' = -7 mm (Left rail is lower than right rail by 7 mm)

If the distance between A & B is 3 meters,

Then Track Twist =  $\frac{(+5) - (-7)}{3} = 12/3 = 4 \text{ mm / Mts.}$

#### 4.4 Permitted Cross Level Difference (Twist):

For a new track, cross level difference permitted is 1 in 720. A vehicle with defective spring gear travelling on a track with twist can cause derailment. In cases of improper loading, the chances are further increased.

#### 4.5 Draw a Sketch of the Accident Site and note

- Make the exact position where engine & vehicles came to rest.
- Prepare a diagram of the Engine and all the vehicles with reference to track indicating the position of derailed vehicles etc.
- Exact position where loose components of vehicles and track are found.
- Whether Engg. staff were on work
- POM/POD, damage to sleepers, rails and other track fastenings.
- Position of wheels in relation to displaced rails in normal alignment.
- Condition of track at least  $\frac{1}{2}$  a mile in rear.
- The condition of signals, points, L/Bars, Levers/Knobs and their relevant indications, SM slides, position of Block Instrument etc.
- Whether any S & T Staff working
- Check the records, register, PN books etc. Seize the order books, if required.
- In case of shunting operation whether proper locking & clamping of points done or not.

#### **4.6 CARRIAGE AND WAGON Related Items:**

(a) Variation in wheel diameter within the wheels of same axle shall not be more than 0.5 mm for both goods and coaching stocks.

- Difference of wheel diameter between wheels of same axle - within 0.5 mm.
- Difference of wheel diameter between wheels of two adjacent axles of the same trolley: Goods: within 13 mm Coaching: within 5 mm.
- Difference of wheel diameter between wheels of different trolleys of a bogie: Goods: within 25 mm Coaching: within 13 mm.

*(Note: Due to difference in wheel diameter, there will be angular motion of the wheels.*

*Wheel with lesser diameter may have tendency to mount over rails and derail whereas wheel with higher diameter will cause increased wear and tear)*

##### **(a) Sharp Flange**

- Flange of the wheel sometimes wears to form a knife edge which becomes unsafe when radius of the flange at the tip is less than 5mm.
- A wheel with sharp flange has biting action particularly while negotiating curves.
- Sharp flange may split open a slightly gaping point.
- While travelling in facing direction it may even mount the tongue rail.
- Rejection limit for flange tip radius is less than 5 mm for BG/MG

##### **(c ) Thin Flange**

- Flange becomes thin by wear and tear of the tyre and flange and is considered unsafe when it becomes less than 16 mm.
- This increases clearance between wheel flange and rail, which in turn increases the derailment proneness.
- Oscillations increase due to greater play between wheel set and track resulting in greater instability of the vehicles
- Rejection limit is 16 mm BG/MG measured at 13 mm from the flange tip.
- It also damages tongue rails due to more play.

##### **(d) Flat Tyre /Skidded wheel**

- It may occur due to continuous brake binding, skidding, brake block tilting and jamming against the tyre.
- Flat tyres cause passenger discomfort and may become unsafe.
- Flat tyre causes greater hammering action on the rail and rail fractures may take place.

##### **(e) Deep Flange**

- Deep Flange may hit track fittings like fishplate joints, lock bars, point and distance blocks.
- A deep flange tends to ride on fishplate and distance or check blocks and damage the track, particularly if there is vertical wear on railhead.
- Rejection limit in depth of flange greater than 35 mm (BG), 32 mm (MG) measured at 63.5 for BG and 57 mm for MG away from back of wheel.

##### **(f) False Flange/Hollow Tyre.**

- Excessively worn-out tyre on tread is a hollow tyre. Hollow tyres develop a false flange. The false flange formed may force open the switches when the vehicle runs in the trailing direction on points and crossing.
- False flange can be dangerous at the wings of crossing as it may ride over the wing rail, lifting the wheels and creating conditions favourable to derailment.
- If the hollowness is more then it results in difference in wheel diameter and the wheel may ride over the rails.

### List of Drawings & Registers at a Station

Name of the station: ....., Section: ..... Division: .....

S.No	Drawings to be Maintained at a Station - Table 1	Yes/No/NA
1	Signal Interlocking plan of station (SIP)	
2	Table of Controls (TOC)/Selection Table/Route Control Charts	
3	Approved Relay/E.I Room Wiring Circuits (with Contact Analysis updated)	
4	Approved EI Logic circuits	
5	Approved E I Interface circuits	
6	Relay Racks layout & Relay Disposition Plan	
7	Cable Termination details in Relay Room	
8	Power Supply Distribution/Wiring Diagram	
9	Power Equipment Layout	
10	Track Circuit bonding diagram	
11	Traction Bonding Diagram	
12	Cable Route plan	
13	Cable core/distribution plan	
14	Location Termination particulars	
15	Signal Sighting committee Reports	
16	Station Working Rules (SWR) & SWOD	
17	Safety Certificate	
18	EI Checksum certificate	
19	Any other as per requirements	

S.No	Registers to be Maintained at a Station - Table 2	Yes/No/NA
1	Signal Failure Register	
2	Control Panel/Control Terminal Maintenance Register	
3	Emergency Route/Sub route Cancellation Register	
4	Emergency Point Operation/Crank Handle Extraction Register	
5	Axle Counter/MSDAC Reset Registers	
6	Cabin/Relay Room Key Register	
7	Disconnection/Reconnection Register	
8	Signal maintenance Register	
9	Signal Equipment History book	
10	Station Signalling Asset Register	

S.No	Registers to be Maintained at a Station - Table 2	Yes/No/NA
11	Integrated Power supply System Maintenance Register	
12	Solar panel Maintenance Register (if any)	
13	Diesel generator Maintenance Record (if any)	
14	IPS/Battery Set/Battery Charger Maintenance Register-24VDC	
15	Cable Meggering (Insulation Testing) Register	
16	Earth Testing Register	
17	Electronic Interlocking Systems Maintenance Record (including System changeover)	
18	Datalogger Register	
19	UAC Axle Counter/MSDAC maintenance Register	
20	SSDAC/HASDAC Maintenance log sheet	
21	MSDAC Maintenance log sheet	
22	Block proving axle counter maintenance Record	
23	Electronic Junction Box/Axle Detector maintenance Register	
24	Track circuit maintenance Register	
25	Joint Inspection of Track circuit Register	
26	Block instrument maintenance Register	
27	UFSBI maintenance Register	
28	Intermediate Block Signal Maintenance Register	
29	LC gate lifting barrier Maintenance Register(EOLB & MOLB)	
30	Point Machine Maintenance Register	
31	Joint Inspection of Points & Crossings Register	
32	Joint Inspection of OHE bonding Register	
33	AMC Registers of equipments	
34	Fire alarm system maintenance Register	
35	System Integrity Test (SIT) Register	
36	Officer`s Inspection Register	
37	Signal Visibility certificate Registers	
38	Any other as per requirements	

Signature:	Signature:	Signature:
Name:	Name:	Name:
<b>SSE/JE(Signal)</b>	<b>SSE(Signal)/Incharge</b>	<b>ASTE/DSTE</b>
Date:	Date:	Date:

**Note:** The above list is not exhaustive. Zonal Railways may add/delete/Update as per individual requirements

Cause Wise Analysis of Signal Incidences						
S.No	Causes	Position of current month	Position of last month	Same month last year	Cum. up to the current month	Cum. up to the same period last year
<b>1</b>	<b>S&amp;T Account (A)</b>					
<b>1a</b>	<b>Equipment Failure</b>					
1a.1	Signal Transformer					
1a.2	HKT, E Type lock, Crank Handle					
1a.3	Lever frame					
1a.4	Magneto Telephone					
1a.5	Annunciator					
1a.6	SM Slide					
<b>1b</b>	<b>Lamp fusing</b>					
1b.1	Filament lamp					
1b.2	LED, HMU/CR					
<b>1c</b>	<b>Cable</b>					
1c.1	Indoor wiring & Dry Soldering					
1c.2	Outdoor Cabling					
1c.3	Cable Termination					
<b>1d</b>	<b>Relay Failure</b>					
1d.1	Metal to Carbon					
1d.2	Metal to Metal					
1d.3	Group Relay					
<b>1e</b>	<b>Point M/c</b>					
1e.1	Point M/c					
1e.2	ED					
<b>1f</b>	<b>Fuse blown off</b>					
1f.1	Fuse Blown off					
1f.2	<b>Power Equipment</b>					
1f.3	IPS/UPS					
1f.4	Battery Charger					
1f.5	DG set					
1f.6	AMF Panel of DG Set					
1f.7	Battery					
1f.8	Invertor					
1f.9	DC to DC Convertor					
<b>1h</b>	<b>Bad Maintenance</b>					
1h.1	Out of adjustment					
1h.2	Loose connection					
1h.3	Jamming					

Cause Wise Analysis of Signal Incidences						
S.No	Causes	Position of current month	Position of last month	Same month last year	Cum. up to the current month	Cum. up to the same period last year
1h.4	Breakage of part					
1h.5	Degradation of Electric Power					
1h.6	Staff working					
<b>1i</b>	<b>Track Circuit Failure</b>					
1i.1	UAC/SSDAC/MSDAC/TC					
1i.2	Impedance Bond					
1i.3	AFTC					
1i.4	Track feed resistance					
1i.5	Track device/UAC/SSAC/MSDAC					
1i.6	EJB/UAC					
1i.7	Reset/UAC/SSAC/MSACT C					
<b>1j</b>	<b>Block Instrument Failure</b>					
1j.1	Block Panel					
1.j.2	UFSBI					
1.j.3	BPAC-MUX					
1.j.4	SGE					
1.j.5	TLI					
1.j.6	Token Instrument					
1.j.7	UAC/SSDAC/BPAC					
1.j.8	Reset/UAC/SSAC/BPAC					
<b>1k</b>	<b>Interlocking</b>					
1k.1	Electro Mechanical					
1k.2	Relay					
1k.3	Electronic Interlocking					
<b>1l</b>	<b>Lifting Barrier</b>					
1l.1	Mechanical					
1l.2	ELB					
<b>1m</b>	<b>Miscellaneous</b>					
1m.1	Right during testing					
1m.2	Route held up					
1m.3	FPL/LB					
1m.4	Mechanical Detector					
1m.5	Rod/Wire/Compensator/ Reverser/Signal Machine					
<b>1n</b>	<b>TCAS (Train Collision Avoidance System)</b>					
1n.1	Line side					
1n.2	Radio					

Cause Wise Analysis of Signal Incidences						
S.No	Causes	Position of current month	Position of last month	Same month last year	Cum. up to the current month	Cum. up to the same period last year
1n.3	On board					
	<b>Total (A)</b>					
	<b>Non- Chargeable ( B)</b>					
<b>2</b>	<b>OPERATING</b>					
2.1	TFOK (Tested and found ON).					
2.2	NINA (None informed none attended)					
2.3	Wrong operation					
2.4	Obstruction in point					
2.5	Others(Sanction Block & NI Wkg.)					
	<b>Total</b>					
<b>3</b>	<b>ENGINEERING</b>					
3.1	Staff working					
3.2	IBJ defect					
3.3	GJ defect					
3.4	Poor drainage					
3.5	Point defect					
3.6	Others					
3.7	Engg. Construction					
	<b>Total</b>					
<b>4</b>	<b>DOT</b>					
4.1	Line faults					
	<b>Total</b>					
<b>5</b>	<b>ELECTRICAL</b>					
5.1	Supply failure					
5.2	Others					
	<b>Total</b>					
<b>6</b>	<b>MECHANICAL</b>					
6.1	Damage by hanging part					
6.2	Token lost					
6.3	Others					
	<b>Total</b>					
<b>7</b>	<b>Miscreants</b>					
<b>8</b>	<b>Miscellaneous</b>					
<b>9</b>	<b>Bad weather</b>					
<b>10</b>	<b>RE/Construction</b>					
	<b>Total (B)</b>					
	<b>Grand Total (A+B)</b>					

**SSE/JE (Signal) Progress Report**

.....RAILWAY

**SIGNAL & TELECOMMUNICATION DEPARTMENT**

.....Division

Monthly Progress Report of..... JE/SSE's (Signal)..... for the month ending..... 20

S.No.	Name of work	Reference to		Date work started	Percentage of work done during the month	Total percentage of work done upto the end of last month	Remarks
		Authority	Sanctioned estimate				

Signature .....

Designation.....



**SSE/JE (Signal) Completion Certificate**

.....RAILWAY

**SIGNAL & TELECOMMUNICATION DEPARTMENT**

No.....

To,

The Sr. DSTE,.....

1. This is to certify that work at ..... in connection with ..... has been carried out correctly in accordance with-

(a) Approved plans as under-

- i) Interlocking and Yard Plan No..... dated.....
- ii) Interlocking Table No ..... dated.....
- iii) Interlocking Chart No ..... dated.....
- iv) Wiring Diagram No ..... dated.....

(b) Instructions contained in the Signal Engineering Manual and Schedule of Standard Dimensions except deviations as sanctioned. *Vide* your letter No..... dated.....

2. The work was brought into use on..... 20.....

Dated.....20

.....(Supervisor).

.....(Supervisor).

**SIGNAL & TELECOMMUNICATION DEPARTMENT**

Name of Technician (Signal).....	Hqrs. of Technician
Signal.....	

Date of Visit	Name of Station/Cabin	Train No. and time arrived	Train No. and time departed	Maintenance Work Done
1	2	3	4	5

Date.....

## Disconnection/Reconnection Notice

FORM NO. S&T/DN _____ RAILWAY Signal & Telecommunication Department <u>Acknowledgement of Disconn/ Reconn Notice</u>	FORM NO. S&T/DN _____ RAILWAY Signal & Telecommunication Department <u>Reconnection Notice</u>	FORM NO. S&T/DN _____ RAILWAY Signal & Telecommunication Department <u>Disconnection Notice</u>
No. _____	No. _____	No. _____
To The Station Master or Cabinman on duty at ..... Station/cabin	Notice for reconnecting Signalling Gear already disconnected	Notice to Transportation Staff for disconnecting Signalling gear
For disconnecting the following gear * .....	Division/District .....	Division/District .....
on ..... at ..... hrs. MSM/ESM/JE/SE(Sig)	To The Station Master or Cabinman on duty at ..... Station/Cabin	To The Station Master or Cabinman on duty at ..... Station/Cabin
Notice about disconnection received at ..... hrs. on ..... 20 SM/Cabinman	Please note that the disconnected gear referred to in Notice No ..... has since been reconnected on ..... at ..... hrs.	Please note that the following gear will be disconnected on ..... at ..... hrs. *
Disconnection allowed/not allowed** at ..... hrs. on ..... 20 SM/Cabinman	Date .....	Date .....
Disconnection will be allowed at ..... hrs. on ..... 20 SM/Cabinman	Signature .....	Signature .....
Reconnected at ..... hrs. on ..... 20 MSM/ESM/JE/SE(Sig)	Designation .....	Designation .....
Notice about reconnecting received at ..... hrs. on ..... 20 SM/Cabinman		
<p>* Fill in details of Gear to be disconnected,    ** Reason for not allowing disconnection to be recorded.</p>		

### Where Disconnection Notice is not Required

Situations in which disconnection notice need not be issued provided suitable precautions are taken are as under;

#### 1. Cleaning and/or Lubricating/Graphiting without affecting any Physical Electrical Disconnection

- (a) Lever frame basement.
- (b) Relay Room & Battery Room.
- (c) Apparatus case/battery boxes/Goomty.
- (d) Lifting barrier mechanism including winch.
- (e) Lever lock and circuit controller without opening cover.
- (f) Inspection and cleaning of inside equipment by opening the covers of point machines, signal motors, reversers, apparatus cases and detectors.
- (g) Point, facing point lock and lock bar.
- (h) Cranks, compensators, pullies, wheels, roller stands, counterweights & levers.
- (i) Power supply equipment.
- (j) Insulation joints.
- (k) Lens/roundels of signal, point indicator, trap indicator & shunt permitting indicator provided phantom indication to driver of an incoming train is prevented by covering lenses.

#### 2. Testing of

- (a) Track locking, approach locking, back locking, indication locking, route release.
- (b) Checking various parameters of axle counter without disconnecting the equipment.
- (c) Power supply equipment.
- (d) Lever frame, SM's control frame, signal operation, point operation, level crossing gate & slot circuits.
- (e) Point by obstruction test for lock only.
- (f) Checking and testing of track circuit parameters when the track is unoccupied.
- (g) Focussing of colour light signal provided phantom indication to Loco pilot of an incoming train is prevented by covering lenses.

#### 3. Adjustment of

- (a) Wire transmission except double wire operated point transmission, where existing.
- (b) Tightening of terminals using insulated tools without causing any shorts on adjacent terminals.

#### **4. Replacement of**

- (a) Electric signal lamp provided phantom indication to driver of an incoming train is prevented by covering lenses.
- (b) Bond wire, one at a time.
- (c) Plug-in relay in case traffic condition permits.
- (d) Indicator lamps.
- (e) Push button/switch/key of panel.
- (f) Lock bar clips/bar stop, one at a time.
- (g) G. D. tubes.
- (h) Fuse, one at a time.
- (i) Pulley, bottom roller/top roller in wire and rod transmission one at a time and split pins.
- (j) Batteries/cells without affecting disconnection of supply to main equipment.

**Competency Certificate cum Training History Book**

.....Railway

**SIGNAL AND TELECOMMUNICATION DEPARTMENT**

Photograph

(Attested by  
Gazetted  
Officer)

Certificate number.....

This is to certify that

Shri	
S/o Shri	
Designation	
Staff No.	
Station	
Division	

who has undergone training in.....has been examined in the relevant rules and instructions pertaining to his duties stipulated in the Signal Engineering Manual & General and subsidiary rules and he is competent to undertake independently such work which may necessitate disconnection of signalling and interlocking gear in service under open line conditions.

This certificate is valid upto.....

He is also qualified to work on the following block instruments and is competent to disconnect and restore working (Tick the appropriate)

1	Double line block instrument	
2	Single line token block instrument	
3	Single line push button block instrument	
4	Single line handle type block instrument	
5	UFSBI	
6	SSBPAC (D)	

Date:.....

Place: .....

Principal  
S& T Training centre

.....Railway

### Renewals of Competency Certificate

Date	Renewed upto	Block Instruments		Signature
		Added	Deleted	

### Refresher Course

S.No	Course No.	Last attended		Next Due	Signature
		From	To		

### Equipment and Other Course Attended

S.No.	Date	Name of Course	From	To	Signature

## Hours of Employment Regulations

**1. Application.** Hours of Employment Regulations will apply to all (non-gazetted) railway servants including casual labour and substitutes except those governed under the Factories Act, the Mines Act, Minimum Wages Act and the Merchant Shipping Act.

**2. Classification.** Railway servants governed under Hours of Employment Regulations are classified as under—

- (a) Intensive;
- (b) Essentially intermittent;
- (c) Excluded; and
- (d) Continuous.

**2.1. Intensive.** The employment of a railway servant is said to be Intensive when it has been declared to be so by the prescribed authority on the ground that it is of a strenuous nature involving continued concentration or hard manual labour with little or no period of relaxation.

The work of a railway servant shall be held to be intensive if it is so declared by the Head of the Railway on the ground that it involves sustained and strenuous attention or physical exertion—

Such that periods of rest, inaction or relaxation do not aggregate to 6 hours or more in a cycle of 24 hours, and

Such that, in any shift of 8 hours he does not get periods of inaction, rest or relaxation of at least one hour in the aggregate.

**2.2. Essentially Intermittent.** The employment of a railway servant is said to be Essentially Intermittent when it has been declared to be so by the prescribed authority on the ground that the daily hours of duty of the railway servant normally include periods of inaction aggregating 6 hours or more (including at least one such period of not less than one hour or two such periods of not less than half an hour each) during which the railway servant may be on duty but is not called upon to display either physical activity or sustained attention.

**2.3. Excluded.** The employment of a railway servant is said to be 'excluded' if he belongs to one of the following categories namely:

- (a) Staff employed in a confidential capacity;
- (b) Armed guards or other personnel subject to discipline similar to that of the armed police forces;
- (c) Staff of Railway Schools imparting technical training or academic education;
- (d) Staff classified as supervisory; and
- (e) Such categories of staff of Health and Medical Department as may be specified by the prescribed authority.



Main provisions as regards Hours of Employment are as follows:

The staff governed by Hours of Employment Regulations will be employed as per the rostered hours of duty which will in no way exceed the statutory limit of hours of employment. The statutory limit of hours of employment and the rostered hours of duty will be as under:

#### **2.4 Statutory Limit of Hours of Employment**

(a) A railway servant whose employment is Intensive shall not be employed for more than 45 hours a week and he shall be granted each week commencing on Sunday, a periodical rest of not less than 30 consecutive hours.

(b) A Railway servant whose employment is Essentially Intermittent shall not be employed for more than 75 hours in any week and he shall be granted each week, commencing on Sunday, a periodical rest of not less than 24 consecutive hours including a full night.

(c) A railway servant whose employment is continuous shall not be employed for more than 54 hours a week and he shall be granted each week commencing on Sunday, a periodical rest of not less than 30 consecutive hours.

(d) The staff treated as excluded shall have no limitation of hours of employment and there is no statutory provision for their periodic rest.

#### **2.5 Rostered Hours of Duty**

(a) The hours of work shall consist of standard hours of duty as under-

(i) 42 hours a week in case of Intensive workers.

(ii) 48 hours a week in case of Continuous Workers.

(iii) In case of E. I. Workers 48 hours a week plus additional hours of work per week which will be subject to the prescribed maximum.

(b) In addition to working hours for the three classifications of workers as in (i) above, the time required for Preparatory and/or Complementary work which includes the work, if any, of handing and/or taking over charge and has necessarily to be carried on outside the standard duty hours vide (i) above.

(c) Office staff are rostered for 8 hours a day including half-an-hour's break, i.e., 7-1/2 hours a day. They enjoy weekly rest on Saturdays and Sundays and holidays as declared by the administration.

### 3. Preparation of Duty Rosters:

- (a) Hours of duty will be exhibited in the duty rosters. (Duties may be shown as running at a stretch or these may be covered in split shifts). (No duty roster should offend the principle of hours of work prescribed for concerned workers or should offend the rules against 'long ons' and 'short offs'). Every roster must provide periodic rest as per rules to be enjoyed within the week commencing from Sunday midnight and ending with Saturday midnight. Weekly rest must not be spread over two weeks. Duty rosters for Continuous workers, covered by the principle of averaging, should be prepared on the basis of 48 hours a week on the average in two weeks plus time for comp/prep. work, if any. Rosters for those Continuous workers who are not covered by the principles of averaging should be framed in such a way that their maximum daily statutory hours are not exceeded. Duty Rosters for Intensive and E. I. workers should also be framed in the same way in conformity with the two-weekly/weekly average number of hours as prescribed. As far as possible, duty rosters should be framed avoiding overtime work as a regular feature. Duty Rosters of Rest Givers should also be framed in the same way.
- (b) **Short off.** A 'Short off' means a short period of rest between the end of one rostered duty and the beginning of the following rostered duty. It is a period of rest where it is less than 12 hours in a roster of 6 hours' duty and less than 14 hours in a roster mixed of 6 and 8 hours' duty in the case of Intensive workers, less than 10 hours in the case of Continuous workers and less than 8 hours in the case of E. I. workers (No railway servant should normally be called on duty unless he has enjoyed rest as above).
- (c) **Long on.** A 'long on' is a period of duty (exclusive of the period or periods of breaks) for long hours and spread over 8 hours in the case of Intensive workers, over 10 hours in the case of Continuous workers and over 12 hours in the case of E. I. workers.
- (d) **Split Shifts.** Split shift means a shift which is punctuated in the daily tour of duty by breaks during which the employee is free to leave his place of work. It is a shift which is split up into two or more parts by intervals (not periods of inaction).
- (e) **Night Duty.** Night duty means employment during any part of the night from 10.00 p. m. to 6.00 a. m. Full night means the period between 10.00 p. m. and 6.00 a. m. Employment of railway servants on continuous night duty should be avoided.
- (f) **Work beyond Ceiling Limits.** All Railway workers governed by Hours of Employment Regulations can be called upon to render duty beyond statutory limits applicable to them by an order of temporary exemption made under Section 71-C of the Indian Railway Act.

## Workmen's Compensation Act

### 1. Application:

1.1. The Workmen's Compensation Act applies to all railway servants as also labourers employed by contractors for the purpose of carrying out railway work but excluding those employed in an Administrative, District or Sub-Divisional Office and those mentioned in Schedule II of the Act whose monthly wages exceed Rs. 500.

1.2. The Workmen's Compensation Act does not apply to staff employed in foreign territories and no compensation under the Act is, therefore, legally admissible in respect of accidents occurring in those foreign territories.

**2. Liability for compensation.** Compensation under Workmen's Compensation Act is payable only when a personal injury is caused to a workman by accident arising out of and in the course of his employment. The Administration shall not, however, be liable to pay any compensation.

- (a) In respect of any injury which does not result in the total or partial disablement of the workman for a period exceeding three days.
- (b) In respect of any injury not resulting in death caused by an accident which is directly attributable to-
  - (i) The workman having been at the time thereof under the influence of drink or drugs, or
  - (ii) The wilful disobedience of the workman to an order expressly given or to a rule expressly framed, for the purpose of securing the safety of a workman, or
  - (iii) The wilful removal or disregard by the workman of any safety guard or other device which he knew to have been provided for the purpose of securing the safety of workmen.

### 3. Notice to the Commissioner-

- (a) In the case of accidents, which result in the death of railway servants or Contractor's servants doing work for the railway, employed otherwise than in clerical capacity, within railway premises, the Divisional Officer concerned shall, within seven days of the date of death, send a report to the Commissioner in the prescribed form. In the case of staff governed by the Factories Act, etc, the forms laid down in those Acts for this purpose shall be used for reporting the fact to the Commissioner.
- (b) This notice shall always be sent irrespective of whether the deceased workman, was or was not on duty at the time-In the latter case the Commissioner's attention shall be drawn to it specifically.
- (c) Copies of such reports shall be sent to the General Manager and the Head of the Department.

### Payment of Wages Act

**1. Application.** The Payment of Wages Act applies to the payment of wages to persons employed in any factory and to persons employed (other than in a factory) upon any railway by a Railway Administration or, either directly or through a subcontractor, by a person fulfilling a contract with a Railway Administration and employing or having employed twenty or more persons on any day of the preceding twelve months.

**2. Wages.** Means all remuneration (whether by way of salary allowance or otherwise) expressed in terms of money or capable of being so expressed which would, if the terms of employment, express or implied, were fulfilled, be payable to a person employed in respect of his employment or of work done in such employment.

### 3. Main Provisions of the Act—

- (a) Responsibility for Payment of Wages.—Every employer shall be responsible for the payment to persons employed by him of all wages to be paid under this Act. In factories, the person named as the Manager of the factory will be responsible for the payment.
- (b) Fixation of wage periods.—Every person responsible for the payment of wages to persons employed by him shall fix periods in respect of which such wages shall be payable and no wage period shall exceed one month.
- (c) Time of payment of wages.—Wages shall be paid on a working day within 7 days of the last day of the wage period in an establishment where less than 1000 men are employed and in other establishments before the expiry of the tenth day.

When the employment of any person is terminated by or on behalf of the employer, the wages earned by him shall be paid before the expiry of the second working day from the day on which his employment is terminated.

- (d) Deductions which may be made from wages.—The wages of an employed person shall be paid to him without deductions of any kind except those authorised by or under this Act.
- (e) Deductions for absence from duty.—Deductions may be made only on account of the absence of an employed person from the place or places where he is required to work, such absence being for the whole or any part of the period during which he is so required to work.
- (f) Deductions for damage or loss.—A deduction for damage to or loss of goods not exceeding the amount of the damage or loss caused to the employer by neglect or default of the employed person. Deductions under this clause shall not be made unless it is established—
  - (i) That the money or goods lost or damaged was expressly entrusted to the custody of the employees concerned, and
  - (ii) That the cause of such loss or damage is directly attributable to his neglect or default.
- (g) Display of notices.—The person responsible for the payment of wages to men employed in a factory shall cause so be displayed in such a factory a notice containing such abstract of this act and of the rules made thereunder in English and in the language of the majority of persons in the factory as may be. prescribed by the Government.

## Chapter 4: Budget Estimates, Expenditure, Budget Control and Completion Reports

### Section 1: Introduction - Budget Terms

- 4.1.1 **Budget Estimates:** Every Railway Administration has to prepare estimates of expenditure expected to be incurred by it in a year and submit them on prescribed dates well in advance of the beginning of that year to the Railway Board for obtaining the sanction of the Parliament or the President. Such estimates are called "Budget Estimates".
- 4.1.2 **Demand for Grants:** On the basis of the Budget Estimates received from the various Railway Administrations and other spending units, the Railway Board prepare their "Demand for Grants" and present them to the Parliament or the President, as the case may be, for sanction.
- 4.1.3 **Grants and Appropriations:** The 'Demands for Grants' as finally approved by the Parliament are called the Budget 'Grants' and those sanctioned by the President without reference to the Parliament are called 'Appropriations'.
- 4.1.4 **Budget Orders and Allotments**
- (a) Railway Grants and Appropriations for a year are distributed by the Railway Board to the various Railway Administrations and other spending units directly under the Railway Board, through what are known as 'Budget Orders'. The Budget Orders are accompanied by the Budget Documents.
  - (b) Grants and Appropriations distributed to the various Divisions and spending units are called Budget Allotments.
- 4.1.5 **Budget Documents:** The complete Budget, is printed in the form of books as under:
- (a) Demands for Grants.
  - (b) Explanatory Memorandum showing the financial results of the year.
  - (c) Works, Machinery and Rolling Stock Programme of Railways.
- 4.1.6 **Re-appropriation:** The transfer of funds originally assigned for expenditure on a specific object to supplement the funds sanctioned for another object is called "Re-appropriation". The powers of the Railway Board and Railway Administration in respect of re-appropriation are detailed in Chapter III of the Indian Railway Financial Code Volume I (extracts at [Annexure: 4-A1](#)).
- 4.1.7 **Review of Expenditure:** The sufficiency or otherwise of the sanctioned budget allotments shall be reviewed periodically by each Railway Administration on the basis of expenditure actually incurred upto the time of review and the anticipated expenditure during the remaining portion of the financial year. The detailed procedure in regard to review of Expenditure is contained in Chapter III of the Indian Railway Financial Code, Volume I (extracts at [Annexure: 4-A2](#)).

- 4.1.8 **Major, Minor, Sub, Detailed Heads:** All revenue working expenses of the Railway are classified under 13 sub major heads with separate abstract for each sub major head. The sub major heads are divided into minor, sub and detailed heads as detailed in Volume II of the Indian Railway Financial Code (Minor, sub and detailed heads, relevant to Signaling and Telecommunication are at [Annexure: 4-A3](#)).
- 4.1.9 **Revenue and Works Budgets:** Budget estimates of the Signal and Telecommunication Department comprise mainly of the following:
- (a) **Estimates of Working Expenses:** These are based on the Working Expenses for the repairs and maintenance of Signaling, interlocking and Telecommunication Services and comprise estimates of expenditure against Demand Nos. 3,7 and 8 referred to in [Para 4.1.8](#).
  - (b) **Works Budget:** Open Line Works Budget otherwise known as 'Annual Works Programme' comprises estimates of requirements for Works against Demand No. 16.
  - (c) Plant and Machinery Programme comprises estimates of requirements for Machinery and Plant against Demand No. 16.
- 4.1.10 **Compilation:** The Revenue Budget or Estimate of Working Expenses is compiled in the prescribed forms in the Headquarters Office on the basis of proposals submitted by the Divisions/Extra Divisional Units in accordance with instructions contained in Chapter III of the Indian Railway Financial Code. Volume I (extract at [Annexure: 4-A4](#)).
- 4.1.11 **Detailed Instructions for Administering the Budget** are contained in Chapter III of the Indian Railway Financial Code (extract at [Annexure: 4-A7](#)).

## **Section 2: Works, Machinery and Rolling Stock Budget**

### **4.2.1 Detailed Instructions for Preparation and Submission**

Detailed instructions for preparation and submission of Works, Machinery and Rolling Stock Budget are contained in Chapter III of Indian Railway Financial Code, Volume I (extracts at [Annexure: 4-A5](#)).

The classification of expenditure by primary units of expenditure are contained in Volume II of the Financial Code (Heads relevant to Signal and Telecommunication Department at [Annexure: 4-A6](#)).

### **4.2.2 Compilation of Plant and Machinery Programme**

- (a) The detailed instructions for the preparation and submission of the Plant and Machinery Programme are contained in Chapter XV of the Indian Railway Code for the Mechanical Department (Workshops).
- (b) The requirements of machinery in Signaling and Telecommunication Workshops shall be collected and shown in Plant and Machinery Programme. The description of machinery, number, allocation, cost etc. shall be shown on the prescribed forms and submitted along with the programme. This programme should be as per the schedule of Works Programme.

## Section 3: Maintenance of Accounts

4.3.1 **Code Rules:** Rules in regard to the maintenance of Open Line accounts are contained in Chapter XIV of the Indian Railway Code for the Engineering Department.

### 4.3.2 Accounting

- (a) The expenditure incurred is brought to account through various vouchers. Subject to such powers as may be delegated to him, the Divisional Signal and Telecommunication Engineer/Divisional Signal and Telecommunication Engineer incharge may incur expenditure on all ordinary maintenance works and establishments upto the limits of the provision in the Revenue Budget Estimates, sanctioned for his unit for the year.
- (b) All vouchers, such as debit notes for stores supplied, freight bills shall be carefully scrutinised before acceptance as to the reasonableness and propriety of the debits raised. Wherever necessary, such debits shall be correlated and checked with the initial records in the office, such as indents and work orders on Workshops and necessary endorsements made thereon.

### 4.3.3 Departmental Registers on Extra-Divisional Units

- (a) **Revenue Allocation Register:** The Deputy Signal and Telecommunication Engineer/ Divisional Signal and Telecommunication Engineer incharge of an Extra-Divisional Unit shall maintain a Register of Revenue expenditure, if any, incurred by him under the relevant grants in order to keep himself acquainted with the progress of expenditure in his unit as compared with the sanction in the Authorization Rolls. The detailed instructions in regard to the maintenance of Revenue Allocation Register are contained in Para 1469 of Engineering Code ([Annexure: 4-A8](#)).
- (b) **Register of Works:** The object of maintaining the Register of Works and Instructions in regard to maintenance of the same are contained in Paras 1472, 1473, 1474 and 1475 of Engineering Code ([Annexure: 4-A9](#)).
- (c) **Reconciliation of Registers:** The registers of the Extra-Divisional Office shall be sent monthly to the Accounts Office with a clerk on such dates as mutually agreed upon in order that the entries made therein may be reconciled with similar registers maintained in the Accounts Office.

4.3.4 **Departmental Registers on Divisions:** On Divisions where the initial accounts are maintained by the Accounts Department, neither Allocation Register nor Register of Works need be maintained by the Departmental Officers. There will be only one set of registers and these will be maintained by the Accounts Officer both for his own use and for that of the other Departmental Officers, who will continue to be responsible for the efficient control of expenditure against estimates and allotments.

## Section 4: Control over Expenditure

4.4.1 The manner in which the budgetary and expenditure control is to be exercised by the various units is indicated in Chapter V of the Indian Railway Financial Code (relevant extract at [Annexure: 4-A10](#)).


### 4.4.2 Indents and Work Orders

When passing requisitions for materials and tools, for works or maintenance, Sr. Divisional Signal and Telecommunication Engineer/Deputy Signal and Telecommunication Engineer/Divisional Signal and Telecommunication Engineer incharge shall ensure that the amounts involved are within the allotments and also within provision in the sanctioned estimates.

Before execution of agreements and work orders with contractors the Sr. Divisional Signal and Telecommunication Engineer/Deputy Signal and Telecommunication Engineer/Divisional Signal and Telecommunication Engineer incharge shall ensure that these have been carefully checked in every respect. Rates allowed in bills received from firms shall be carefully scrutinized before they are passed for payments.

## Section 5: Completion Reports

4.5.1 **Code Rules:** Rules in regard to the preparation and submission of Completion Reports are contained in Chapter XVII of the Indian Railway Code for the Engineering Department (relevant extracts at [Annexure: 4-A11](#)).

 Note: This Chapter has under mentioned Annexures		
S.No	Annexure No.	Description
1	<a href="#">4-A1</a>	Powers of the Railway Board
2	<a href="#">4-A2</a>	Review of Expenditure
3	<a href="#">4-A3</a>	Revenue Expenditure
4	<a href="#">4-A4</a>	Preparation of the Budget
5	<a href="#">4-A5</a>	Works Machinery and Rolling Stock Budget
6	<a href="#">4-A6</a>	Classification of Capital and other Works Expenditure
7	<a href="#">4-A7</a>	Distribution of Funds by the Railway Board
8	<a href="#">4-A8</a>	Revenue Allocation Registers
9	<a href="#">4-A9</a>	Register of Works is a Collective Record of Expenditure Designed
10	<a href="#">4-A10</a>	Revenue and Works Expenditure
11	<a href="#">4-A11</a>	Completion Report



**Powers of the Railway Board**  
(Extract of Chapter III of Indian Railways Financial Code, Volume I)

- (1) Powers of the Railway Board:** Within the amount of a grant as voted by the Parliament, the Railway Board have full power of transferring the provision from one sub-head to another by a formal order of re-appropriation but re-appropriations, from one grant to another are not permissible. Under Grant No. 16 no re-appropriation of funds is permissible between Capital, Railway Funds and Revenue even though re-appropriation is permissible between the various sub-heads of grant viz., the various plan heads. As regards "Charged" expenditure there are no restrictions on the powers of the Railway Board to transfer provision from one sub-head to another by a formal order of re-appropriation but no re-appropriation is permissible from one grant to another from "Charged" heads to "Voted" heads or Vice Versa. (Para 376)
- (2) Powers of Railway Administrations:** No re-appropriation is permissible between "Voted" and "Charged" allotments or between the allotments made under one grant and another. In the case of Grant No. 16 no re-appropriation is permissible between the Capital Railway funds and revenue. The re-appropriations. (Para 377)
- (a) to and from the provision for the following plan heads under Grant No. 16:
- (i) New Lines (Construction);
  - (ii) Gauge Conversion;
  - (iii) Electrification Projects;
  - (iv) Track renewals;
  - (v) Staff quarters        } Staff Welfare Works.
  - (vi) Amenities for staff } Staff Welfare Works.
  - (vii) Passenger Amenities and other Railway Users' amenities.
- (b) to and from the provision for "Payments to other Railways" in Grant No. 9, and;
- (c) to and from the provision for "Suspense" in Grant No, 12 require the prior approval of the Railway Board.
- (3) The amount allotted to the Railway administrations under the Civil Grant for "Interest on debt and other obligations and reduction or avoidance of debt" is distributed under the following units of re-appropriations, viz.,**
- (a) State Provident Funds;
  - (b) Railway Staff Benefit Fund;
  - (c) Eastern Group Sleeper Control Provident Fund;
  - (d) Indian Railways Conference Association Employee's Provident Fund;
  - (e) Depreciation Reserve Fund, Railways;
  - (f) Revenue Reserve Fund;
  - (g) Railway Development Fund;
  - (h) Accident Compensation, Safety and Passenger Amenities Fund, and
  - (i) Pension Fund.
- No re-appropriation is permissible from one unit to another.

- (4) Other re-appropriations may be sanctioned by the Railway Administrations but no re-appropriations are permissible after the close of the financial year i. e., 31<sup>st</sup> March. The re-appropriations by Railway administrations should not be made haphazardly on the basis of individual items of expenditure where the original provision is exceeded, nor should they be postponed to be made only towards the end of the year. The Railway administration should review the position as a whole at intervals and carry out the necessary re-appropriations. When funds have to be provided for new expenditure under one of the sub-heads and the administrations are definitely in a position to transfer the grant from another sub-head for this purpose, the appropriations should be made promptly. The whole object is to ensure that, as far as possible, funds which are not required are withdrawn from disbursing officers as soon as it is definitely known that they are not required, and incidentally to provide that any really unavoidable expenditure is met from such savings as far as possible. (Para 379)
- (5) All proposals for re-appropriation of funds which are beyond the General Manager's powers shall be submitted to the Railway Board sufficiently early to admit of action being taken before the close of the financial year. (Para 380)

**Review of Expenditure**  
(Extract of Chapter III of Indian Railways Financial Code, Volume I)

**(1) Review of Expenditure:** Railway Administrations should review their expenditure in August to see whether any modifications are necessary in the allotments placed at their disposal. The review in respect of each grant should be submitted to the Railway Board in Form No. F-383 so as to reach them not later than 1<sup>st</sup> September each year. (Para 383)

Statement showing ..... necessary in the allotments under Grant No. .... during .....

(in thousands of rupees)												
Detailed heads	Actuals last year		Latest Estimate, Current Year					Amount advanced from the Contingency Fund	Total Columns 8 and 9	Variations between Columns (10 and 7)		Brief reasons for large variation
	First Four months	Full year	Actuals first three month	Approximates for month	Total for first four month	Full year	Budget Current year			Excess (+)	Savings (-)	
1	2	3	4	5	6	7	8	9	10	11	12	13
Detailed heads of the Grant												
Total...												

- (2) The Administrations should review the position in as much detail as possible at the time, and if there is any new expenditure which was definitely not anticipated in the budget and which cannot be postponed without serious detriment to safety or efficiency, they should examine whether such expenditure can be met by saving in expenditure provided for in the budget, when such savings can be foreseen or can be achieved without serious damage. The review should show whether such examination discloses the necessity of additional grants or the possibilities of net savings, in order to enable the Board to set off savings on one railway against excesses on another and to arrive at one estimate of the net additional grant required if any. (Para 384)
- (3) **Final Modification Statement:** The Railway Board should be furnished, for each grant separately, so as to reach them not later than the 21<sup>st</sup> February each year, with statements showing the additional allotments required (both voted and charged) or surrenders to be made, during the current financial year under each head of appropriation, as prescribed in the budget orders, and requiring the sanction of the President. The variations between the Final modified allotment required and the revised estimates as fixed by the Board should in all cases be supported by adequate explanations of the reasons for the demand or surrender. (Para 315)
- (4) The railways should, however, continue to review the budgetary position further on submission of the Final Modification statements and any modification that may be considered necessary as a result of new factors visualized and the further review of budgetary position should be advised telegraphically to the Board so as to reach them on the 1<sup>st</sup> of March or any other date in March which would be advised to the Railways by the Board. (Para 386)
- (5) Any important changes subsequently found necessary, should be intimated before the 20<sup>th</sup> March of the year, to enable President to accord sanction to them where possible, so that the Railway Administration may sanction in time, before the 31<sup>st</sup> March of the year, any re-appropriations to cover the anticipated excess over allotments. (Para 388)

*Note: Latest Proforma of above table shall followed.*

**Revenue Expenditure**  
(Extract of Indian Railways Financial Code, Volume II)

S. No	Demand No.	Abstract	Name of Demand	Main Heads		Sub-Heads	
				No.	Name	No.	Name
1	3	'A'	General Superintendence and Services.	800	Signal and Telecommunication Management	810	Administration.
						820	Signalling.
						830	Telecommunication
						840	Workshop, Drawing and Estimating.
						870	Miscellaneous Expenses.
						890	Credits and Recoveries.
2	7	'E'	Repairs and Maintenance Plant and Equipment	100	Establishment in offices	110	Officers and Office Establishment (S&T)
						120	Supervisory Staff and their Office Staff/S&T.
						130	Contingent Expenses/S&T.
				500	Plant and Equipment (Signalling)	510	Mechanical Signalling
						520	Electrical Block Signalling
						530	Electrical Power Signalling
						540	Other Repairs and Maintenance.
						550	Miscellaneous Expenses.
				600	Plant and Equipment (Tele-communication)	610	Microwave Multichannel Radio Relay System and Wireless System.
						620	Railway Telephone Exchange.
						630	Line Communication System.
						640	Other Expenses.

S. No	Demand No.	Abstract	Name of Demand	Main Heads		Sub-Heads	
				No.	Name	No.	Name
3	8	'F'	Operating Expenses, Rolling Stock and Equipment.	700	Rental to BSNL for Signalling and Telecommunication Circuits.	710	Circuits of Signalling System.
						720	Line Wire.
						730	Administrative Telephone.
				700	Signalling and Telecommunication.	740	V.F.T. Channel.
						730	Other Operating Expenses
4	12	'K'	Miscellaneous Working Expenses.	500	Cost of Training Staff.	510	Other than Hindi, Medical Health and Welfare.
5	14	'M'	Appropriation to Funds.	100	Appropriation to Depreciation Reserve Fund.	160	Signal and Telecommunication Department.
				500	Appropriation to Accident Compensation, Safety and Passenger Amenity Fund.	510	Appropriation to Accident Compensation, Safety and Passenger Amenity Fund.

*Note: Sub heads are further divided into Detailed Heads. The expenditure is classified into primary Units (objects) of Expenditure. For further details, Revised Classification of accounts of expenditure and earnings may be referred to.*

**Preparation of the Budget**  
**(Extract of Chapter III of Indian Railways Financial Code, Volume I)**

- (1) For the preparation of the Budget by the Railway Board, the Railway Administrations and other authorities empowered to incur expenditure are required to submit to the Railway Board their revised estimates for the current year and budget estimates for the following year on the dates prescribed below: (Para 307)

Revenue Demands 2 to 15 .. . . . 1<sup>st</sup> December.

Works Demand 16 .. . . . 23<sup>rd</sup> December.

The revised estimates are required in respect of the current year and Budget Estimates for the following year.

- (2) Responsibility for framing the Estimates: Preparation of the Revised and Budget Estimates should commence at the 'grass root level' i. e., Division, Workshop, Stores Depot, etc., as the case maybe. The entire responsibility for framing the estimates devolves upon the spending/earning authorities concerned, though the actual work of compilation and scrutiny would rest with the Financial Adviser and Chief Accounts Officer who would also draw the attention of the General Manager to matters of purely financial import. (Para 309)
- (3) The estimates should be as accurate as possible and, to achieve this object, care should be taken to see that the data on which the forecast is based is adequate and reliable and that the conclusions arrived at from the data can be sustained by past experience and future expectations of likely events. (Para 310)
- (4) No stereotyped method of estimating will be helpful in forecasting accurately, unless the data on which the forecast is based is selected with due care and all the useful knowledge is brought to bear on the conclusion to be derived from the data. The manner in which the data required for the preparation of the estimate should be collected is, therefore, left to the General Managers, but the general principles on the basis of which the various estimates should be framed are described, wherever necessary, in the following paragraphs. (Para 311)
- (5) The Revised and Budget Estimates should be framed by the various concerned authorities separately for
- (i) Ordinary Working Expenses and (Para 312).
  - (ii) Works Expenditure.
- (6) The estimates of expenditure in respect of each demand should be prepared in duplicate, the figure being given in thousands of rupees. In preparing their estimates the Railway Administrations should ensure that the figures of actual expenditure for the preceding year shown in the estimate agree with those reported to the Railway Board. The figures of actual expenditure for the current year should represent the latest data. (Para 325)

- (7) **Explanation of variations:** A brief narrative explanation should be given of the causes (with amounts involved in each case) of substantial differences between the figures adopted for the revised estimates of the current year and (i) the actual of the previous year, and (ii) budget allotment for the current year. Similar explanation should be given for differences between the figures of the budget estimate of the ensuing year and the revised estimate of the current year. Large variations which compensate each other should also be indicated. (Para 326)
- (8) The revised estimate for the current and the budget estimate for the next year should be fixed after taking into account the expenditure of the previous year and comparing the expenditure during the first seven months of the year with the corresponding period of the previous year. A full explanation of special features and any exceptional and abnormal adjustments (with amounts involved) included in each period of the previous and current year as also in the next year, should be given in the explanatory note accompanying the estimates. The financial effect of variations on account of specific reasons should be clearly brought out under each Demand. (Para 327)
- (9) When the expenditure anticipated in the last five months of the year is disproportionate as compared with (i) the first seven months of the year or (ii) the corresponding period of the previous year, reasons for the disproportionate expenditure should be given in the revised estimate. Special and non-recurring items of expenditure in a year should show a corresponding saving in the following year. Likewise, when transfers are made from one demand to another due to changes in classification, the saving shown under one demand should agree with the excess shown under the other demand.



**Works Machinery and Rolling Stock Budget**  
(Extract of Chapter III of Indian Railways Financial Code, Volume I)

- (1) **Works Machinery and Rolling Stock Budget:** The revised and budget estimates for expenditure on construction acquisition, and replacement of assets (briefly known as the Works Budget) are prepared in the form of the Works Machinery and Rolling Stock Programmes. The Works Programme is required to be prepared in accordance with the instructions embodied in Chapter VI of the Indian Railway Code for the Engineering Department. (Para 5.12 may be referred to) (Para 346).
- (2) There is one single Demand for Grant for Works Budget viz., Demand No. 16 – Assets Acquisition, Construction and Replacement; and expenditure whether met out of loan obtained from the general exchequer or internal resources of Railways viz, 'Revenue', the 'Depreciation Fund', the 'Development Fund' and 'Accident Compensation', Safety and Passenger Amenities Fund in the case of last named fund, expenditure on safety works and passenger amenities works only, is included in this Demand. Works Demand provides for booking of expenditure by – various plan heads; the list of Plan Heads is as follows:

Code No. of Plan Head	Description of Plan Heads
11	New Lines (construction)
12	Purchase of new Lines
..	.. ..
14	Gauge conversion
15	Doubling
16	Traffic facilities – Yard remodeling and others
29	Road Safety Works
33	Signalling and Telecommunication Works
34	Taking over of line wires from BSNL Departments
35	Electrification projects
..	.. ..
41	Machinery and plant
42	Workshops including production units
..	.. ..
64	Other specified Works (OSW)
65	Training/HRD

### Classification of Capital and other Works Expenditure (Extract of Indian Railways Financial Code, Volume II)

The sources of financing will be indicated in the beginning by the following alphabets:

P – Capital.

Q – DRF.

S – DF

RRSK

V – SF...

U – Revenue.

The next 4 digits will represent the Main, Sub and Detailed Heads of Classification, as illustrated below:

#### Classification of Capital and other Works Expenditure

Sl. No.	Demand	Abstract	Name of Demand	Main Heads		Sub-Heads	
				No.	Name	No.	Name
1.	..	..	Assets, Acquisition, construction and other Works Expenditure	1100	New lines (Construction).	1170	Equipment Plant and machinery*.
						1180	General Charges Establishment. ++
				1400	Gauge Conversation.		Same sub and detailed classification as under no. 1100 with codified digits for the relevant plan Head.
				1500	Doubling.		
				1600	Traffic facilities Yard Remodelling and others.		
				3300	Signalling and Telecommunication works.		Do.
				3400	Taking over of line wires from P. & T. Department.		Do.
				3500	Electrification projects.		Do.

\*(Detailed Heads No.1173, 1177 for S&T and 1179 for Motor Vehicles).

++ (Detailed Head 1187 for S&T).

**Distribution of Funds by the Railway Board**  
**(Extract of Chapter III of Indian Railways Financial Code, Volume I)**

- (1) **Distribution of Funds by the Railway Board:** The Grants as voted by the Parliament and the appropriations for the charged expenditure as sanctioned by the President, are distributed by the Railway Board among the Railway Administrations and other authorities subordinate to them, as soon as possible, after the Budget is sanctioned. The sums so distributed are called "Allotments" and the orders by means of which the allotments are made are called "Budget Orders". The allotments made out of funds voted by the Parliament are shown as "Voted" and those fixed by President are shown as "Charged". (Para 361)
- (2) The Budget Orders are accompanied by the final issues of "Demands for Grants" and "Works, Machinery and Rolling Stock Programmes" containing the detailed distribution of the Budget allotment made to The Railway administrations for working expenses and Capital, Depreciation Reserve Fund, Development Fund, Open Line Works (Revenue) and Accident Compensation, Safety and Passenger Amenities Fund expenditure. The Budget allotment made to a Railway administration is intended to cover all charges, including the liabilities for past years to be paid during the year or to be adjusted in the accounts for it. It shall be operative until the close of the financial year. Under the "doctrine of lapse" any unspent balance shall lapse and shall not be available for utilization in the following year. (Para 362)
- (3) In the event of the Budget Orders of the Railway Board not being received before the commencement of the financial year, the Railway administrations are empowered to incur expenditure, pending the receipt of the Budget Order, on works which were in progress at the end of the previous financial year. All expenditure incurred under this rule must be treated as a charge, against the allotment eventually made for such works. (Para 363)
- (4) **Distribution of Funds by General Managers to Lower Authorities:** Subject to the other provisions of this Chapter or of any general or specific orders issued by the Railway Board, a General Manager is expected to take steps immediately to distribute the funds, placed at his disposal, to authorities subordinate to him in such manner as he may consider most suitable, provided that the total of the sums so allocated does not exceed that total of the grant placed at his disposal. In making this initial distribution, he may, at his discretion, keep a sum unallotted as a reserve for emergencies that may arise in future. He may also vary the initial distribution as necessity arises during the course of the year. In regard to "Carry over" works, the latest information as to the necessity and extent of funds required for such works should be obtained from the authorities concerned and taken into consideration in making the initial distribution. (Para 365)
- (5) No expenditure shall be incurred by an authority without the allotment of necessary funds. The authorities to whom the funds are allotted, shall be responsible to report at once to the next higher authority the probability of any lapses or excesses over the sums placed at their disposal. In exceptional cases, where expenditure is authorized in anticipation of the allotment of funds, or in excess of the existing provision, the authorization should be followed, as soon as possible, by a formal allotment of funds to the extent required. (Para 367)

- (6) The expenditure on each work shall be limited to the sum allotted for it. If for exceptional reasons, expenditure in excess of Budget allotment has to be incurred and if the authority incurring the expenditure is either not in a position to find funds by re-appropriation or is not empowered to sanction a re-appropriation thereof, application for additional funds shall be made to the next higher authority stating how the expenditure is proposed to be met. In doing so, it should invariably be explained why the need for the expenditure was not foreseen in time for inclusion in the Budget and why the outlay cannot be postponed to the next financial year. In each case a copy of the order making the allotment or sanctioning a re-appropriation shall be sent to the Accounts Officer concerned by the authority issuing the order or sanctioning the re-appropriation. (Para 368)
- (7) **Responsibility of Railway Administrations in case of Excesses of Lapses:** The Railway administrations shall be responsible to ensure that no expenditure is incurred in excess of the Budget allotments made to them. Should it become apparent at any time that the grant for the year is likely to be exceeded from any cause whatsoever, the General Manager should report the position to the Railway Board and apply for additional funds. No liability may be incurred in one year against anticipated grants of a succeeding year except that advance commitments for procurement of stores for works may be made as provided in para 812-S to the extent authorised by the Railway Board from time-to-time. (Para 371)
- (8) It shall also be the duty of the administrations to see that the allotments made to them are fully expended, in so far as is consistent with economy and the prevention of large expenditure in the last months of the year for the sole purpose of avoiding lapses. They shall be responsible for ensuring that money which is not likely to be needed during the year is promptly surrendered so as to allow of its appropriation for other purposes. (Para 372)
- (9) **Powers of Railway Administrations in regard to emergent and inevitable expenditure:** Notwithstanding the provisions of paragraph 7 above, the commencement of works urgently necessary to safeguard life or property or to repair damage to the line caused by flood, accident, earthquake or other unforeseen contingency, so as to restore or maintain through communication may be authorised by the Executive Engineer, but he should at once submit a report through the usual channel to the authority competent to give administrative approval to the work and to allot the required funds. (Para 373)
- (10) Expenditure to meet a sudden increase in traffic or for ensuring the safe operation of traffic may be incurred with the personal sanction of the General Manager in anticipation of the allotment of necessary funds by the Railway Board provided that the Financial Adviser and Chief Accounts Officer concurs. This power cannot be delegated and can be exercised by the General Manager only where the expenditure is within his power of sanction. In all cases where this requires an allotment of additional funds, a report showing the expenditure involved and the additional funds required should be submitted to the Railway Board, as soon as possible. (Para 374)

The entries in the Revenue Allocation Registers maintained in the Accounts Office shall be sub-divided as under:

and sufficient space should be left after each head for the entries which normally come under it. Alternatively, separate registers may be maintained to record the expenditure in these three divisions, in which case a separate summary will have to be prepared to arrive at the total expenditure under the various heads of revenue classification. The sanctions by heads of accounts as given in the Authorization Rolls or the Distribution Statement of Budget allotment should be entered in red ink at the head of the several Abstracts so as to form a ready means of comparison and check with the outlay and to admit of this being done the grand total expenditure for each month will be deducted at the foot of the abstract form (Form E. 1469), the sanctioned amount and the balance thus arrived at will be carried forward in red ink from month to month. At the end of the month when the Registers have been totalled, the 'Cash' totals will be agreed with the debits to 'Demands Payable' in the Monthly Classified Abstract of Cash transactions and a journal slip will be prepared crediting 'Demands Payable' and debiting the various abstracts of the Revenue Accounts. (Para 1469)

For the month of ..... 20..... Allotment for the year. 20.....

Sl. No.	Particulars of Transactions	Voucher		Detailed Heads of Accounts as per Revenue Classifications and Demand Heads			Total*	Grand Total	Sl. No.	Remarks
		No.	Date							
				Rs. P.	Rs. P.	Rs. P.	Rs. P.	Rs. P.		

Total for the month .....  
Add total to end of previous month .....  
Total to end of the month .....

\* In Column (5) under Total should be posted "Wages and Materials" or "Ordinary and special" According to the requirements of the rules.

*Note: The expenditure (Other than on surveys) under the major head 345-A/B Policy formulation direction, research and other Miscellaneous Organisations should be recorded in a separate register in accordance with the prescribed classification.*

**Register of Works is a Collective Record of Expenditure Designed**  
(Extract of Indian Railways Engineering Code)

**(1) Register of works is a collective record of expenditure designed:**

- (i) for effecting control of expenditure on works with reference to estimates, by facilitating comparison between the expenditure incurred on each work and the detailed provision made in the estimate for work; (Para 1472)
- (ii) for effecting budgetary control, by facilitating a comparison between the budget allotment for the work and the actual expenditure to the end of the month; and
- (iii) to enable any material modification occurring being spotted.

**(2) Single set of works registers:** Detailed Register of Works in form E-1473 given below should be kept for all sanctioned works including those chargeable to Revenue, 'New minor works', showing the amounts of estimates sanctioned. This register shall be maintained in the Accounts Office both for open line and construction organisation. (Para 1473)

..... RAILWAY

**Form E-1473**

**WORKS REGISTER**

Name of work.....

Authority.....

Capital.....Rs. Cash .....Rs.

Depreciation Fund.....Rs. Stores .....Rs.

Development Fund.....Rs. Total .....Rs.

Accident compensation Passenger

Amenities Fund.....

Open Line Works-revenue.....

Revenue.....Rs

Date of commencement.....

Date of completion.....

Budget Allotment for the year.....Rs

Original estimate No.....

Revised Estimate No.....

**Annexure: 4-A9 (Contd.)**

Date	No of Vouchers	Particulars	Items of Estimate				Heads of Accounts				Advance payments for supply of materials	Material at site	Value of material received in advance of payment of contractor	Total charges		
			Amount	Amount	Amount	Amount	Capital	DRF	Revenue	Development Fund				Cash	Store	total
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

- (3) This register should show the amount of estimate sanctioned, the budget allotment and details of expenditure on each work by heads of accounts and in addition under sub-heads of estimates in case of track renewal works estimated to cost Rs. 3 lakhs and over and Rs. 1 Lakh over and in the case of other works. In this register sub-heads of estimate estimated, to cost less than Rs. 10,000 need not be separately detailed, but may be grouped together as may be found convenient. The Register may be arranged by detailed heads of classification (for works falling under the demand relating to creation and replacement of assets) separate folios being set apart for each work. At the close of every month the register of works should be totalled up and the monthly, yearly and 'up-to-date' totals for each work struck. The register of works should be preserved for a period of 10 years. (Para 1474)
- (4) In posting the Register of works in the case of works, the accounts of which are kept by sub-heads, the last column relating to each work will always show the 'total charges', the last column but one will show 'value of materials received in advance of payment to contractors', the last column but two will show the value of the 'materials-at-site' and the last column but three will show 'advance payment for supply of materials'. In case of works, the accounts of which are not kept by sub-heads, the value of 'materials-at-site' need not be separately shown but the value of materials received in advance of payment to contractor and advance payment for supply of materials, if any, should be shown in all cases. (Para 1475)

**Revenue and Works Expenditure**  
**(Extract of Chapter V of Indian Railways Financial Code)**

- (1) **Revenue and Works Expenditure:** As all Railway expenditure, other than that 'charged' on the Consolidated Fund of India, is voted in the form of the Demands for Grants, the budgetary control is intended to ensure that expenditure is incurred for the purposes, and within the limits, as voted by Parliament. (Para 504)
- (2) The exercise of authority for incurrence of expenditure carries with it also the responsibility for control of expenditure within the authorised limits. Further, these powers are subject to provisions contained in the various Codes, rules and regulations and also observance of the standards of financial propriety. (Para 505)
- (3) **Standards of financial propriety:** In the exercise of their financial powers, the sanctioning authorities must pay due regard to the following principles: (Para 116)
- (i) The expenditure should not prima facie be more than the occasion demands, and that every Government servant should exercise the same vigilance in respect of expenditure incurred from public moneys as a person of ordinary prudence would exercise in respect of the expenditure of his own money.
  - (ii) No authority should exercise its powers of sanctioning expenditure to pass an order which will be directly or indirectly to its own advantage.
  - (iii) Public moneys should not be utilised for the benefit of a particular person or section of the community unless
    - (a) the amount of expenditure involved is insignificant; or
    - (b) a claim for the amount could be enforced in a court of law; or
    - (c) the expenditure is in pursuance of a recognised policy or custom.
  - (iv) The amount of allowances, such as travelling allowances, granted to meet expenditure of a particular type, should be so regulated that the allowances are not on the whole sources of profit to the recipients.
- (4) **Revenue Expenditure:** The revised and budget estimates of ordinary working expenses submitted by the General Manager to the Railway Board are based on detailed estimates of revenue expenditure obtained by him from the various heads of departments of the railway. On receipt of the allotment from the Railway Board, these detailed estimates may require modification consistent with the allotment sanctioned by the Railway Board or as may be deemed necessary by the General Manager. (Para 506)
- (5) Within the amounts of the allotments fixed by General Manager for the various spending authorities in charge of divisions and departments, such authorities have full power to sanction expenditure on revenue account during the year, subject to the condition that the specific sanction of the competent authority must be obtained separately to all items of expenditure on establishment and experimental or special temporary works where under rules or orders such sanction is necessary; in a case in which the General Manager has prescribed that detailed estimates should be prepared and administrative approval and technical sanction obtained before the incurrence of expenditure, the procedure laid down by the General Manager must be followed. (Para 508)



**(6) Revenue Allocation Registers:** All revenue expenditure is to be recorded in registers, which are known as Revenue Allocation Registers, by the various heads of accounts. The object of these registers is to keep the heads of divisions, and departments informed of the progress of expenditure against the allotments placed at their disposal by the General Manager, which should be entered in red ink in the appropriate columns provided for in these registers, so as to form a ready means of comparison and check with the outlay. (Para 512)

**(7) Monthly Financial Reviews:** The monthly reviews show the expenditure to the end of the previous month, against the allotments placed at the disposal of the controlling authorities under each sub-head of the grant for which they are responsible. The review should be prepared in Form No. 513 and submitted to the controlling authorities every month, by such date as may be fixed in consultation with them.

**Form No.F.51**

Sub-heads of grant and heads of account	Budget Allotment for 2021-22	Proportionate Budget allotment to end of June 2021	Actual expenditure to end of June 2021	Actual expenditure to end of June 2020	Expenditure upto June 2021 more (+) or less (%)	
					As compared with column (3)	As compared with column (5)
1	2	3	4	5	6	7

*Note: The periods have been shown in the Pro forma for the purpose of illustration only.*

**(8) Expenditure on, acquisition construction and replacement of Railway assets:** Separate allotments are placed at the disposal of Railway Administrations under each Grant for expenditure on works chargeable to Capital, Depreciation Reserve Fund, Development Fund, Accident Compensation, Safety and Passenger Amenities Fund, or Open Line Works Revenue. These allotments are made in lump sums and their distribution over the various sub-heads and over the works for which they are intended are spelt out in the "Works, Machinery and Rolling Stock Programmes" which are furnished to the Railways also with the Budget Orders sanctioning the allotments. These 'Programmes also show, in the case of works costing over Rs.50,005 each, the total estimated cost of each work, and the railway administrations are required to exercise a control over expenditure not only against the allotment sanctioned for the year for each works but also against its total estimated cost as shown in the Programmes'. In regard to works costing not more than Rs.30,000 each, a lumpsum is allotted to each Railway administration in the 'Programme', before any expenditure is incurred against the lumpsum allotment; the estimates of such works should be sanctioned by the General Manager or any lower authority empowered by him in this behalf. Thus the control of expenditure on railways is exercised through.

- (i) the preparation, in advance, of estimates of the expenditure to be incurred;
- (ii) the allotment of funds through Budget Grants for the year, on the basis of these estimates; and
- (iii) the continuous and concurrent review of the expenditure as incurred against the details of the estimates and against the sanctioned grants, so that revisions of estimates or re-appropriation of funds are arranged for at the earliest possible point of time.

The procedure to be followed in Controlling expenditure against estimates is detailed in Chapter XIV and XII of the Indian Railway Code for the Engineering and Mechanical Departments, respectively. (Para 517)

- (9) **Watch over Progress of Expenditures:** From the moment expenditure or liability is incurred on works, a check at regular and frequent intervals should be made on its progress, both against estimates and against funds. The check should originate in the lowest executive unit, viz., a division. (Para 520)

*Note: Estimates are prepared for New Minor Works costing over Rs. 5,000 each which are chargeable to "Open Line Works-Revenue". The provisions in paragraph (10) apply equally to such works.*

- (10) The Works Registers (Form No. E. 1474) maintained in each division enable a running comparison to be made between (Para 521)
- (a) the expenditure incurred on each work and the detailed provision made in the estimate for the work, and
  - (b) the budget allotment for the work and the actual expenditure to the end of the month.

The executive officer should examine the works registers monthly or at more frequent intervals, and watch the progress of expenditure on each work, so that any tendency towards excess over sanctioned estimates may be investigated and curbed or fresh administrative and technical sanctions obtained in time to cover the anticipated excess.

- (11) **Review of Expenditure:** The Accounts Officer should prepare every month two reviews, one by sub-heads/Plan heads of the Grant and the other by individual works, and present them to the authorities concerned by such dates as may be fixed in consultation with them. (Para 524)
- (12) The review of expenditure chargeable to Capital, Depreciation Reserve Fund, Development Fund, Accident Compensation, Safety and Passenger Amenities Fund Open Line Works – Revenue by sub-heads/Plan Heads of the Grant should be prepared monthly by the Accounts Officer in Form No. F. 525. (Para 525)

Review showing Progress of Expenditure chargeable to Capital, Depreciation Reserve Fund, Accident Compensation, Safety and passenger Amenities Fund and Open Line Works-Revenue to end of .....

Department.....

Office.....

(Figures in thousands of rupees)

Sub-head/ Plan head Grant No.16	Budget Allotment for the year	Total Estimates sanctioned during the year	Appropriate Expenditure to end of June 2020						Percentage of expenditure to allotment (Col.9/Col.2 x 100)	Percentage of expenditure to allotment of the corresponding period of last year	Reasons for variations between 1 Col.10 & 1 and brief to remarks as the rate of progress of expenditure
			Capital	DRF	DF	DF	RRSK	Total			
1	2	3	4	5	6	7	8	9	10	11	12

Date.....

Signature: .....

Designation: .....

The quarterly reviews for period ending June, September and December may be sent to the Board by 25<sup>th</sup> of the second following month to which the figures relate. The review for the period ending March, will be sent to the Board by 6<sup>th</sup> August, each year.

Reasons for variations and brief remarks as to the rate of progress of expenditure to be indicated in Col. 12 of the Form, should be meaningful and should be recorded in consultation with the spending authorities.

### Completion Report (Extract of Chapter XVII of Indian Railways Engineering Code)

- (1) Completion Estimates:** In the case of Railway Projects costing over rupees one crore, the Construction or Abstract Estimate should be closed at the end of one of the first three financial half years after the date of "opening" (as defined in para 2) as maybe convenient and a "completion estimate" prepared. The completion estimate is a "stock taking estimate" and all works not started on that date are excluded from the scope of the project and are to be dealt with separately. (Para 1701)
- (2)** In the case of open line projects the date of "opening" should be held to be the date on which the projects fulfills the purpose for which it was sanctioned. (Para 1702)
- (3) Closing the Accounts of a Project:** Those items of work which were in progress at the time of closing of Construction or Abstract should be got completed and the accounts of the project should be closed as soon as possible. Executive Engineers in-charge of project should therefore take prompt action to bring to account all charges and credits pertaining to the projects. They should before closing the accounts of a project, take steps to liquidate all outstanding liabilities, clear suspense balances, pay up all outstanding contractor's claims and dispose of all surplus stores and tools and plant returned from works. After all charges and credits relating to the project have been booked in the accounts of the project a Completion Report of the project should be prepared. (Para 1704)
- (4) Form of Completion Report:** The Completion Report should be prepared in the following form and brief explanations should be furnished for
- (i) excess of not less than 10 per cent or Rs. 25,000 whichever is less over the estimated provision under each sub-work;
  - (ii) saving of not less than 20 per cent or Rs. 1 lakh whichever is less, occurring under any sub-work. (Para 1706)

*Note: The Divisional Railway Manager/Deputy Chief Engineer concerned may be empowered by the General Manager to approve the completion reports of works within the General Manager's competence in the Works Registers if variations are within 5 per cent of the sanctioned estimate.*

#### Form No.E.1706

Completion Report for the work .....

Particulars (Heads of Account and Description of works)	Amount of Estimate (with reference to authority for sanction)	Actual Expenditure	Difference		Remarks and Explanations
			Excess	Saving	

- (5) Completion of Works:** In common with works costing over Rupees one crore, a work or scheme costing less than this amount should be considered as completed when it fulfills the purpose for which it, when sanctioned, was intended, and when there has been no expenditure thereon for three months thereafter. All outstanding debits and credits pertaining to a completed work should as a rule be adjusted in the account of the work within three months of the date of completion. The accounts of a completed work should be closed six months after the date of completion and a completion report of the work drawn. (Para 1708)
- (6)** A completion report for works costing Rupees one crore and less should subject to the detailed instructions issued by the Railway Administration, be prepared in the same form as that for works costing over Rupees one crore. It should compare the actual expenditure incurred with the sanctioned amount and should give under each sub work brief explanations of all excesses and savings of over 5 per cent or Rs. 10,000 whichever is less. The authority sanctioning the estimate may prescribe any additional information to be submitted along with the completion report. (Para 1709)
- (7)** A certificate to the effect that necessary addenda or corrigenda to the list of Buildings have been issued should be recorded on all completion reports for staff quarters and other buildings. A certificate to the effect that the necessary entries have been made in the siding registers and the register of deposit works should be recorded on all completion reports relating to assisted sidings and deposit works. (Para 1710)
- (8)** A completion report duly verified by the Accounts Officer should ordinarily be submitted to the authority who accorded the administrative approval to the work for information or regularisation. In respect of structural and track renewal works costing over Rupees ten lakhs included in the sanctioned budget with the prior approval of the Railway Board, and works sanctioned out of turn with the administrative approval of The Railway Board being beyond the General Manager's power of sanction, the completion reports may be finally dealt with by General Managers except (a) when they involve an excess beyond the General Manager's powers of sanction or (b) when a material modification is involved. For works costing rupees one crore and less the completion report should be submitted within six months of the completion of work. In the case of works on which no expenditure is recorded for three consecutive months, the Accounts Officer should call for the completion reports. If the works are incomplete the executive officer should advise the Accounts Officer of the probable dates of completion and submission of the completion reports. Abnormal delay in the submission of reports by the executive officers should be brought to the notice of the Head of the Railway Administration by the Accounts Officer. (Para 1711)
- (9) Completion Reports of Unfinished Works:** If for any reason a work on which expenditure has been incurred is stopped and if there is no reasonable prospect of completing it in near future, the account of the work should as in the case of a completed work, be closed and a completion report drawn and submitted to the authority which accorded the administrative approval to the work, for information. In the case of structural works, other than Track Renewal works, costing more than Rupees one crore each for which administrative approval of the Railway Board is obtained by the submission of separate Abstract Estimates notwithstanding their specific inclusion in the sanctioned budget, the completion reports in such cases should be submitted to the Railway Board, duly verified by the Financial Adviser and Chief Accounts Officer. (Para 1713)

**(10) Completion Statements:** As a general rule, a completion report should be submitted in respect of each completed work. Nevertheless, in the case of works, the expenditure on which is within the competence of the head of the railway to sanction, a formal completion report on the prescribed form need not be prepared. In such cases all the information required in the Completion Report form, the certificate of the Accounts Officer and the sanction of the competent executive authority may be recorded in the register of works under the relevant accounts Completion Statements showing the following information being prepared and recorded under the orders of the competent executive authority, after verification by the Accounts Officer: (Para 1714)

- (i) Reference to estimate.
- (ii) Amount of sanctioned estimate.
- (iii) Actual expenditure as finally booked.
- (iv) Brief explanation of excess or saving.

*Note: The provisions of this paragraph do not apply to works, for which detailed estimates are not required to be prepared.*

**(11) Expeditious closing of Accounts of Works:** The account of a work costing rupees one crore and less should not be kept open beyond three months of the date of its completion. Efforts should be made to bring to account all liabilities and credits pertaining to the work by liquidating the former and realising the latter within that period. If a contractor's claim could not be finally settled within that period whatever the railway considers as legitimately due to the contractors should be adjusted by debit to the work and credit to "Deposit" and the account of the work finally closed. If the disposal of released materials is likely to delay the closing of the account of a work, credit should be afforded to the work on the basis of estimates by the Stores Department in consultation with the Engineer. (Para 1715)

**(12) Entry in the Register of Works:** When a work is completed and its accounts closed, a double red ink line should be drawn below the last entry in the Register of Works and a note made as under— (Para 1716)

Works completed.

Completion report submitted on .....

## Chapter 5: Planning, Estimating & Survey

### Section 1: Planning

#### 5.1.1 Planning General

The process of programming Works, Survey as well as Rolling Stock, Machinery and Plant in advance, deciding their relative priorities, preparing necessary justification and estimates, making available funds for their execution within the ceilings prescribed, and including them in the "Works, Machinery and Rolling Stock Programme" is termed Planning.

#### 5.1.2 Initiation of Works Programme: Detailed instructions for preparation and submission of Works Programme are contained in Chapter VI of the Indian Railway Code for Engineering Department (relevant extracts at [Annexure: 5-A1](#)).

- (a) Programme of Signalling and Telecommunication Works may be initiated as a result of proposals made by the Signal, Operating or other Departments for periodic replacement of worn out assets with or without improvements or for meeting operating requirements or for improving the safety of train operation or for provision of amenities to passengers.
- (b) Works may be initiated either on a Division or at the Railway Headquarters or by Railway Board. Works initiated on the Division shall be first examined by the Divisional Officers. Where there is sufficient justification, the proposal after approval by the Divisional Railway Manager shall be forwarded to the Headquarters Office along with the remarks of the Accounts Branch for scrutiny and examination by the Heads of Departments concerned. If the work is approved by them and concurred in by PFA, it is noted for inclusion in the Works Programme of the ensuing year.
- (c) Works initiated by the Headquarters Office shall be sent to the Principal Financial Adviser for obtaining concurrence and thereafter included in the Works Programme. In case it is, however, desired to obtain the estimate from the Division, the Division may be asked to process the work in which case the procedure as in [Para 5.1.2\(b\)](#) shall be followed.
- (d) A work should be considered as remunerative only if it satisfies the test of remunerativeness as contained in Para 204 of the Indian Railway Financial Code ([Annexure: 5-A2](#)).

## Section 2: Estimates

**5.2.1 Code Rules:** Instructions regarding the different kinds of estimates and their preparation are contained in Chapter VII of the Indian Railway Code for the Engineering Department. (Relevant extracts at [Annexure: 5-A3](#))

### 5.2.2 General Instructions Applicable to Estimates

- (a) While preparing the Abstract Estimate in accordance with the Code Rules, the expenditure for Stores may be grouped under Indoor Signalling Equipment, Point mechanism, Colour Light Signals, Cables, Train Detection, Block working, ATP, CTC, Mobile Train Radio Communication, Control Communication etc. besides Labour, Tools and Plant, Establishment Charges, Freight and Contingencies, Works to be done by other Departments, e.g. construction of S&T buildings, construction of staff quarters, provision of sleepers, power supply arrangements, etc. are to be included where necessary.
- (b) While preparing the detailed estimates in accordance with, the Code Rules, the following guidelines shall be observed:
  - (i) Details of cost of S&T Building, staff quarters and other buildings and electric power connections shall be included, by obtaining them from the Departments concerned and shall be provided for under separate sub works.
  - (ii) Establishment and Supervision charges, where necessary, shall be included. Additional weightage for works to be done under traffic conditions should be provided.
  - (iii) Provision shall be made for additional quarters required for additional maintenance staff to be posted as a result of the scheme. Provision shall also be made for additional Stores/Office accommodation where necessary.
- (c) For preparing estimate for Line Capacity Work, the Traffic Department will advise the Signal and Telecommunication Department of the detailed traffic projections/requirements. Necessary feasible technical solution will be submitted by Signal & Telecommunication department including justification. If the proposed scheme is agreed to by Traffic department. The estimates shall be prepared on the basis of requirements furnished by the Traffic Department. The justification for the proposed work will be furnished by the Traffic Department together with the anticipated financial implications. A similar procedure shall be followed for works to be executed for other departments, e.g. Electrical, Civil Engineering etc.
- (d) In regard to grouping of Works, instructions contained in Para 750 of the Indian Railway Code for Engineering Department and instructions contained in Para 776 of the Indian Railway Code for finance Department in regard to allocation of charges, shall be observed (relevant extracts at [Annexure: 5-A4](#)).



- (e) Where works are customarily executed through the agency of contractors, each Divisional Office shall maintain the Schedule of Rates, issued under the authority of the Principal Chief Signal and Telecommunication Engineer/Chief Signal and Telecommunication Engineer (Construction). The Schedule of Rates may be reviewed and revised by the Principal Chief Signal and Telecommunication Engineer/Chief Signal and Telecommunication Engineer (Construction) every five years or at shorter intervals as considered necessary. No variation in the Schedule of Rates is permissible without the specific authority of the Principal Chief Signal and Telecommunication Engineer/Chief Signal and Telecommunication Engineer (Construction).
- (f) Each Divisional Office shall maintain the Price Lists of Stores as issued by the Stores Department.
- (g) The Sr Divisional Signal and Telecommunication Engineer/Deputy Chief Signal and Telecommunication Engineer/Divisional Signal and Telecommunication Engineer incharge shall be in possession of copies of authorized Scheduled of Rates and Price Lists of Stores and amendments advised to him from time-to-time.

**5.2.3 Reports Accompanying Estimates:** The reports shall generally include the following:

- (a) A clear description of the work to be carried out and the object to be gained by its execution together with such information as will enable the sanctioning authority to appreciate the necessity for the work.
- (b) Reasons for the adoption of the proposed lay out or design with special reference to any variations from usual practice and its special feature, if any.
- (c) When the Project is of a nature involving scientific points or other considerations of special character such as a new Signaling or Telecommunication System not tried out before, the reports shall contain a complete account of the basis on which every part of it has been framed, the various considerations in regard to Signaling and Telecommunication details, economy of construction, utility of the practical working of the Project when carried out and the method by which it is proposed to execute any portion of the work involving unusual difficulties of construction, if any.
- (d) In case of works of important nature like, Centralized Traffic Control, Automatic Signaling, ATP and other Modern Technology, a complete account of the various considerations in regard to engineering details, economy of construction and utility of the Project shall be given. Any local considerations which may affect the Project shall also be fully detailed.

### **Section 3: Surveys**

**5.3.1 Code Rules:** General instructions for conducting surveys for Railway Projects are contained in Chapter II of the Indian Railway Code for the Engineering Department.

### 5.3.2 General Instructions Applicable to Surveys

- (a) The System of Signalling to be provided shall be as in [Chapter 7 of SEM](#).
- (b) Surveys for new lines, line capacity works, electrification etc. - Engineering-cum-Traffic Surveys shall be carried out for New lines, Conversions, Doublings and other Line Capacity Works costing more than Rs 2.5 Crores before the inclusion of such works in the Works Programme.
- (c) Survey for Signalling & Telecommunication Works. Field surveys shall be carried out for the following categories of Signal and Telecommunication works costing more than rupees 2.5 crores each before inclusion in the Works Programme:
  - (i) Electronic/Relay Interlocking of Major yards.
  - (ii) Modern Signalling Works including CTC, ATP etc.
  - (iii) Communication Works including LTE/MTRC/UHF/OFC/QUAD etc.
  - (iv) IP Networks/Data Security/Web based Applications.
  - (v) IoT and AI based systems.

**5.3.3 Alternative Proposals:** Where alternative proposals of importance have been examined and rejected, particulars shall be suitably indicated in the Plans or in the report and the reasons for rejecting the alternative shall be explained in the report.

**5.3.4 Notes to be made in the Field:** During the survey, careful notes with data shall be made at site, from personal enquiry and observation, regarding any information likely to be useful in working out the details of the Projects, and in determining the prospects of the proposals. The following points shall receive special attention:

- (a) Availability of Space for S&T building including Office/Depot/Residential quarter etc. as per requirement.
- (b) Availability of required concrete sleepers.
- (c) Availability of power supply at site or sites.
- (d) Whether climatic condition will suit the type of equipment to be installed.
- (e) Special problem like rocky soil, existence of wide rivers which may have to be traversed by cables or overhead lines etc.
- (f) Gradients on the section particularly if the Project is for provision of Automatic Signalling.
- (g) Detention to trains that can be saved; additional services that can be introduced.
- (h) Availability of road approach.
- (i) Any other specific requirement/consideration for the project like impact and precautions due to nearby industrial conditions, line of sight etc.

### 5.3.5 Expenditure on Surveys


- (a) Railway Administrations have no powers to undertake Surveys on their own. After a survey is included in the sanctioned Budget, the General Managers can sanction Survey Estimates as per the powers delegated in SOP.
- (b) If it is decided to undertake a Survey in connection with any proposal/ modification in Signalling or Telecommunication System, an estimate of the cost of the proposed Survey shall be prepared, and the information collected in the course of the preliminary investigation, if any, shall be embodied in the report accompanying the Estimate of the Survey.
- (c) The proposal for Surveys shall be submitted to the Railway Board well in advance to enable necessary provision being made in the Budget.
- (d) The Budget allotment for preliminary Survey of a work shall be charged under Demand No.2 and when final estimate for that particular work is sanctioned, the amount charged under Demand No.2 shall be transferred to the sanctioned Estimate of the Project.

5.3.6 **Imprest Amount:** The official incharge of Survey shall be provided with an adequate Imprest. He shall be responsible for maintaining all accounts with necessary vouchers. The Imprest shall be recouped on need basis, within the validity of the period of Survey.

### 5.3.7 Survey Teams

- (a) A Signalling/Telecommunication team shall be provided in Survey Estimates for Projects like Doublings, Remodeling, Conversions, New Lines, Railway Electrification including Techno-economic Surveys, Feasibility Studies, etc. to carefully study the needs of the Traffic and to make provision for Signaling equipment accordingly duly taking into account the age and condition of existing equipment, if any.
- (b) The period for which the Signalling/Telecommunication team is to be catered for in the Survey Estimates shall be commensurate with the workload in each case and shall be decided by the Principal Chief Signal and Telecommunication Engineer in consultation with the Principal Financial Adviser of the Railway concerned while finalizing the Survey Estimate.
- (c) The requirements of the Signal & Telecommunication Department shall be obtained from the Principal Chief Signal and Telecommunication Engineer by the Principal Chief Engineer while preparing the Survey Estimates for such Projects.
- (d) Similarly in Survey Estimates for Signal and Telecommunication Projects, suitable provision shall be made for other Departments, viz., Traffic, Engineering, Accounts, Electrical, etc. as found necessary.

- 5.3.8 **Administrative Control on Survey Team:** The Signaling/Telecommunication Survey team shall work under the Administrative and Technical Control of the Principal Chief Signal and Telecommunication Engineer or Chief Signal and Telecommunication Engineer (Construction), as the case may be, both for Surveys for Signaling & Telecommunication works and for Signaling portion of the Surveys for Projects mentioned in [Para 5.3.7](#).
- 5.3.9 **Progress Reports on Surveys:** The Official incharge shall submit periodical reports of progress in prescribed forms as may be directed by the Principal Chief Signal and Telecommunication Engineer.
- 5.3.10 **Report:** At the conclusion of the Survey, a report should be formulated by the Officer incharge of the Survey. The details of the information collected, calculations and diagrams, shall be embodied in Tables as Annexure to the Report. Inference out of the Survey on the feasibility of the work with clear decision whether to take up the work or drop it shall be brought out at the conclusion of the survey.
- 5.3.11 **Covering Note:** The Survey Report and Annexures shall be submitted to the Railway Board under a covering note, which shall have the authority of the Railway Administration submitting the Report. It should provide a summing up and should contain clear recommendation together with the views of the Principal Financial Adviser (PFA).

 <i>Note: This Chapter has under mentioned Annexures</i>		
<i>S.No.</i>	<i>Annexure No.</i>	<i>Description</i>
1	<a href="#">5-A1</a>	<i>Preparation of the Preliminary Works Programme</i>
2	<a href="#">5-A2</a>	<i>Test of Remunerativeness</i>
3	<a href="#">5-A3</a>	<i>Code Rules for Estimates</i>
4	<a href="#">5-A4</a>	<i>Grouping of Works</i>

**Preparation of the Preliminary Works Programme**  
**(Extract of Chapter VI of Indian Railways Code for the Engineering Department)**

609. The Chief Engineer of the Railway will be primarily responsible for ensuring that the proposals prepared by the various departments are complete in all respects and are correctly prepared. The overall priorities within the ceiling given by the Board will also be fixed by him in consultation with the General Manager and other Heads of Departments. He will be responsible for the preparation and timely submission of the Preliminary and the Final Works Programme.

610. In or about June/July each year the Railway Board should convey to each Railway, in respect of each Plan Head, the total outlay within which the Works Programme should be framed by the Railway. A list of the Plan Heads is given in Annexure I. On receipt of this financial ceiling the Railway Administrations should take stock of the schemes already formulated and those under consideration and select for inclusion in the Works Programme within the financial ceiling such works as are expected to yield the maximum benefit to the Railway, preference being given to works in progress. Further necessary changes in the investments schedule may be made in order to work within the financial ceiling for the year such modifications being taken note of in framing the Preliminary Works Programme and revising the financial implications, if necessary.

611. The Preliminary Works Programme for the following year should be submitted by the Railways to the Railway Board by 1st week of September or such earlier date as may be laid down by the Board. Proper financial appraisal of each work should be given in the Preliminary Works Programme together with the comments of the Financial Adviser and Accounts Officer.

612. The project cost should be based on firm data both as to quantity and rates at current price levels, and should any increase occur in prices during the period intervening between the initial preparation of the project estimate and its inclusion in the Works Programme, the estimate should be updated taking into account any significant changes in the wages and material prices as well as increase in freights and fares. No other increase such as on account of change in scope of the project should be allowed without prior reasons being adduced for acceptance by the Railway Board. A sketch showing the proposal should accompany each proposal.

613. Each investment proposal should be accompanied by a detailed plan showing the scheduling of the project to match the traffic requirements and the financial outlay proposed for the year should be in accordance with this project schedule to enable the Railway Board to arrange for a realistic funds allocation for implementation of the programme.

614. In deciding the outlays for the various works Railway Administrations must endeavour to progress all works in progress speedily and bring them into use at the earliest possible date. A work which has been sanctioned and for which funds have been allotted whether in the original or supplementary budget of a year should be treated as a "Work in progress" for the next year and provided for as such in the programme. Such works should be grouped as indicated in para-619.

615. The Railway Administrations should make realistic assessment of the amount required for each work in progress and necessary provision should be made for it in the Works Programme. In estimating the provision for works during the budget year a generous allowance should be made for those delays in execution which though unforeseen are known from experience to be so liable to arise particularly prior to inception and during the initial stages of large projects. The provision made should take into account adjustment of charges on surveys connected with a project.

616. In exhibiting the outlay for the current year against individual works in the works programme, the outlay should be as per Pink Book, and in exceptional cases where the Railways propose any substantial increase in the outlay with corresponding reductions against other works, such revised outlay may be shown separately in brackets below the outlay as furnished in the Pink Book duly explaining the reasons for doing so in foot notes at the appropriate places. As far as possible only the last sanctioned cost should be exhibited. Wherever it is visualised that the cost would involve an excess over the last sanctioned cost, effective steps should be taken well in time to have the revised estimates prepared and sanctioned by the competent authority before the Works Programme is sent to the Board. In case where the revised estimates are sanctioned subsequent to the despatch of the final Works Programme but before the end of January of the following year, the same should be promptly advised to the Board to enable the latest sanctioned cost being exhibited in the Pink Book to be circulated along with the Budget. In all cases of revised costs sanctioned by the Board, reference to the letter of sanction should invariably be indicated.

617. Works once introduced through a Works Programme (including Track Renewal Programme) and taken up after the estimates have been sanctioned by the competent authority should continue to be included every year till they are finally completed, except in cases where the works have reached the completion stage and where funds required if meager, could be found by reappropriation.

618. The Works Programs is compiled in the following format:

#### **Work Programme**

Demand No. .... (Figures in thousand of rupees)

Item No.	Authority	Particulars of works	Cost	Expenditure to end of 3/21	Outlay for		Balance
					2021-22	2022-23	
1	2	3	4	5	6	7	8

*Note: Years have been shown in the form for the purpose of illustration.*

In respect of "Works in Progress" reference to item No. of the current year's Pink Book and also the authority under which the work was first started should be indicated. The works should be arranged as per the Plan Heads.

619. The items in the Works Program should grouped under the following categories while compiling the works Programs:

- (i) New Works.
- (ii) Works in Progress.
- (iii) Works approved in earlier years, which have not been actually commenced and on which no expenditure has been incurred till 30<sup>th</sup> June of the year previous to the Programme year.
- (iv) Works approved in the earlier years but estimates for which have not been sanctioned by 30<sup>th</sup> June of the year previous to the Program year.

620. The works are further made into sub-groups of (i) Works costing more than Rupees Five Lakhs each, and (ii) works costing upto Rupees Five lakhs each. Under (iii) Works costing upto Rupees two lakhs each in the case of Track Renewal works and for works costing upto Rupees one lakh each in the case of other works, only lumpsum provision should be shown without detailing individual works. Within each sub-group, the works are presented under each Plan Head.

**Test of Remunerativeness**  
**(Extract of Indian Railways Financial Code, Volume I)**

**204. Test of Remunerativeness:** The net financial gain expected to accrue from a project may be either by way of savings in expenditure or increase in the net earnings (i. e., gross earnings less working expenses), or a combination of both. Except in the case of residential buildings, assisted sidings and rolling stock to which special rules are applicable no proposal for fresh investment will be considered as financially justified unless it can be shown that the net gain expected to be realised as a result of the proposed outlay would, after meeting the working expenses (see Para 217), yield a return of not less than 10 per cent on the initial estimated cost.

*Note: (1) Interest during construction should be added to the cost (excluding that chargeable to Revenue) of the projects, the construction of which is likely to last for more than one year.*

*(2) Depreciation should be calculated on the total cost of the scheme and not only on the portion chargeable to Capital, unless the contrary procedure can be justified in any particular case. However, depreciation as an element of working expense is to be ignored for assessing annual cash flows under the B. C. F. method (See Para 228).*

*(3) In the case of construction of bridges, maintenance charges should include, besides the maintenance charges on the bridges proper, the maintenance charges of the training works also.*



**Code Rules for Estimates****(Extract of Chapter VII of Indian Railways Code for the Engineering Department)****Ref. Advance Correction Slip (ACS)-53**

701. Kinds of Estimates: All proposals for

- (a) the construction or purchase of new works or assets;
- (b) the renewals and replacements of existing works or assets chargeable to Depreciation Fund/Development Fund or Open line Works - Revenue when estimated to cost more than Rs. 50,000/- or if chargeable to Revenue when estimated to cost more than Rs. 2 Lakh.
- (c) the scrapping, dismantlement or abandonment of existing works or assets;
- (d) the reconditioning of the existing works or assets, if estimated to cost more than Rs. 1 lakh, any repair work chargeable to revenue costing **more than 5 lakh** and that of a single housing unit, if estimated to cost more than Rs. 20,000/-.
- (e) temporary and experimental works;
- (f) renewals and replacements on worked lines; and
- (g) renewals of ballast.

Should, subject to the provisions of paragraph 1103 regarding urgent works, be scrutinized by the authority competent to sanction them before any expenditure or liability is incurred thereon. For the purpose of this scrutiny, all such proposals should be presented in the form of one or other of the following estimates, according to the- circumstances mentioned in paragraphs 702 to 713.

- (a) Abstract Estimates.
- (b) Detailed Estimates.
- (c) Supplementary Estimates.
- (d) Revised Estimates.
- (e) Project Abstract Estimates.
- (f) Construction Estimates.
- (g) Completion Estimates.

*Note: For "New Minor Works" costing Rs. 50,000/- and/less, for renewals and replacement works chargeable to Revenue costing Rs. 2 lakh and less and for "Reconditioning Works" costing Rs. 1 lakh and less detailed estimates need not be prepared for formal sanction. Rough estimates should, nevertheless, be prepared and kept on record by the Executive Engineer. (Authority: Railway Board Letter No. 2001/CE 1/CT/17 (Part) dt. 24.03.2003).*

**702. The Abstract Estimate:** An abstract estimate is prepared in order to enable the authority competent to give administrative approval to the expenditure of the nature and the magnitude contemplated, to form a reasonably accurate idea of the Probable expenditure and such other data sufficient to enable that authority to gauge adequately the financial prospects of the proposal. Abstract estimates avoid the expense and delay of preparing estimates for works in detail at a stage when the necessity or the general desirability of the works proposed has not been decided upon by competent authority. An abstract estimate should contain a brief report and justification for the work, specifications and should mention whether funds are required in the current year and to what extent. It should also show the cost sub-divided under main heads and sub-heads or specific items, the purpose being to present a correct idea of the work and to indicate the nature of the expenditure involved. The allocation of each item as between Capital, Development Fund, Open Line Works-Revenue, Depreciation Reserve Fund and Revenue should be indicated.

*Note: Administrative approval to a work or scheme should be accorded by the authority competent to do so (vide paragraph 748), after a through examination of its necessity, utility and financial prospects. See also rules in Chapter II of Indian Railway Financial Code.*

..... RAILWAY

**Form E.702**

### Abstract Estimate

Department ..... Division..... Station .....

Estimate No. ....

Framed By ..... Division.....

Description of work .....

Plan No. ....

Reference .....

Cost	Capitals	DF	DRF	RRSK	Ordy. Rev	Deposit	Misc. advances	Total
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Existing sanctioned estimate (if any)								
Present Estimate ... ..								
Total ... ..								

Cost of stores..... To be purchased ..Rs.....Rs.....

Funds ... .. To stock.....Rs.....

Report and Justification--- Specification.

Enclosed: \* Details of cost with allocation (Form E.704). Sub estimate

Has Accounts Officer agreed to the pro. allocation ?

Station: ..... Signature: .....

Date: ..... Designation: .....

\*Required in case of any existing sanctioned estimate.

**703. Detailed Estimates:** On receipt of administrative approval to a project or scheme other than that for which construction estimate in Form E. 553 is prepared and, conveyed through the sanction to the abstract estimate relating thereto detailed estimates for various works should be prepared and submitted for technical sanction of the competent authority. It should be prepared in sufficient detail to enable the competent authority to make sure that the abstract estimate sanctioned by a higher authority is not likely to be exceeded. No work included in an abstract estimate should be commenced till a detailed estimate for the same is prepared and sanctioned and adequate funds are allotted by the competent authority. The detailed estimate of an open line work will comprise (i) statements showing details of estimated cost and (ii) an outer sheet giving the abstract of cost of work, the report, the financial justification and the allocation.

*Note: (1) Technical Sanction - The sanction of the competent authority to the detailed estimate of a work is called the "technical sanction". The authority according technical sanction should satisfy itself that (i) the details of the scheme as worked out are satisfactory, (ii) the methods proposed for the execution of the work are adequate; and (iii) the cost has been estimated from reliable data and is likely to be reasonably accurate.*

*(2) In the case of works within his power of sanction, the General Manager may, in lieu of the procedure of preparing Abstract Estimates for administrative approval, prescribe that both the administrative approval and the technical sanction should be accorded on the detailed estimates.*

707. A supplementary estimate should be prepared for any item of work, which ought to have been included in the first instance in an estimate already sanctioned but has not been so included, or which it is found later, should be considered as being a part or a phase of an estimate already prepared and sanctioned, if it cannot be met out of contingencies (see paragraph 727). Such, a supplementary estimate should be prepared in the same form and the same degree of detail as the main estimate and for all purposes be treated as a part of the main estimate.

**708. Revised Estimate:** As soon as it becomes apparent that the expenditure on a work or project is likely to exceed the amount provided therefore in the detailed estimate or construction estimate a revised estimate should (subject to provision of paragraph 1336) be prepared and submitted for the sanction of the competent authority. It should, unless otherwise ordered by the sanctioning authority, be prepared in the same form and the same degree of detail as the original estimate and should be accompanied by a comparative statement showing the excess or saving under each sub-head of account against the latest sanction. In cases where a supplementary estimate; or a previous revised estimate has been sanctioned by the Railway Board, it should be made clear how the original sanction has been modified by such further sanctions.

**709. The Project Abstract Estimate:** The abstract estimate of a Construction Project should be submitted for the approval of the Railway Board on Form E. 554 "Abstract cost of Railway" accompanied by (i) an abstract estimate of junction arrangements, (ii) a narrative report explaining the salient features and major items of expenditure (iii) detailed estimates on Form E. 553 prescribed for a construction estimate under the following heads:

Capital –

1120 – Land Structural Engineering Works.

1132 – Tunnels,

1151 and 1152 – Major Bridges,

1153 and 1154 Minor Bridges,

1140 – Ballast and Permanent-Way (Detailed estimate for one kilometre).

1180 and 1190 – General Charges—Establishment and General Charges—Other than Establishment

2000 – Rolling Stock.

*Note: Head shown above are for Plan Head 'New Lines' as an example.*

Those detailed estimates should be prepared from an engineering survey report.

*Note: The abstract estimate for an unremunerative project chargeable to Development fund will be prepared in the same detail as the abstract estimate for a construction project chargeable to Capital.*

**710. The Construction Estimate:** When it is decided to undertake the execution of a new line gauge conversion, or doubling of lines a final location survey should be made ; and based on the information collected in that survey detailed estimates of all the works included in the project as a whole should be prepared (of paragraph 540). These detailed estimates are collectively called the "Construction Estimate" of the Project. It should be prepared after a careful examination of the various details of construction involved in the Project. It should be in such detail as to render it possible to dispense with working estimates or any other further estimating after the Construction Estimate has been sanctioned (except when supplementary or revised estimates are necessary). It should provide for the buildings and equipment of the Railway upto a standard that will be sufficient for working such traffic as may be expected during the first year or two after opening of the line. It is the basis on which technical sanction to the various works included in the construction of a Project is accorded.

**713. Completion Estimate:** A Completion Estimate is prepared in super session of a construction estimate as provided in paragraph 1701. It should show in a tabular form (E. 713) the following particulars in respect of all the works included in the construction estimate:

- (i) amount of sanctioned estimate;
- (ii) actual expenditure on all works up to the date of construction estimate;
- (iii) commitments on that date;
- (iv) anticipated further outlay;
- (v) total estimated cost; and
- (vi) difference between the sanctioned estimate and the estimated cost.

An abstract of the completion estimate showing the above particulars against the various heads of capital classification should be submitted for information or sanction, vide paragraph 1703 to the Railway Board together with brief explanations for excesses of not less than Rs. 10,000 or 10 per cent over the provision under sub-heads of account and for savings of 20 per cent or one lakh, whichever is less, occurring under any main head of account. Provision for further outlay should be made in completion estimate only for those works which are in progress or completed on the date of closing of the construction estimate. All works not started on that date should be dealt with separately as open line works both as regards estimate and expenditure. In forwarding, therefore, estimates for sanction for works in connection with new lines opened, it should be clearly indicated whether the cost of the work is chargeable to Capital Construction or Open Line Capital.

*Note: The completion estimate of an unremunerative construction project chargeable to Development Fund will be prepared in the same detail as the original construction estimate using the various heads of capital classification for the purpose.*

**714. Estimates for Railway Project:** Scope — A Construction Estimate (Form E. 553) should be prepared in such detail as to reduce to a minimum the probability of omission of any item of expense which is capable of being foreseen. It should be remembered particularly that the provision for contingencies allowed in the estimate is not intended to meet items of expense which can be foreseen and which are reasonably likely to occur. With good estimating it should seldom be necessary to encroach, to any appreciable extent, on the provision for contingencies.

**727. Provision for contingencies:** Provision for unforeseen contingencies should be made in all estimates at 3 per cent of the total estimated cost. All incidental expenditure which can be foreseen such as works establishment, sheds for workmen and stores should be separately estimated and provided for in the estimates. The provision for contingencies should not be diverted to any new work or repair which is not provided for the estimate, and of which the cost exceeds Rs. 1,000 without the sanction of the authority who sanctioned the estimate.

**729. Schedule of Rates:** To facilitate the preparation of estimates, a schedule of rates of each kind of work commonly executed should be maintained in each open line division, and it will be the duty of the Chief Engineer when inspecting the divisional offices, to see that correct schedules of the rates at which work is actually being carried out, are invariably recorded in a complete and satisfactory manner. The regulations for the due record of rates in a clear and systematic manner and for their periodical revision to bring them on line with the rates prevailing in the market and those paid by other government departments will be laid down by the General Manager.

### Estimates of Deposit Works

**732.** A Railway Administration is occasionally required to execute works for and at the cost of other Government departments, local bodies, private persons, etc. Such works are referred to in this Code as "Deposit Works" (see also paragraph 1843 for a definition of this term). To meet the cost of plans and estimates of such works as also those to be carried out for other Departments out of Railway funds, which are subsequently not carried out, charges at the following sliding scale shall be levied on the total of the estimate inclusive of departmental charges:

	Rs.		Rs.	Percent
For works costing over	1,00,000			2
For works costing over	60,000	but not more than	1,00,000	2 ½
For works costing over	30,000	but not more than	60,000	3
For works costing over	20,000	but not more than	30,000	3 ½
For works costing over	10,000	but not more than	20,000	4
For works costing over	1,000	but not more than	10,000	4 ½
For works costing over	1,000	and below 5 percent subject to a minimum of Rs.25		

The acceptance of the government departments or the payment in cash by the local bodies or private individuals concerned should be obtained to the above percentage charges before the work of preparation of plans and estimates is taken in hand. In cases where the proposed works are subsequently carried out, these percentage charges should be adjusted against departmental charges.

The levy of the above percentage charge may, at the discretion of the General Manager, be waived in particular case subject to the conditions laid down in paragraph 1138.

*Note: The scale of charges prescribed in this rule does not apply to assisted sidings, recovery of preliminary expense in respect of which has been separately provided for under paragraph 1825.*

**733.** In preparing estimates of works for other departments, local bodies, private individuals & etc. particular care should be taken to see that.

(i) Railway freight and carriage charges of materials proposed to be used in the works are provided for at the rates applicable to the public and not at the concessional rates applicable to railway material; (Works of Branch Line Companies are not governed by this rule, but by the relevant contracts).

(ii) departmental charges at the prescribed rates (paragraph 1137) are provided for.

**734.** All estimates of deposit works should be got accepted by the parties ordering the works before submission to the competent railway authority for sanction. In the case of works, which under the rules (see paragraph 1851) are required to be maintained after completion by the Railway department at the cost of the department, local body, private firms or individuals ordering the work, the acceptance of the party concerned should also be obtained for the recurring expenditure that is likely to be incurred on repairs, maintenance, etc.

**735.** No work asked for by another government department should be commenced till a detailed estimate for the same has been accepted by the department concerned and sanctioned by the competent railway authority. No work asked for by local bodies, private individuals, and c, should be commenced till a detailed estimate for the same has been sanctioned the competent Railway authority and the estimated cost thereof deposited with the Railway. The amounts so deposited should be credited to the head "Deposits—Miscellaneous". Competency of Sanction

**748.** The previous sanction of an authority higher than the General Managers of Indian Railways is necessary:

- (i) To expenditure on new lines or rolling stock or surveys not provided in the sanctioned budget for the year or carried forward from the sanctioned budget of the previous year;
- (ii) To expenditure on other works not provided in the sanctioned budget or carried forward from the sanctioned budget of any previous year except:
  - (a) (i) Track renewal works — costing not more than Rupees two lakhs;
  - (ii) Other works — costing not more than Rupees one lakhs;
  - (iii) Machinery and Plant — costing not more than Rupees Fifty thousands.

Provided that the total lump-sum provision made in the budget for such works is not exceeded.

- (b) (i) On line capacity works costing above Rupees one lakh but not more than Rupees ten lakhs each;
- (ii) On track renewal works costing above Rupees two lakhs but not more than Rupees five lakhs each;
- (iii) On other than line capacity and track renewal works costing above Rupees one lakh but not more than Rupees five lakhs each;

Subject to ceiling of Rupees one crore in all in a financial year provided that the sanctioned budget (other than lump-sum) for works in these categories is not exceeded.

*Note: (1) The works thrown forward from previous years may be taken up only if the funds required for them can be found by reappropriation within the sanctioned allotment.*

*(2) The savings in the lumpsum provision made in the sanctioned budget shall not be utilized for the category of works in (b) above without the prior approval of the Railway Board.*

*(3) The General Manager may sanction expenditure on new works out of turn in respect of users' amenities including goods shed and booking office not exceeding Rupees one lakh in each case provided the funds required for such works as provided in the sanctioned budget for works in these categories is not exceeded; and expenditure upto Rupees fifty thousand in each case, in respect of existing Railway schools, institutes, hospitals and dispensaries provided the lumpsum provision in the sanctioned budget is not exceeded.*

(iii) To expenditure on works provided in the sanctioned budget for the year or carried forward the sanctioned budget of any previous year as follows:

(a) Works sanctioned under the lumpsum provision — To an excess over the total lumpsum provision in the sanctioned budget for such works;

(b) Works outside the lumpsum provision — Rolling Stock, Track renewals and other works — to an excess over the estimated cost as entered in the sanctioned budget or sanctioned separately, as follows:

(i) of more than 25 per cent over the original estimated cost;

(ii) of more than 15 per cent over the first revised cost;

(iii) of more than 10 per cent over the second and further revised estimated cost.

Provided further that all codal provisions regarding sanctions for material modification are strictly followed.

(c) Surveys: To an excess over 10 per cent on original estimate sanctioned by higher authority (General Manager can sanction survey estimates costing upto Rupees one lakh each provided the surveys are included in the sanctioned budget)

*Note: (1) The works thrown forward from previous years may be taken up only if the funds required for them can be found by reappropriation within sanctioned allotment.*

*(2) The amount first given in the Budget or sanctioned separately by higher authority shall be the original estimated cost and the revised amount given in subsequent Budgets or sanctioned separately by higher authority, the second, third, etc. revised estimated cost.*

*(3) The powers of sanction to excess over estimated costs allowed in item (b) above shall not make the cost of such works exceed Rupees one crore in any case.*

*(4) The powers for sanctioning the excess over the estimated costs of works outside the lumpsum provision as in item (b) above shall not be redelegated to lower authority in respect of works, the original estimated cost of which is over Rupees fifty lakhs.*

(iv) To the scale of

(a) a portion of a Railway line;

(b) in item of the authorised Rolling Stock; or

(c) any other Railway asset costing over Rupees three lakhs.

**756. Currency of Sanction:** The sanction to an estimate will ordinarily remain current for five years from the date on which it has been accorded unless it has been renewed for a further term by the acceptance of a revised estimate. Acceptance by competent authority however, of a budget estimate which includes specific provision/for expenditure on a work which is in progress, may be regarded as reviving for the year in which provision is made, the sanction to the estimate-regardless of the five years' limit. But if no work has been commenced on a sanctioned scheme within two years of the date on which the sanction was accorded to the estimate, such sanction should be held to have lapsed and fresh sanction should be obtained from the competent authority by the submission of an up-to-date estimate, if necessary.



**758. Scope of the sanction to an Estimate:** The authority granted by a sanction to an estimate should, on all occasions, be looked upon as strictly limited to the precise objects for which the estimate was intended to provide. Accordingly any anticipated or actual saving on a sanctioned estimate for a definite project should not, without special authority be applied to carry out additional work not contemplated in the original project fairly contingent on its actual execution. Saving due to the abandonment of a substantial sanction of any project should not be considered as available for work on other sections.

### **The Execution of Works**

1102. The ordinary rule is that no work may be commenced and no liability or expenditure incurred on a work until a detailed estimate for it has been sanctioned and an allotment of the requisite funds made by competent authority. This rule pertaining to preparation of estimates does not apply in the following cases:

- (i) For the construction or purchase of new work or asset under the category of new minor works if estimated to cost upto Rs. 5000.
- (ii) For renewals and replacements of existing works and assets chargeable to Open Line Works Revenue as a new minor work if estimated to cost upto Rs. 10,000.
- (iii) For renewals and replacements of assets charged to Development Fund and Depreciation Reserve Fund if estimated to cost upto Rs. 10,000.
- (iv) For renewals and replacements of assets charged to Revenue if estimated to cost upto Rs. 50,000; and
- (v) For repairs and reconditioning of existing assets if estimated to cost upto Rs. 50,000 (of para 701).

**1103. Work started on Urgency Certificates:** In addition to the exception mentioned in the preceding paragraph the following are the only classes of work on which expenditure or liability may be incurred prior to the receipt of sanction of the authority competent to sanction the estimates under the ordinary rules:

- (i) Works, which are considered to be urgently necessary to safeguard life or property or to repair damage to the line caused by flood, accident or other unforeseen contingency, so as to restore or maintain through communication.
- (ii) Works considered urgent but not falling within (i) above, as for instance, works required to meet the immediate needs to traffic, which are considered by the General Manager so urgent that they must be started before the earliest date by which detailed estimates could be prepared.

*Note: Where applicable the instructions in paragraph 1260 should be observed.*

**1105.** In according administrative approval or sanction and in allotting funds, if required, the competent authority will give such instructions as he considers necessary regarding the execution of the work to executive officers subordinate to him and fix a date by which the detailed estimate for the work should be prepared and got sanctioned. He will at the same time furnish a copy of his sanction and instructions to the Accounts Officers.

**1109. Material Modifications:** No material modification in a work or scheme as sanctioned, should be permitted or undertaken without the prior approval of the authority who sanctioned the estimate. In the case of estimates sanctioned by the Railway Board or higher authority, instances of what will be considered to be a material modifications of a sanctioned project or work are given in paragraph 1110 below.

**1110.** The following may be taken as material modifications on lines under construction and open line works estimated to cost rupees one crore and over:

- (a) Any change in the alignment likely to affect the facilities offered to the public in the neighbour-hood or likely to increase or decrease the length of the line by over one kilometre.
- (b) Introduction of any new station or omission of any station.
- (c) Any alteration in the type or number of engines or vehicles provided in an estimate for rolling stock.
- (d) A change in the layout of a yard affecting the general method of working or increasing or reducing the number of trains that can be dealt with.
- (e) Any departure from the standards of construction as prescribed in Chapter II or as accepted by the Railway Board in the Abstract Estimate or use of any second hand material if it affects the speed of trains or the number of trains to be dealt with than contemplated originally.
- (f) The introduction or omission of any work or facility involving a sum of Rs. 5 lakhs and over.
- (g) Any modification of a sub-work provided for in the estimate of a sanctioned work involving an additional outlay on that sub-work of more than Rs. 5 lakhs.
- (h) The introduction of any new sub-work not provided for in the estimate of a sanctioned work involving an outlay of more than Rs. 5 lakhs.
- (i) Any alteration in the standards of interlocking.

**1137. Departmental Charges:** When work is undertaken by the Engineering Department of a Railway for outside parties, including other Railways, Government Department, Public bodies (e. g., Municipalities, Port Trust, etc.) and employees of the Railway, Departmental charges should be levied to cover the cost of tools and plant and of establishment supervision. The charges leviable will be 12-1/2 percent on the total cost of the work (wages and materials) including the cost of land, except where a rate higher than 12-1/2 percent is charged to Governmental Departments on a reciprocal basis. The charge will be levied once only on the total outlay on a work (cash and stores, and will not be addition to a first charge of 12-1/2 percent on the value of stores, vide paragraph 2329-S.

*Note: (1) The above rules do not apply to works undertaken by Engineering Workshops to which the rules applicable to works undertaken in workshops of the Locomotive and Carriage and Wagon Department apply.*

*(2) Railway Units of the Territorial Army: The charges under the foregoing rules may be remitted in the case of works not exceeding Rs. 500 in cost executed by the Engineering Department of a Railway for Railway Units of the Territorial Army provided that no additional establishment is entertained for such works.*

**1138. Remission of Departmental Charges:** The General Manager may, at his discretion, waive wholly or partially the recovery of the Departmental charges leviable under Paragraph 1137 provided that

- (a) the Railway gains some advantage, not necessarily financial, by such remission:
- (b) the reasons for the remission are recorded in each case and the remission is allowed with the concurrence of the Financial Adviser and Chief Accounts Officer; and
- (c) the non-incurrence of extra charges on accounts of tools and plant and establishment supervision does not in itself constitute sufficient justification for the remission.

*Note: Always check for updates from Indian Railways code for the Engineering dept.*

**Grouping of Works**  
**(Extract of Indian Railways Code for the Engineering Department)**

**750. Grouping of works:** When two or more works are so connected either by their situation or by the purpose or purposes which they are designed to serve, that construction of one necessarily involve that of the other or others, the works should be considered as one scheme and the aggregate estimated cost of the work so connected should determine the authority competent to sanction expenditure on the scheme. When the works constituting a connected scheme are situated in more than one executive division separate detailed estimate should be prepared of the cost of the work in each division in order that the Executive Engineer entrusted with the actual construction may be in a position to watch expenditure against a sanctioned estimate of the cost of the work in his charge.

**Allocation of Charge**  
**(Extract from Indian Railways Financial Code, Volume I)**

**776. Cost of Tools and Plants and Special Posts:** No portion of the pay or allowances of permanent open line staff shall be charged to Capital, Depreciation Reserve Fund, Development Fund or Accident Compensation, Safety and Passenger Amenities Fund or Open Line Works- Revenue, as the case may be, when such staff is employed on special works and the vacancies thus caused in the open line cadre remain unfilled. The cost (less return value) of tools and plant specially purchased and the cost of any posts specially created for the supervision or construction of a work chargeable purely to Capital or Depreciation Reserve Fund or Development Fund or Accident Compensation, Safety and Passenger Amenities Fund or Open Line Works- Revenue, as the case may be. When the cost of work is chargeable partly to Capital or Development Fund, Accident Compensation, Safety and Passenger Amenities Fund or Depreciation Reserve Fund or Open Line Works - Revenue, the cost of such posts and tools and plant should be allocated to Capital or Development Fund or Accident Compensation. Safety and Passenger Amenities Fund or Depreciation Reserve Fund or Open Line Works- Revenue in the same proportion in which the estimate for the work excluding the estimated cost of tools and plant and special posts, is chargeable. For working out the proportion, the gross amount of the estimate (ignoring the provision for credits on account of released materials) should be taken into account. The cost of a post, for the purpose of this rule includes the leave salary and contribution towards passages, pensions provident fund, bonus and special contribution to provident fund, which the holder of the post may be entitled to.

*Note: The provision for credits on accounts of released materials to be ignored in working out the proportion of cost of tools and plants and special posts, should be the net credit in terms of paragraph 710(2).*

## Chapter 6: Signalling Stores and Accountal

### Section 1: Classification of Stores

6.1.1 The Stores in the custody of the SSE (Signal)/incharge and SSE(Signal)/(Stores) may be broadly grouped under the following Stock Heads:

- (a) Imprest Stores - Charged Off to Revenue
- (b) Tools and Plant
- (c) Protective Clothing
- (d) Books of Reference
- (e) Office Furniture
- (f) Stationery and Forms
- (g) Stores Obtained for Specific Works
- (h) Returned Store

### Section 2: Imprest Stores

6.2.1 **Operation of Imprest Store:** The materials classified as Imprest Stores, their procurement and accountal are contained in Chapter XXVIII of Stores Code and XIV of Engineering Code (relevant extracts at [Annexure: 6-A1](#)).

6.2.2 **Location and Scale of Imprest**

- (a) Imprest Stores shall be provided with each SSE (Signal)/incharge and SSE (Signal)/(Stores) on a Division/Construction/Project or any other as may be nominated for the purpose. The nature of items of Imprest Stores, location and the scale for each Imprest holder shall be fixed by the PCSTE.
- (b) The quantity of each item of Imprest stores which each Imprest holder may hold at a time shall be generally based on quarterly average consumption for normal maintenance and upkeep of equipment. Time for procurement in case of non-stock items and also time required for Stores Van movements, in the case of stocked items may be taken into consideration for determining the quantity of imprest. The sanctioned scale shall not be increased or decreased without prior approval of the sanctioning authority.

### Section 3: Tools and Plants

6.3.1 **Scale:** A scale of Tools and Plant shall be fixed by the Principal Chief Signal and Telecommunication Engineer for each SSE/JE(Signal). This scale will include Tools for each Technician and Artisan besides a small reserve with the SSE/JE.

6.3.2 **Accountal:** Instructions in regard to accountal of Tools and Plant are contained in Paras 1456 and 1457 of Engineering Code (extracts at [Annexure: 6-A2](#)).

## Section 4: Protective Clothing

- 6.4.1 **Periodical Requirements:** The SSE (Signal)/incharge or SSE (Signal)/(Stores) shall submit to his Sr DSTE/Dy CSTE of work, the periodical requirements of protective clothing for all the staff eligible for the supply of the protective clothing in accordance with instructions issued from time-to-time.
- 6.4.2 **Preparation of Indents:** Guidelines in regard to preparation of indents and accounting of protective clothing are contained in [Annexure: 6-A3](#).
- 6.4.3 **Accountal of Protective Clothing:** Accounts of protective clothing shall be maintained by the SSE (Signal)/incharge and SSE (Signal)/(Stores) on Ledgers similar to the Tools and Plant Ledgers.

## Section 5: Books of Reference

- 6.5.1 **Supply of Books of Reference:** The SSE (Signal)/incharge and SSE (Signal)/(Stores) shall arrange to get copies of all Books of Reference, in accordance with, instructions in [Para 3.5.2](#) for the use of his office, for himself and for the use of staff under him by submitting necessary indents to his Sr Divisional Signal and Telecommunication Engineer/Deputy Chief Signal and Telecommunication Engineer.
- 6.5.2 **Accountal:** Accounts of Books of reference shall be maintained on Ledgers similar to the Tools and Plant Ledgers.

## Section 6: Office Furniture

- 6.6.1 The SSE (Signal)/incharge and SSE (Signal)/(Stores) shall maintain an account of all office furniture in his charge on Ledgers similar to the Tools and Plant Ledgers.
- 6.6.2 All replacements shall be made on return of unserviceable articles. For any additional item, prior approval of the competent authority shall be obtained as per the SOP before placing the indent.

## Section 7: Stationery and Forms

- 6.7.1 **Indents of Annual Requirements:** The SSE(Signal)/incharge and SSE (Signal)/(Stores) shall submit the indents of their annual requirements of stationery to the Sr DSTE/Dy CSTE incharge of the work in accordance with the scale for the supply of stationery.
- 6.7.2 The Sr. DSTE/Dy CSTE incharge of the work shall see that the sanctioned scale is not exceeded and the items for which no sanctioned scales have been fixed are essential and have necessarily to be supplied.
- 6.7.3 **Accountal:** A numerical accountal of receipt and issue of all items shall be kept. The office of Sr DSTE/Dy CSTE incharge of the work shall make checks periodically, to see that there is no accumulation of items of stationery and forms in the subordinate offices.

## Section 8: Stores Obtained for Works including Special Revenue Works

- 6.8.1 **Requisitioning:** Materials for specific works shall not ordinarily be requisitioned, unless the estimate of the work has been sanctioned by the competent authority and funds have been allotted.
- (a) Requisitions for materials shall show the name and particulars of the estimate and sanctioning authority for the work.
  - (b) Advance procurement of stores may be authorised by the PCSTE or Sr DSTE or Dy CSTE incharge of the work for long lead vital materials such as relays, cables, point machines, block instruments, etc. which are required for the next three years, and which have to be specially arranged or have to be imported. In such cases, the indents may be placed as soon as a Work appears in the Final Works Programme. These indents shall be prepared on the basis of realistic estimate of quantities of materials and subject to prior scrutiny by Finance Branch in respect of reasonableness of the quantity of materials indented. The PCSTE or Sr DSTE or Dy CSTE incharge of the work, shall certify the quantities of materials indented for each work. Indents shall specify the delivery schedule for the next three years and funds shall be arranged according to the delivery schedule.
  - (c) The materials on receipt shall be either utilized on the work or if this is not immediately possible, stored carefully.
- 6.8.2 **Materials-at-Site Account:** The material received for Works detailed in [Para 6.8.1](#) above, if not used up immediately, shall be kept at debit of a numerical account of Materials-at-site of the particular work. Detailed instructions in regard to maintenance of accounts for Works estimated to cost less than Rs. 1 lakh and more than Rs. 1 lakh are contained in Chapter XIV of Engineering Code (extracts at [Annexure: 6-A4](#)).

## Section 9: Daily Material Transactions

- 6.9.1 **Daily Material Transactions Register (DMTR)**
- (a) A Daily Material Transaction Register shall be maintained by each SSE (Signal)/incharge or SSE (Signal)/(Stores), where specifically posted similar to Annexure: 6-A5.
  - (b) All receipts and issue of Stores pending their transfer to their appropriate Ledgers shall be entered in this Register.
  - (c) The Register shall be written up daily. A line shall be drawn across both pages under the last entry of each date to prevent subsequent entries being made.
  - (d) There shall be no direct posting of materials in Ledgers from Challan. All transactions shall first be shown in the Daily Material Transaction Register.
  - (e) The dates shall be the same in both Ledger and the Register.

- (f) Issues of materials from outside stocks will be recorded by the SSE (Signal)/incharge or SSE (Signal)/(Stores) in their line note books first. These entries will then be transferred to the Daily Material Transaction Register. The date of entry in the Daily Material Transaction Register shall be recorded on the note book.
- (g) The SSE (Signal)/incharge or SSE (Signal)/(Stores) are personally responsible for all the Stores in their custody and shall satisfy themselves that the Daily Material Transaction Register and the Ledgers are being correctly posted. They shall initial the Daily Material Transaction Register at least once a week in token of having verified the entries thereof.

## **Section 10: Returned Stores**

**6.10.1 Instructions:** Instructions regarding returned stores are contained in Chapter XVI of the Indian Railway Code for Stores Department (relevant extracts at [Annexure: 6-A6](#)).

### **6.10.2 Dispatch of Spare, Second Hand and Scrap Materials**

- (a) Spare and second hand materials sent to Stores Depot shall be carefully loaded to avoid loss or breakage.
- (b) Material complete but having pins badly worn out and not sufficiently good to be considered second hand, shall be entered up as serviceable scrap and their approximate weight shall be stated. If parts are missing, full details shall be given.
- (c) In the case of Signals, height, Type, & condition of post and fittings shall be stated.
- (d) All cast iron, steel, brass, zinc, copper and lead scrap shall be collected from Sections regularly and sent to Stores Depot, with description and approximate weight.
- (e) Empties such as tins, drums kegs, barrels and cement bags shall be accounted for along with the materials contained in them and shown in the Returns. They shall not be held longer than necessary and shall be returned to Stores Depot for disposal.

### **6.10.3 Credit for “Returned Stores”**

- (a) The credit value allowed in the estimate for the returned Stores which are not likely to be required again shall be kept within the figure likely to be realised for it as an obsolete material or as scrap.
- (b) For materials likely to be used again, after return credit value proportionate to its further life may, however, be provided in the estimate. The normal life of some of the Signalling equipments as laid down in para 219 of the Indian Railway Financial Code shall be followed.



## Section 11: Requisitions

**6.11.1 Preparation of Requisitions:** The following instructions shall be observed in the preparation of requisitions.

- (a) Separate requisitions shall be prepared for each item of material. Requisition for stock items shall be prepared in Form No. S. 1313 and for Non-Stock items in Form No. S.1302 (sample at [Annexure: 6-A7](#)).
- (b) Nomenclature, price list Nos. and other references shall be correctly reproduced, in the case of special and non-standard items, description with complete specifications and drawings shall be given.
- (c) Blank space, if any, below the last item shall be crossed.
- (d) The designation of the consignee shall be written in full. No code abbreviations shall be given.
- (e) The head chargeable shall be entered on all the requisitions.
- (f) The requisition for materials for different sanctioned works and revenue maintenance shall be distinguished by a mark or a code letter, as laid down by the Stores Department.
- (g) In the case of sanctioned works, the number of estimate and the reference of the sanctioning authority shall be given clearly.
- (h) The quantity of each material shall be given in correct units in words and figures. Corrections, if any, shall be initialed.

Requisition may be submitted in Electronic form (where available).

- (i) Availability of funds shall be certified by the Sr DSTE/Dy CSTE incharge of the work.


### 6.11.2 Requisitioning of Materials

- (a) All materials and equipment shall normally be indented in accordance with Indian Railways Standard Drawings and specification. Where any such drawing or specification number is quoted, the latest alteration number as on the date of purchase will automatically apply. For items for which an I.R.S. specification does not exist, an appropriate specification shall be quoted.
- (b) No alteration or modification to or deviation from I.R.S. drawings shall be permitted without the specific sanctions in writing of the PCSTE. In the case of deviations having been decided upon before the placing of an order, the indenting authority concerned shall quote such sanction in the order for procurement.

## Section 12: General Instructions

**6.12.1 Stores Supplied by Firms/Contractors:** Receipt of Stores received direct from firms/Contractors shall be promptly acknowledged. All details of Make, Model Number, S.No, Invoice, PO/Agt No, Inspection Details shall be noted, Discrepancy or defect (if any) shall be brought to the notice of the Asst. Divisional Signal and Telecom Engineer. Where Inspection of materials is to be done by consignee, such inspection shall be done by JE/SSE (Signal) duly nominated by ASTE/DSTE concerned. Quality, Quantity and adherence to laid down specifications must be ensured.

**6.12.2 Custody and Maintenance:** The SSE (Signal)/incharge & SSE (Signal)/(Stores) shall be responsible for the maintenance of all Stores and Tools and Plant in their charge in proper condition. Where Watchmen/Private Security is necessary, the SSE (Signal)/incharge or SSE (Signal)/(Stores) shall approach the Sr DSTE/DyCSTE incharge of the work giving full justification. The guidelines laid down in Annexure: 6-A8 shall be followed as far as practicable.

 Note: This Chapter has under mentioned Annexures		
S.No.	Annexure No.	Description
1	<a href="#">6-A1</a>	Imprest Stores
2	<a href="#">6-A2</a>	Tools and Plant
3	<a href="#">6-A3</a>	Guidelines for Preparation of Indents
4	<a href="#">6-A4</a>	Materials At-Site Account
5	<a href="#">6-A5</a>	Daily Material Transaction Register (DMTR)
6	<a href="#">6-A6</a>	Returned Stores
7	<a href="#">6-A7</a>	Accounts (EDP) Requisition and Issue Note
8	<a href="#">6-A8</a>	General Instructions for Proper Custody and Maintenance of Stores

### **Imprest Stores** (Extracts from Indian Railways Stores Code)

**1801. Definition of Imprest Stores:** Materials whether stock items or non-stock items, held in stock not for specific works but as a standing advance for the purpose of meeting day to day requirements in connection with the repair and maintenance shall, including consumable stores such as cotton waste, jute, oil, grease etc. be treated as imprest stores, so long as they are under the control of the authority in charge of the executive unit and have not been issued to works.

**1802. Object of Imprest System:** The main object of the Imprest System is to control the expenditure on materials used each month in the running repairs of rolling-stock, etc. But this involves inter alia, effective financial and departmental control on the stocks of materials held at outstations and their issue and recoupment.

**1805. Schedule of Imprest Stores:** Schedules of items of such materials showing the quantities of each item which should be held as an imprest should be prepared separately for each imprest holder. This schedule (S. 1805) shall show the following details;

#### **Form No. S.1805**

- (1) Class of Stores.
- (2) Price List or part List Number.
- (3) Brief description of Stores.
- (4) Sanctioned Imprest.
- (5) Rate.
- (6) Value.

**1806.** Copies of the schedule and any subsequent modifications of it should be supplied to the DRM, immediate superior of the imprest holders, the Stores Department and Accounts Officer, Stores, who should each keep the same up-to-date.

**1811. Control of Imprests:** It shall be the duty of the controlling authority in charge of the imprest holders to see that the imprests are revised from time-to-time so as to ensure that they are the lowest possible both as regards quantity and value, consistent with actual working requirements. The imprest holder shall be held responsible to ask for a reduction or deletion of any item of imprest on the basis of the consumption in his shed or station.

**1817. Accounting:** Each JE/SSE (Signal) holding imprest stores shall maintain a numerical ledger on Form No. S. 1817 showing receipts, issues and balances of imprest materials. Each item of the imprest stores shall be dealt with on a separate page of the ledger.

**1829. Closing of Ledgers and Recoupment of Imprests:** The Divisional or District Officers should fix the dates of accounting period for each imprest holder and intimate the same to the Accounts Officer, Stores.

**1830.** Each Imprest Holder should close his ledgers monthly on the dates fixed for him and check them with the Issue and Recoupment Schedule which should be prepared in the form shown below from the Monthly Summary of Issues (S. 1823).

Monthly Summary of Issues: "Charged OFF" Stores Class

Form No. S.1823

Date	P.L. No.			P.L. No.		
	Allocation	Allocation	Allocation	Allocation	Allocation	Allocation
	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity
Total quantity for each head of account under each P.L. No.						
Total Issues						

*Note: The need for the daily abstracts and monthly summaries provided for in paragraphs 1821 to 1823 does not arise in case the Issue Tickets (S. 1819) themselves are valued.*

**1838. Authority to Sign Indents:** Indents for recoupment may be made directly by the imprest holders under their signatures and the counter signature of District or Divisional Officers for such indents is not necessary.

*Note: Always check for latest updates from "Stores code".*

## (Extracts from Indian Railways Engineering Code)

**1417. Monthly Stores Returns:** At the close of each month, separate returns showing receipts, issues and balances of all imprest and surplus stores operated on during the month should be submitted by each engineering subordinate to the Divisional Officer through his Assistant Engineer. These returns are referred to in this Chapter as Imprest Stores Account and Surplus Stores Accounts and should be submitted in the form printed below (Form No. E. 1417). Both the accounts should as far as possible, be supported by the various receipt and issue vouchers, i. e., Issue Notes Adjustment Memo and Advice Notes. These accounts should bear a certificate from the subordinate concerned that no stores other than those included in the accounts have been received or issued during the month and that the balances of all items of stores not included in the accounts remain the same as at the end of the previous month.

..... RAILWAY

## Account for Engineering Materials

Form No. E.1417

Permanent Way Imprest for the month of .....20.....

Division.....

Section.....

Section of Material	U.L. No.	Class I or II	Rate	Description of Material	Sanctioned Imprest Quantity	Opening Balance		Receipt			Issues		
						Quantity Number	Value	Source of receipt and particulars of receipt documents	Quantity Number	Value	Works for which issued	Quantity Number	Value
1	2	3	4	5	6	7	8	9	10	11	12	13	14

Closing Balance			Corresponding material released						How disposed off with particular of document reference
Quantity number	Value	Remarks	Description	U.L.No.	Class	Rate	Quality	Value	
15	16	17	18	19	20	21	22	23	24

Forwarded to: .....

Signature: .....

Station/Office: .....

Designation: .....

**1418. Check of Monthly Stores Returns:** In the Divisional Office, the Imprest and Surplus Stores Accounts (Form No. E. 1417) received from the subordinates should be checked to see

- (i) that the opening balances of the items appearing in the accounts agree with the closing balances of the accounts in, which the items last appeared;
- (ii) that all receipts have been taken correctly to account as debits;
- (iii) that the issues of materials are in order and reasonable and have been correctly taken to account as credits;
- (iv) that all transfers within the Division agree - i.e., that the issues in the account of one subordinate agree with the receipts in the account of another subordinate, any disagreement noticed being rectified and the subordinates concerned advised of the correction; and
- (v) that, in the case of Imprest Accounts, the sanctioned imprest has not been exceeded without proper authority.

**Form No. S.1817**

.....**Railway**

.....**Department**

**Ledger for Imprest Stores**

Reference to Authority:

Authorized Stock .....Unit ..... Rate .....

Class ..... P.L.No. ....

Nomenclature .....

Date of Receipt or issue	Issue or Receipt Notes		Quantity			Remarks	Date of Receipt or issue	Issue of Receipt Notes		Quantity			Remarks
	Number	Date	Receipt	Issue	Balance			Number	Date	Receipt	Issue	Balance	
1	2		3			4	5	6		7			8

### Tools and Plant (Extracts from Indian Railways Engineering Code)

**1456. Tools and Plant for Maintenance:** A scale of Tools and Plant will be fixed for each gang under a Permanent Way Inspector and the total with his gangs plus a small reserve in his own godown will form the scale fixed for each Inspector. A scale for tools and plant will similarly be fixed for other Engineering Supervisors. On issue to the permanent way and other Engineering Supervisors, the cost of these tools and plant is charged off finally. It will, therefore, be necessary for the Supervisors to maintain a tools and plant register (Form E. 1462) and submit it after the close of each financial year to the Divisional Office for check.

.....RAILWAY

**Form No. E.1456**

#### Register of Tools and Plants

Department .....Division.....Office.....Sanctioned Strength.....

Authority.....

Class	Name of articles	Sanctioned scale	Balance brought over	Receipts				Total receipts and balance	
				April..... March (to show 12 months separately)					
				Date	Particular of Voucher	Quantity	Cost	Quantity	cost
(1)	(2)	(3)	(4)	(5a)	(5b)	(5c)	(5d)	(6a)	(6b)

Issues		Quantity	Total	Balance at the end of year		Explanation of difference Ref. and Remarks
April..... March (to show 12 months separately)				As per the return	As actually counted	
Date	Particular of Voucher					
(7a)	(7b)	(7c)	(8)	(9)	(10)	(11)

Place.....

Signature.....

Dated.....

Designation.....

### Guidelines for Preparation of Indents

A consolidated indent for the supply of uniforms for all the eligible sanctioned staff shall be prepared by the Sr. DSTE and submitted to the PCMM for compliance. The indent shall be prepared in accordance with the following guide lines

- (1) Clear description of Uniforms with Style number shall be furnished and the category of staff indicated for whom Uniforms are required.
- (2) The year for which the supply is meant shall be furnished and fund certification indicated.
- (3) Since one P. L. number has been allotted for one Style of all sizes, indents shall be submitted accordingly for one style duly indicating the required sizes for that style category wise, consignee wise for the entire Division and sent to PCMM.
- (4) For staff headquartered at places not coming under zones prescribed as "Winter or mild Winter" but who are required to be supplied with Winter uniforms due to their being rostered for travel during the course of their duty to "Mild Winter" and "Winter" places at least five times a month, a certificate to this effect shall be furnished on the reverse of the indent.
- (5) Certificate to the effect that the styles and scales furnished are as per standing instructions shall be given in the indent.
- (6) It shall also be certified that the size furnished are as per measurement card maintained for the staff concerned.



**1441. Daily Record:** The estimated value of works for which accounts are kept by such-heads in the Register of Works will be as provided for in Para 1486. A daily numerical record of receipts and issues of materials shall be maintained by the Stock holder in Form E. 1441.

Form No. E.1441

## Division.....

Section.....

[illegible]

From page No.....

To page No.....

From page No.....

To page No.....

Return submitted on .....

Stock Holder's Initials.....

Chapter 6: Signalling Stores and Accountal

As materials are issued for consumption on the work, the date, the quantity and the sub-head to which they are chargeable should be recorded under 'Issues'. Materials so issued, but found subsequently to be surplus to requirements should be brought back into record as 'Minus Issues'. Such transactions should wherever practicable be avoided by confirming issues to exact and immediate requirements.

Materials released from the work should, on displacement be recorded separately as such and be entered with the date and quantity as 'Receipts'. When subsequently utilized on the work again they should be shown as 'Issues'.

Materials-at-site returned to stores, transferred or otherwise disposed off should be shown in the respective records with date and disposal reference as 'Minus Receipts'.

**1446. Quarterly Materials-at-site>Returns:** The Supervisor who is executing the work and is also functioning as stock holder shall prepare a quarterly Materials at site account return (Form E. 1446) in respect of each work valued at Rs. 3 lakhs in the case of Track Renewal Works and Rs. 1 lakh in other works for which Register of Works is maintained by sub-heads of estimates, and send the same to the Divisional Office. This return should include only those items for which there have been any receipt or issues/transactions during the quarter. The quarterly return may be followed by a complete Materials-at-site account return for all the items at the end of half-year ending September and March. A number of works may be included in one form provided that all such works are under the executive charge of the same authority.

**1447. The check of Materials at site return:** The Materials-at-site returns received in the Divisional Office should be checked in the following respects:

- (a) The Opening balance should be checked with the closing balance of the previous return;
- (b) The receipts during the period covered by the returns should be checked with the relevant issue notes, the summary of stores, adjustment memo and other receipt vouchers;
- (c) The reasonableness of the issues during the period covered by the return should be checked with reference to the relevant sanctioned estimate, and the progress of work reported during the period;
- (d) As regards materials returned to Stores Depots or transferred elsewhere, the correctness of credits to site accounts should be checked with the relevant advice of returned stores or adjustment memo.
- (e) The arithmetical accuracy of the returns should be checked.

**1448. Accountal in the Register of Works:** All materials obtained specifically for a particular work should be charged off immediately to the head to which the cost of that work as a whole is allocated (or if more than one head is involved to that bearing the greatest cost); but should, so long as they are not consumed on the work be borne under a suspense head "Materials-At-Site" opened under that head. All materials released from a work should also be borne under the same suspense head. The adjustment from the "MAS" suspense to the relevant final detailed heads should be carried out as soon as the materials are shown in the monthly return as having been issued for use on work.

**1449.** The responsibility for having a daily record maintained, a monthly return prepared, checked and valued and cost adjusted as prescribed in these rules devolves on authority in executive charge of the works. The Accounts Officer who maintain the works Register is responsible for the final adjustment of all materials-at-site transactions.

**1450. Verification of Materials-at-site:** The authority in executive charge of works for which material at site accounts are maintained should arrange for a periodical verification of the following materials at site pertaining thereto

- (a) Permanent Way materials.
- (b) Other materials at site which can be readily separated and distinguished from any of the same description but of different category.

..... Railway  
**Material-at-Site Record Quarterly Returns**

Division .....

Section .....

Name of work ..... Sanction No ..... Date .....

Designation of Subordinate ..... Account of Receipts and Issues during the Quarter ending .....

Sl. No.	Name of work and description of material	Classification	U.N. List No.	Rate	Unit	Opening balance			Receipts				Issues				Closing balance		
						Date	Quantity	Value	Date	Source and reference	Quantity	Value	Date	Sub-head to which chargeable	Quantity	Value	Quantity	Value	Remarks
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

Forwarded to .....

Station/office .....

Signature .....

Date. ....

Designation .....

It is not necessary that all articles should be checked at the same time; but every item should be verified at least once in a year. A certificate by the authority in executive charge of works that such verification has been carried out should, together with a note as to whether or not the materials were found to be unduly depreciated, be furnished on the materials at site return for the month of March, or on the last return on which a balance is shown, submitted in the year. The stock verification prescribed in this paragraph is in addition to the periodical stock verification of engineering stores arranged for by the Accounts Officer.

**1452. Daily Record:** A daily numerical record in respect of materials-at-site works in this category for which a separate account is not maintained by sub-heads in the Register of Works shall be kept in Form E. 1441.

**1453. Monthly Return:** At the end of every month, an Excess Materials Return in Form E. 1453 given below should be prepared in respect of all completed works in this category. These Returns should show separately for materials obtained and materials released, the numerical balance only of materials-at-site i. e., those that have neither been consumed on the work nor returned to the stores, transferred or otherwise disposed off and the date of completion of the works to which they relate.

.....RAILWAY

**Form No. E.1453**

**Materials-at-Site Record excess Materials Return**

Division.....

Section.....

Balance of Materials still "At-Site" on .....

Name of work		Materials Obtained for the work		Materials Released in connection with the work		Date of completion of the work	Remarks
Description of Materials	Classification	Rate	Quantity	Rate	Quantity		

Station/office.....

Signature.....

Date.....

Designation.....

**1454. Check of Excess Materials Returns:** The Excess Materials Returns should be checked in the Divisional Office as regards the correctness and reasonableness of the balances shown therein against the various receipt vouchers and the sanctioned estimates and put up to the Executive Engineer for his orders as to the disposal of the balances. If the 'Excess Materials' cannot be utilized on some other works, they should either be returned to the Stores Depot or taken to Engineering Stores Surplus — (i) Permanent Way, (ii) other than Permanent Way; (iii) Awaiting sale.

**1455. Accountal in the Register of works:** Materials obtained specifically for particular works in this category should be charged off finally in accordance with their allocation.

**Daily Material Transaction Register (DMTR)**

..... RAILWAY

**SIGNAL AND TELECOMMUNICATION DEPARTMENT**

Receipt							Issues						
Date	Description of material	Quantity	Ledger reference and Page	Challan or Receipt Note No. and date	From whom received *	For what work	Date	Description of material	Quantity	Ledger reference and Page	Challan No. and date	To whom issued	For what work

\* Details of Inspection certificate number shall be recorded.

**1601.** All Stores which have been previously issued for the services of the Railway and are no longer required on a work should, in the absence of special instructions to the contrary, be returned to the Stores Depots. If there is more than one Stores Depot on a Railway, the PCMM may nominate the depot or depots to which particular classes of Stores may be returned and advise the various Railway departments accordingly.

**1602. Advice Notes:** The Officer Returning Stores to Stores Depots should prepare Advice Notes in Form (S. 1539) in six foils by carbon process. Separate Advice Notes should be prepared for each class and for new, second hand and scrap stores.

**1604. Disposal of the Foils of Advice Notes:** One foil of the Advice Note should be retained by the subordinate returning the Stores to the Stores Depot as his office copy, three foils (the 2nd, 3rd and 4th) should be sent to the depot direct along with the Railway Receipt. Of the remaining two copies, one copy (the 5th) should be sent to the Accounts Officer, Stores, and the other (the 6th) to the Divisional or District Officer through the immediate superior of the subordinate returning the Stores.

**1605. Departmental Register of Advice Notes:** The Advice Notes (6th foil) should be carefully examined in the division or district office to see that they have been correctly prepared. They should then be listed in a Register of Advice Notes for Returned Stores maintained in the form shown below:

Form No. S.1605

## Departmental Register of Advice Notes for Returned Stores

Designation of the Officer returning the Stores .....

[illegible]

**1606.** A separate page of this register should be allotted to each returning officer or subordinate as may be found convenient. If the particulars furnished by the subordinates returning the stores regarding nomenclature, rates, etc., are found to be incomplete, the Advice Notes (S. 1539) (6th foil) should be completed in the divisional or district office in these respects. The Advice Notes (6th foil) should then be forwarded to the depot to which the stores have been returned.

**1620. Posting Numerical Ledgers:** The Depot Officer, after having the necessary entries made in the numerical ledgers as well as in the Depot Register of Advice Notes (S. 1608) should retain one copy of the Advice Note (2nd foil) as his office record and send the two copies (3rd and 4th foil) duly completed in all respects to the Accounts Officer, Stores.

**1621. Disposal of Receipt (6th) Foil:** The sixth foil of the Advice Note should also be sent by the Depot officer duly receipted to the divisional or district officer concerned to be retained as the latter's office record after making the entries in columns 7 to 9 of the Departmental Register of Advice Notes (S. 1605). He should take up with the depot and returning officers any discrepancies in quantities (vide columns 5 and 9 of the Register) if the reasons given on the Advice Notes are not satisfactory.

**1626. Advice of Credits:** From the 3rd foil will be prepared the Advice of Credits (S. 2705) according to the departments from which the stores have been received. The number and date of the Advice of Credit should be noted in the Accounts Register of Advice Notes (S. 1622) against the entries of the Advice Notes included in the Advice of Credits. The Advice of Credits with the 3rd foils as supporting vouchers and the corresponding 5th foils should then be sent to the divisional or district officer concerned.

**1628. Procedure in the District or Divisional Office:** On receipt of the copies of the Advice Notes along with the Advice of Credit from the Stores Accounts Officer in the division or district office, the 5th foil should be transmitted to the subordinate concerned after noting on it the fact of credit having been received. The Advice of Credit supported by the 3rd foil should then be carefully checked with and noted in the Departmental Register of Advice Notes (S. 1605).

**1607.** The Register of Returned Stores (S.1605) should be inspected frequently to see that there is little avoidable delay on the part of the stores depots in acknowledging the stores. Any cases of omission to acknowledge the stores and/or to afford credit for the same within one month of the Advice Notes should be taken up with the Depot and Accounts Officers.



**Accounts (EDP) Requisition and Issue Note**

.....RAILWAY

**ACCOUNTS (EDP) 1****REQUISITION AND ISSUE NOTE****S.1313/S.1319**

To be filled by Indentor

To be filled by Store Depot

CD Code  
**56**

Indentors	Consignee	Supplying Depot	Depot	Ward	Issue Note No.	Date	
Consignee code		Allocation	Quantity Issued in Words				
Requisition No.		Date					
Qty. Demanded in figures		P.L. No.	Category	Unit code	Quantity Issued in Figures		
Qty. Demanded in words		Unit	Rate Rs.	P.	Value Rs.	P.	
Description			No. of Packages		Wagon No.		
			R.R.No.		Date		
Indenting Official		Approving Officer		Issuing Official		Receiving Official	

Signatures

.....RAILWAY

**DEPOT 2****REQUISITION AND ISSUE NOTE****S.1313/S.1319**

To be filled by Indentor

To be filled by Store Depot

CD Code  
**56**

Indentors	Consignee	Supplying Depot	Depot	Ward	Issue Note No.	Date	
Consignee code		Allocation	Quantity Issued in Words				
Requisition No.		Date					
Qty. Demanded in figures		P.L. No.	Category	Unit code	Quantity Issued in Figures		
Qty. Demanded in words		Unit	Rate Rs.	P.	Value Rs.	P.	
Description			No. of Packages		Wagon No		
			R.R.No.		Date		
Indenting Official		Approving Officer		Issuing Official		Receiving Official	

Signatures

.....RAILWAY

**INDENTOR 3****REQUISITION AND ISSUE NOTE****S.1313/S.1319**

To be filled by Indentor

To be filled by Store Depot

CD Code

**56**

Signatures

Indentors	Consignee	Supplying Depot	Depot	Ward	Issue Note No.	Date
Consignee code		Allocation	Quantity Issued in Words			
Requisition No.		Date				
Qty. Demanded in figures		P.L. No.	Category	Unit code	Quantity Issued in Figures	
Qty. Demanded in words		Unit	Rate Rs.	P.	Value Rs.	P.
Description			No. of Packages		Wagon No.	
			R.R.No.		Date	
Indenting Official		Approving Officer	Issuing Official		Receiving Official	

.....RAILWAY

**RECEIPT 4****REQUISITION AND ISSUE NOTE****S.1313/S.1319**

To be filled by Indentor

To be filled by Store Depot

CD Code

**56**

Signatures

Indentors	Consignee	Supplying Depot	Depot	Ward	Issue Note No.	Date
Consignee code		Allocation	Quantity Issued in Words			
Requisition No.		Date				
Qty. Demanded in figures		P.L. No.	Category	Unit code	Quantity Issued in Figures	
Qty. Demanded in words		Unit	Rate Rs.	P.	Value Rs.	P.
Description			No. of Packages		Wagon No.	
			R.R.No.		Date	
Indenting Official Officer		Approving	Issuing Official		Receiving Official	

.....RAILWAY

**BILL 5****REQUISITION AND ISSUE NOTE****S.1313/S.1319**

To be filled by Indentor

To be filled by Store Depot

CD Code  
**56**

Signatures

Indentors	Consignee	Supplying Depot	Depot	Ward	Issue Note No.	Date
Consignee code		Allocation	Quantity Issued in Words			
Requisition No.		Date				
Qty. Demanded in figures		P.L. No.	Category	Unit code	Quantity Issued in Figures	
Qty. Demanded in words		Unit	Rate Rs.	P.	Value Rs.	P.
Description			No. of Packages		Wagon No.	
			R.R.No.		Date	
Indenting Official		Approving Officer		Issuing Official		Receiving Official

.....RAILWAY

**BLOCK 6****REQUISITION AND ISSUE NOTE****S.1313/S.1319**

To be filled by Indentor

To be filled by Store Depot

CD Code  
**56**

Signatures

Indentors	Consignee	Supplying Depot	Depot	Ward	Issue Note No.	Date
Consignee code		Allocation	Quantity Issued in Words			
Requisition No.		Date				
Qty. Demanded in figures		P.L. No.	Category	Unit code	Quantity Issued in Figures	
Qty. Demanded in words		Unit	Rate Rs.	P.	Value Rs.	P.
Description			No. of Packages		Wagon No.	
			R.R.No.		Date	
Indenting Official		Approving Officer		Issuing Official		Receiving Official

RAILWAY

REQUISITION FOR STORES

<b>DEPOT 1 S.1302</b>				Requisition No.	Date
Indentor	Consignee	Consignee Code		Matrls Reqd. at	Depot
Description		P.L No.	Cat.	Qty. Demanded in Figs	Unit
				Qty. Demanded in Words	
				Allocation	
Last purchase particulars		Rate	Value	Purpose	

Funds Availability Certified.

Originating Official.

Approving Officer.

RAILWAY

REQUISITION FOR STORES

<b>DEPOT 1 S.1302</b>				Requisition No.	Date
Indentor	Consignee	Consignee Code		Matrls Reqd. at	Depot
Description		P.L No.	Cat.	Qty. Demanded in Figs	Unit
				Qty. Demanded in Words	
				Allocation	
Last purchase particulars		Rate	Value	Purpose	

Funds Availability Certified.

Originating Official.

Approving Officer.

**General Instructions for Proper Custody and Maintenance of Stores**

- (1) All materials shall be kept clean and free from dust. Materials liable to get rusted shall be kept free from rust by oiling/greasing whenever required.
- (2) Stores enclosures shall be provided with weather proof protections where necessary.
- (3) Materials shall be kept properly sorted and neatly stacked. Racks or other suitable arrangements shall be provided for storing any tools and petty consumable stores.
- (4) Parts and small items of materials shall be kept in properly labelled bins or on shelves.
- (5) Clutch Resetting Handles/Crank Handles/Electric key Transmitter keys, master keys and spare keys shall be kept locked up with the key in the custody of the JE/SSE.
- (6) Bags of cement shall not be stored in too large a quantity nor for too long a period. Bags shall be issued strictly in rotation, the first bags is being the first to be issued out. Bags of cement damaged by rain or moist air shall not be issued.
- (7) Point rodding shall be loaded in open wagons.
- (8) Inflammable materials such as oils, spirits, petrol, etc., shall be stored separately and away from cotton waste, stationery and furniture. Naked lights and smoking shall not be allowed inside such godowns. Adequate arrangements shall be made for fire protection, i. e., fire extinguishers shall be kept handy at easily accessible spots and fire buckets shall be kept full of water/or sand where inflammable materials are stocked.
- (9) Cables should be stored properly without damage to the cable drum as far as practicable. Cable shall not be removed from drums until ready to install. When a length of cable is cut off, the exposed end shall be effectively sealed.
- (10) Signalling relays shall be kept separately at a place where environment is not likely to be damp and free from chemical pollution due to acid fumes, etc. Relays shall be transported from one place to another carefully in box with "thermocole" packing to avoid damage during transportation. Similar care should be taken for upkeep of tokenless block instruments and other sophisticated materials like Electronic Interlocking Cards, IPS cards. Axle Counters Relay Groups, etc.
- (11) Paints shall be stored in a cool dry place away from flame or naked light. All containers shall be kept tightly closed to avoid loss of material due to skinning and contamination caused by open atmosphere.
- (12) Surplus or Scrap materials shall be disposed regularly.
- (13) All measures to prevent theft, fire shall be taken.
- (14) Transport vehicles/pick up vans shall be maintained at all times to ensure their availability at all times in emergencies.

# Chapter 7: Essentials of Signalling

## Section 1: Signals in General

- 7.1.1 Multiple Aspect Colour Light Signalling (MACLS) is covered in this chapter.
- 7.1.2 All signals shall be electrically Lit. The signals shall be free from the possibility of phantom indication.
- 7.1.3 All Main signals shall be colour light multi-unit type and shunt signals shall be of the Position Light type. Calling on signals may be provided as per Operational needs.
- 7.1.4 **Uniformity of Signalling:** It is desirable that;
- (a) The signalling at all stations and interlocked level crossing gates in a section conforms to the same type & standard as per maximum Permissible speed of the section.
  - (b) Signalling at a station at either end(s), shall also be uniform as far as possible.
- 7.1.5 **Signals – Location**
- (a) The number of signals and their height shall be limited to what is necessary for Safety and operational requirements.
  - (b) Signals shall normally be on the left of, or above the line to which they apply, unless authorized by special instructions to the contrary.
  - (c) Where signals are erected on right hand side, they shall be provided with an arrow, pointing towards the applicable line.
  - (d) Signals shall be so located and aligned so as to;
    - (i) Display the best possible view of their aspects to Loco Pilot of approaching trains.
    - (ii) Avoid, as far as possible the possibility of the aspect of one signal being mistaken for the aspect of another, and
    - (iii) Avoid confusion between the lights of Main signals and the lights of Subsidiary signals or any other lights. The size of lamps/LEDs of Subsidiary Signals shall be smaller than that of Main signals. Subsidiary signals shall not be brighter than Main signals.
- 7.1.6 All equipments shall be so designed, located and secured as to obviate, as far as possible, any outside interference.
- 7.1.7 Non-Operational Signal(s) shall be turned away from Track.

*Note: (i) when a signal is not in use, it shall be distinguished by two crossed bars across it, each bar being not less than one metre long and 10 cm wide (GR 3.18)*

*(ii) Signals not in use, shall not be lit (GR 3.18(3))*

- 7.1.8 **Block Overlap:** Shall not be less than 180 metres in case of multiple-aspect signalling. (Ref: GR.8.01(2)(b))

Relevant extract of GR is given below.

*GR 8.01: (2) Unless otherwise directed by approved special instructions, the adequate distance referred to in clauses (b) and (c) of sub-rule (1) shall not be less than-*

- (a) 400 metres in case of two-aspect lower quadrant signalling or two-aspect colour light signalling, and*
- (b) 180 metres in case of multiple-aspect signalling or modified lower quadrant signalling.*

- 7.1.9 **Signal Overlap:** Shall not be less than \*120 metres

\* Method of reckoning of 120 Metres signal overlap (adequate distance) is given below - GR extract;

*GR 3.40. Conditions for taking 'off' Home signal. —*

*(1) When a train is approaching a Home signal otherwise than at a terminal station, the signal shall not be taken 'off' until the train has first been brought to a stand outside it, unless*

*(a) on a double line, the line is clear for an adequate distance beyond the Starter; or*

*(b) on a single line, line is clear for an adequate distance beyond the trailing points, or for an adequate distance beyond the place at which the train is required to come to a stand. (G.S.R 1168(E) Dt 05-12-18)*

*(2) Where a train has first been brought to a stand outside the Home signal, the signal may be taken 'off', if-*

*(a) on a double line, the line is clear up to the Starter, or*

*(b) on a single line, the line is clear up to the trailing points or under approved special instructions up to the place at which the train is required to come to a stand.*

*(3) Except under approved special instructions, the adequate distance referred to in sub-rule (1) shall never be less than-*

*(a) 180 metres at stations equipped with two-aspect lower quadrant or two-aspect colour light signals, or*

*(b) 120 metres in the case of stations provided with multiple aspect signals or modified lower quadrant signals.*

*(4) Where a sand hump of approved design, or under approved special instructions a derailing switch, has been provided for the line on which a train is to be received, they shall be deemed to be efficient substitutes for the adequate distance referred to in subrule (3).*

**7.1.10 Overlap beyond IB signal** (Class C station): shall not be less than 400 meters beyond IB home.

*GR 8.04: At a class C station on single line or double line, in two aspect ,multiple aspect or modified lower quadrant signalling, the line shall not be considered clear and line clear shall not be given, unless-*

*(a) the whole of last preceding train has passed complete at least 400 metres beyond the home signal and is continuing it`s journey and.....*

**7.1.11 Visibility of Signals:** The minimum visibility distance of various signals shall be as under;

**(a) Distant Signal - 400 Metres.**

*Note: (i) Where it is not possible to obtain 400 meters of continuous visibility (due to site constraints), then imposition of a suitable speed restriction may be considered.*

*(ii) An Inner Distant Signal (where provided), shall be continuously visible from a minimum distance of 200 metres.*

**(b) All Stop Signals - 200 metres.**

*Note: Where it is not possible to obtain 200 metres of continuous visibility of any stop Signal (due to site constraints), then a suitable speed restriction shall be imposed.*

**7.1.12 Aspects of Signals**

**(a) Aspects of Distant Signals**

(i) In Single Distant Territory:

- The Distant signal shall display ; A yellow light (bottom) in the 'ON' position for the 'Caution' aspect, Two yellow lights in a vertical line (Distinguishably apart) for the 'Attention' aspect and one green light for the 'Proceed' aspect.

(ii) In Double Distant Territory:

- The Distant signal shall display; two yellow lights in a vertical line (Distinguishably apart) in the 'ON' position for the 'Attention' aspect, and one green light for the 'Proceed' aspect.
- Inner Distant signal shall display; a yellow light (bottom) in the 'ON' position for the 'Caution' aspect, two yellow lights in a vertical line (Distinguishably apart) for the 'Attention' aspect and one green light for the 'Proceed' aspect. Inner Distant signal shall display the same aspects as that of Distant signal in Single Distant territory.



*Note: Under approved special instructions, a colour light Distant signal may be combined with the last Stop signal of a station in rear or with an Intermediate Block signal or with a Stop signal protecting a level crossing. When a colour light Distant signal is combined, (i) with the last Stop signal of a station in rear or (ii) with an Intermediate Block signal or (iii) with a Stop signal protecting a level-crossing, arrangements shall be such that the signal shall not display a less restrictive aspect than the stop aspect till Line Clear has been obtained from the station ahead as in case of (i) and (ii) above and until the level-crossing gates have been closed and locked for the passage of trains as in case of (iii) above (Ref: GR: 3.07(7) , G.S.R. 157(E).-Dated-05-3-21)*

### **(b) Aspects of Stop Signals:**

The signal shall display , a red light for the 'Stop' aspect , a yellow light for the 'Caution' aspect, Two yellow lights in a vertical line (Distinguishably apart) for the 'Attention' aspect and one green light for the 'Proceed' aspect.

*Note: In a typical station (in Double Distant Territory), signals display as under.*

<b>Table-1</b>							
<b>S.No.</b>	<b>Distant signal</b>	<b>* Inner Distant signal</b>	<b>Home signal</b>	<b>Main Line Starter</b>	<b>Loop Line Starter</b>	<b>Advanced Starter</b>	<b>Indication to Loco Pilot</b>
1.	Double Yellow	Yellow	Red	-	-	-	Stop dead at Home
2.	Green	Double Yellow	Yellow	Red	-	-	Stop dead at Main line Starter
3.	Green	Green	Green	Green	-	Green	Run through on Main Line
4.	Double Yellow	Double yellow	Yellow with Route indicator	-	Red	-	Stop dead at loop line starter
5.	Double Yellow	Double Yellow	Yellow with Route indicator	-	Yellow	Green	Run through via loop line

\* Or Distant Signal in Single Distant Territory

<b>Signal Aspect</b>	<b>Lamp lit</b>
Stop	Red
Caution	Yellow
Attention	Double Yellow
Proceed	Green

### 7.1.13 Placement of Distant Signal

- (a) Distant Signal shall be placed at an \*adequate distance in rear of the first Stop Signal.

*\*Note: Such an adequate distance shall not be less than 1 kilometre in Single Distant Territory*

- (b) In Double Distant territories: On sections, where Emergency Braking Distance (EBD) of more than 1.0 km is to be catered for, a second Distant signal shall be provided. Such a Distant signal shall be placed at an adequate distance of not less than 2 kms in rear of First Stop signal and Inner Distant Signal shall be placed at a distance of not less than 1 km in rear of First Stop signal.

*Note: Both Distant and Inner Distant Signals shall be provided with a marker consisting of a white coloured disc with letter 'P' in black.*

### 7.1.14 Placement of Stop Signals

- (a) **Home Signal:** The Home Signal shall be placed in rear of all connections, if any, on the line to which it refers. The Home Signal shall be placed at not less than \*180 metres in rear of the points up to which the line may be obstructed, after line clear has been granted to the station in rear.

*\*Note:*

- (i) *Where there is a continuous down gradient towards station steeper than 1 in 260 between Distant and Home signal in single distant territory and between Inner Distant and Home Signal in Double Distant territories, the Home signal may be placed at a distance of sum of Block Overlap and Signal Overlap from BSLB (Block Section Limit Board) or the outer most Facing Point, as the case may be (i.e  $180 + 120 = 300$  m in MACLS).*
- (ii) *If there is rising gradient in between or there is no emergency crossover for criss-cross movement cutting across the main line, then this shall not be applicable.*

- (b) **Routing Signal:** A Routing Signal shall be placed in rear of the Points, which it protects

- (c) **Starter Signal:** When one Starter Signal is provided for each converging line, it shall be so placed as to protect the adjacent running line or lines

*Note: For long/curved platforms, a Starter Indicator may be provided to repeat the aspect of the Starter as an aid to the Guard to enable him to know the aspect of the Starter. The Starter Indicator shall exhibit no light when concerned Starter is at 'ON' and yellow light when it is 'OFF'. This Indicator may be provided only where essentially required.*

- (d) **Intermediate Starter Signal:** An Intermediate Starter Signal shall be placed clear of fouling marks in rear of the points, if any, which it protects.

- (e) **Advanced Starter Signal:** Unless approved under special instructions, an Advanced Starter Signal shall be placed outside all connections on the line to which it applies;

It shall be located at a distance of not less than 120 meters from the outermost points in the case of Single Line section. This distance shall be reckoned from the starter in case of Double Line Section.

- (f) **Gate Stop Signal:** shall be located at not less than 180 meter (in MACLS territory) in rear of the gate, which it is protecting. Gate Signal shall be provided with a marker consisting of a yellow coloured disc with letter 'G' in black.

- (g) **Intermediate Block Stop (IBS) signal:** Is the Home signal provided at an Intermediate Block post on a Double Line or Single Line. IB Signal shall be provided with a marker consisting of a white coloured disc with letter 'IB' in black.

*Note: IB Signal shall be located in such a way, to split the block section into near halves subject to other criteria.*

- (h) **Automatic Block Signals:** They shall be normally located with a spacing of one km from each other, subject to other criteria and headway required. Automatic Signal shall be provided with a marker consisting of a white coloured disc with letter 'A' in black.

#### 7.1.15 Aspects-Sequence

- (a) When a Signal is displaying the 'Stop' aspect, the signal next in rear shall not display a less restrictive aspect than 'Caution'.
- (b) Every Multiple Aspect Signal, whether automatic, semi-automatic, or manually operated which, is required to display 'caution' aspect to a train shall normally be placed at an adequate distance from the next signal in advance. This adequate distance shall not be less than 1 kilometre. Where the adequate distance cannot be provided and the 'caution' aspect is being displayed, the next signal in rear shall display the 'attention'/'caution' aspect.
- (c) If necessary, the 'Attention'/'Caution' aspect shall be repeated back on successive signals in rear, until the adequate distance is obtained.
- (d) In all cases the signal next in rear of a Signal protecting diverging lines shall display 'Attention'/'Caution' aspect in the 'OFF' position, when the points are set for any line other than the line over which the higher speed is permitted. When this signal cannot be placed sufficiently in rear of the 'STOP' signal protecting the Points to permit the Loco pilot of an approaching train to reduce to the permitted speed, the 'Attention'/'Caution' aspect shall be repeated back on successive signals in rear, until the required adequate distance is obtained.

- (e) For Metro Services, every Multiple Aspect Signal, whether automatic, semi-automatic, or manually operated which, is required to display 'Caution' aspect to a train, it shall normally be placed at an adequate distance from the next signal in advance. This adequate distance shall not be less than the maximum emergency braking distance of the trains running on the section at the maximum permissible speed on the ruling gradient. Where the adequate distance cannot be provided and the 'caution' aspect is being displayed, the next signal in rear shall display the 'attention'/'caution' aspect. The 'attention'/'caution' aspect shall be repeated back on successive signals in rear, until the adequate distance is obtained.

**7.1.16 Combined Signals:** When owing to their location, it is necessary to combine any two signals, one Stop Signal only may be provided under approved special instructions, capable of displaying any or all the following aspects:

- (a) Stop
- (b) Caution
- (c) Attention
- (d) Proceed

*Note: Under approved special instructions, a colour light Distant signal may be combined with the last Stop signal of a station in rear or with an Intermediate Block signal or with a Stop signal protecting a level crossing. (Ref: GR: 3.07(7), G.S.R. 157(E). Dated-05-3-21)*

**7.1.17 Distinction between Signals:**

- (a) **Diverging Lines:** Unless otherwise permitted by approved special instructions, where two or more lines diverge, a route indicator of approved design shall be provided.

**(i) Route Indicator** - The type of Route Indicator to be provided, shall be as under -

- For speeds in excess of 15 kmph: Direction type Route Indicator for up to 3 diversions in any side of the main line or Direction Type Route Indicator with LED Matrix for more than 3 diversions on any side of the main line.
- For speeds not exceeding 15 kmph: Any Route Indicator of approved design.

- (b) **Converging lines:** Unless otherwise permitted by approved special instructions, when two or more lines converge, the signals shall be fixed on separate posts.

### 7.1.18 Subsidiary Signals - Calling-on Signal

- (a) **Function:** A Calling-on signal when taken 'OFF' calls on the Loco Pilot of a train to draw ahead with caution, after the train has been brought to a stop even though the Stop Signal above it is at 'ON'. Such 'OFF' position indicates to the Loco-pilot that he should be prepared to stop short of any obstruction.
- (b) **Aspects:** A Colour Light Calling-on signal has no independent aspect in the 'ON' position and shall display no light in the 'ON' position and a miniature yellow light in the 'OFF' position.
- (c) The colour light Calling-on signal shall be provided with a marker consisting of a white enamelled disc with letter 'C' in black.
- (d) **Placement of Calling-on Signal:** Calling-on signal shall be placed below a Stop Signal governing the approach of a train. Under approved special instructions, a Calling-on Signal may be provided below any other Stop Signal except the last Stop Signal.
- (e) **Working of Calling-on Signal**
  - (i) Calling-on Signal shall neither be capable of being worked at the same time as the Stop signal above nor shunt signal below it (if any)
  - (ii) Calling-on signal shall lock and detect all the points in the route including isolation points (if any), which the Main signal above it detects excluding those in overlap.
  - (iii) Calling-on signal requires all the level crossing gates in the route to be closed and locked against road traffic
  - (iv) At stations where Station Master controls the reception and dispatch of trains, such control shall be extended to Calling-on Signals also.
  - (v) It is required to provide track circuits at a \*suitable distance and a time delay circuit to ensure that the Calling-on Signal is taken 'OFF' only after the train has been brought to a stop.

**\*Note:**

- (i) For reception signals, 5 rail length (65 metres) Calling-on track circuit and 60 seconds time delay shall be provided.
- (ii) For dispatch signals, no time delay is required for taking off Calling-on Signal. However provision for ensuring that the train has stopped shall be covered in Station Working Rules (SWR) and to be ensured by operating staff.
- (vi) Provision for manual replacement of Calling-on Signal shall be included in concerned Station working Rules (SWR).

### 7.1.19 **Subsidiary Signals - Shunt Signal**

- (a) Shunt movements shall, as far as possible, be controlled by Shunt Signals. The Shunt Signals shall lock and detect all the points in the Route and prove that the tracks in the route excluding the berthing track are clear and that the level crossing gates in the Route are closed and locked against the road traffic.
- (b) Shunt Signals shall be of the Position Light type. The lights of a Position Light Signal shall be white. Two lights of a Position Light signal shall be horizontal in the 'ON' position and 45° above the horizontal in the 'OFF' position.
- (c) **Placement and aspects of Shunt Signals**
  - (i) Shunt Signals may be separately located on posts or close to the ground or may be fixed below Stop Signals other than the First Stop Signal of a station.
  - (ii) Where a Shunt Signal is required to be fitted on a Signal post on which a Calling-on signal is also fitted, the Shunt Signal shall be fitted below the Calling-on Signal.
  - (iii) A Shunt Signal placed below a Stop Signal or a Calling-on Signal shall not be capable of being worked at the same time as the relevant Stop Signal or Calling-on signal.
  - (iv) Where a Shunt Signal is fixed below a Stop Signal, it shall show no light in the 'ON' position.

## **Section 2: Warning Boards**

- 7.2.1 A Warning Board to warn the Loco-pilot of his approaching a Stop Signal shall be provided at a distance of 1.4 km in rear of the First Stop Signal of a station, Intermediate Block Stop Signal and Gate Stop Signal. This distance may be increased suitably to cater for gradients.

*Note: (i) On Broad Gauge and Metre Gauge, Passenger Warning Board should be provided at not less than 1000 m in rear of the first stop signal of a station, intermediate block stop signal and gate stop signal. The Passenger Warning Board need not be provided where the distance between distant signal and stop signal is 1000 m or more.*

*(ii) Goods warning board shall be provided at a distance of 1400 m in rear of the first stop signal of a station, intermediate block stop signal and gate stop signal.*

*(iii) In Double Distant Territory, no warning board is required.*

- 7.2.2 In those cases, where Gate Signals and station signals happen to be located close to each other, only one warning board shall be provided at a distance of not less than 1.4 km from the First Stop Signal.

- 7.2.3 Where inter-signal distance between two signals is less than the distance required for warning Board, the signals in rear shall either be controlled by the signal in advance or they shall be combined.
- 7.2.4 Self-reflecting sheets of approved type or reflectors shall be provided, on the warning board as per approved drawings.
- 7.2.5 The warning board shall normally be on the left of the line to which it applies unless there are special reasons to the contrary.

### **Section 3: Indication Boards**

- 7.3.1 Indication Boards are provided to give warning to Loco Pilots about changes in type of signalling or type of Block Working or Automatic Train Protection Territory.
- 7.3.2 Where a Block station, which is provided with two aspect signalling without a Warner signal in rear of the First Stop Signal, is approached from a section provided with Multiple Aspect Signalling or with two aspect signalling with a Warner signal in rear of the First Stop Signal, an Indication Board bearing alternate yellow and black diagonal stripe shall be fixed at not less than 1.4 km. in rear of the First Stop Signal. The Board shall have a legend "Approaching unwarned Stop Signal".
- 7.3.3 When a station provided with single line Token block is approached from a Double Line or a Single Line section equipped with Tokenless block working, an indication board with a legend "Entering Token Territory" shall be provided at the First Stop Signal of the station.
- 7.3.4 Where the block working at one end of a station is automatic and the other end is absolute, an indication board with suitable legend shall be provided at the First Stop Signal of the station. The legend on the board shall be "Entering Absolute Block Territory" or "Entering Automatic Block Territory" as appropriate.
- 7.3.5 **Shunting Limit Board:** A Shunting Limit Board shall be provided at Class 'B' stations over a single line section worked on Absolute Block System where shunting in the face of an approaching train is permitted and where an Advanced Starter is not provided. The Shunting Limit Board shall be fixed at a distance of 180 metres in advance of the First Stop Signal.
- 7.3.6 **Block Section Limit Board (BSLB)**
- (a) At Class 'B' stations worked on Double Line Absolute Block System (with multiple aspect signalling) a Block Section Limit Board shall be provided where there are no points or the Outermost points are trailing.
  - (b) The Block section Limit Board shall be located at 180 metres in advance of the Home Signal and protecting the fouling mark of the trailing points, if any.
  - (c) The Block section Limit Board or the Shunting Limit Board shall be so located that the legend is facing towards the station. They shall be fitted with lamps showing white light in both directions during night or shall be painted with Retro-reflective type coating.

### 7.3.7 Miscellaneous Indication Boards

- (a) An indication board shall be provided at the foot of Gate signal if it is protecting more than one mid section LC gate with appropriate legend.
- (b) An indication board shall be provided at the foot of the IB signal if it is protecting mid section LC gate with legend "Look out for LC gate when passing IB signal at ON".
- (c) Any other indication boards as required.

## Section 4: Points, Operation, Indicators & Isolation

- 7.4.1 The points shall be operated by Point machines (approved type). Points leading to un-signalled lines or sidings may be manually operated with suitable electrical controls.
  - 7.4.2 **Obstruction Test:** Insertion of a 5 mm obstruction between the switch rail and the stock rail of a Facing Point, at approximately 150 mm from the toe of the switch shall prevent the Point from being locked and the relevant signal(s) being taken 'OFF' for movements over them.
  - 7.4.3 **Crank Handles for Point Operation:** where power operation of Point Machine is not functional, provision for manual cranking shall be done through interlocked crank handles.
  - 7.4.4 Where required, provision may be made for emergency operation of points during track circuit failures. Each such individual operation shall be recorded on a suitable non-resettable Counter.
  - 7.4.5 **Point Indicators** (For Non-Interlocked points)
    - (a) They shall be provided at all Points on running lines which are not interlocked with Signals, unless the position of Points is otherwise proved. Point Indicators shall be of the target type.
    - (b) Indications:
      - (i) When the points are set for the straight line, the indicator shall display a white target by day and a white light by night, in each direction.
      - (ii) When the points are set for the diverging line, the indicator shall display the edge of the disc by day and a green light by night, in each direction.
      - (iii) At Points where a green light would give a misleading indication to a Loco pilot, a red light may be permitted under special instructions.
- Refer to [Drg No: 12-D1](#)



#### 7.4.6 Trap Indicators (For Non-Interlocked Trap points)

(a) **Trap Indicators** shall be provided at all Trap Points on running lines which are not interlocked with signals, unless the position of trap points is otherwise proved. Trap indicators shall be of the target type.

*Note: Points leading to a short dead end and used solely for the purpose of trapping the running line or sidings shall be treated as derailing switch.*

##### (b) **Indications -**

- (i) When the Trap Points or derailing switches are open, the Indicator shall display a red target by day and a red light by night in each direction
- (ii) When the trap Points or derailing switches are closed, the indicator shall display the edge of the disc by day and a green light by night, in each direction. At trap points where a green light would give a misleading indication to a Loco pilot, a white light may be permitted to indicate trap 'CLOSED' position only.

*Note: Points and trap Indicators shall be provided with miniature lights and be placed as close to the ground as possible.*

#### 7.4.7 Shunting Permitted Indicator (SPI)

(a) Shunting Permitted indicator may be provided to permit uninterrupted to and fro movements towards shunting neck or other connected lines. Shunting Permitted Indicator may be of the Disc or Light type.

(b) Indications of SPI: Day and night indications of the Shunting Permitted Indicator shall be as follows

Table-2				
Type	Indication when shunting is permitted in the direction to which it refers		Indication when shunting is not permitted in the direction to which it refers	
	Day Indication	Night Indication	Day Indication	Night Indication
Disc Type	Black disc with a yellow cross painted on it	Yellow cross light	Edge of disc	No light
Light Type	Yellow cross light	Yellow cross light	No light	No light

(c) **Operation of SPI:** Shunting permitted Indicator may be operated by a ground lever/EKT which works in conjunction with a Stop Signal, so that either the shunting permitted indicator or the associated stop signal can be taken off at a time.

(d) Sidings shall be so arranged that shunting operations upon them involve the least possible use of, or obstruction, to running lines.

#### 7.4.8 Spring Points

- (a) Spring points shall be used only in exceptional cases where the same purpose cannot be achieved conveniently by other means.
- (b) Spring Points if used in the facing direction must be fitted with facing point locks. They may be operated from a Cabin or from a ground lever. In the latter case, the ground lever shall be of such a type that it will not move when the Points are being trailed through.

#### 7.4.9 Provision of Isolation

- (a) At block stations where trains are permitted to run at speed in excess of 50 kmph, the line on which that speed is permitted, shall be isolated from all connected lines during the passage of the train.
- (b) Such isolation need not be provided at Block stations where trains are permitted to run at a speed of 50 kmph or below, provided GR. 4.11(2) is complied with.

**Note:- The provisions of *Para no. 7.4.9 (a)* do not apply to**

*(i) Junctions where two block section lines meet at the same end of a station and system of Block Working with adjacent stations on both lines is done by one of the approved means and the junction is equipped with full complement of signals.*

- *At such junctions, the First Stop Signal on Single Line sections shall be placed at an adequate distance from the outermost facing point/fouling mark, the adequate distance not being less than the sum total of the adequate distances prescribed in GR. 8.01 in regard to condition for granting Line Clear and GR. 3.40 in regard to the condition for taking off the Home Signal.*
- *On Double Line section, the First Stop Signal shall be placed at an adequate distance from the outermost facing point/fouling mark, this distance not being less than the adequate distance prescribed in GR. 8.01 in regard to the conditions for granting Line Clear.*

*(ii) Block stations where track circuits or other appliances have been provided to prove whether the connected non-isolated lines are clear or occupied and the signalling is such that a distinctive aspect is given to the Loco Pilot of a run through train, restricting the speed to 50 kilometres per hour when a connected line is occupied.*

*(iii) Catch and Slip Sidings and Sidings provided for isolation purposes only.*

#### 7.4.10 Means of Isolation

- (a) Sand humps, trap points, or other approved means of isolation shall be provided on all goods lines and sidings at their junctions with passenger lines, the normal setting being such as to prevent the passenger lines from being fouled.
- (b) At interlocked layouts, the means of isolation shall be interlocked with the relevant signals.

(c) **Derailing Switches on main or through line:** In order to maintain safety for through running, Points for \*trap sidings/derailing switch shall not be inserted in the main or through line. However in exceptional circumstances, they may be allowed under approved special instructions, only in those cases where;

(i) Owing to grades in or near stations, it is necessary to prevent -

- Trains being brought to a stand at a Stop Signal on a rising grade, or
- Vehicles running away from the station.

(ii) It is operationally required to receive trains from different directions at the same time.

(d) At stations where Points for trap sidings/ derailing switch are inserted on Main lines or through line for reasons given at (c) above, through running shall be permitted only under approved special instructions.

*\*Note: Points leading to a short dead end and used solely for the purpose of trapping the running line or sidings shall also be treated as derailing switch.*

7.4.11 Please refer to [Annexure: 7-A1](#) on Extract from “Rules for Opening of Railway Lines” for Isolation for more details.

#### 7.4.12 **Siding Points on Passenger running lines outside station limits**

**(a) Facing Points:** Where Siding Points take off a running line in a facing direction, the following minimum equipment shall be provided:-

- (i) A gauge tie plate and a facing point lock which shall lock each switch independently.
- (ii) The control of the points shall be made by means of a key or other suitable device which shall secure the bolting mechanism of the Points in the plunged or locked positions, i.e., when the Points are set and locked for the running line. The means for control of the Points shall be interlocked with the block system in force.
- (iii) Where Siding Points are provided only with the minimum equipment specified in [Para no. 7.4.12 \(a\)](#), an appropriate speed limit over the facing points shall be imposed for all trains passing over such Points in the facing direction only and an 'S' marker at the Points and a speed indicator at not less than 30 metres from the Points shall be provided, neither of which, need be lighted. In addition a caution and termination indicator shall also be provided as for open line speed restrictions. Where the sanctioned speed of the section does not exceed 50 kmph, the 'Marker' at the points and the Indicators need not be provided.
- (iv) The siding points on passenger lines outside the station limit shall be detected for permitting speeds of up to 50 kmph in facing direction. In case the detection is not provided, speed restriction of 15 kmph shall be imposed.

**(b) Trailing Points (Double Line):** Where Points take off a running line in a trailing direction the following minimum equipment shall be provided for unrestricted speed:

- (i) A gauge tie plate.
- (ii) A suitable type of key lock or equivalent mechanism, the key of which can only be extracted when the Points are set and locked for the running line. The points shall be controlled through the block system in force.
- (iii) A 'S' Marker at the Points, which need not be lighted.

*Note: Some provisions in this section are applicable for Mechanical/Electro mechanical Signalling (where existing).*

## **Section 5: Interlocking of Catch Siding and Slip Sidings**

**7.5.1** At stations where \*Catch and Slip Sidings are provided in accordance with the Rules for opening of a Railway, interlocking arrangements and other safeguards shall be provided as given in this section.

*\* Note: Catch Siding is provided to protect the Station Section, if the gradient is steeper than 1 in 80 falling towards the station section. Slip Siding is provided to protect Block Section, if the gradient is steeper than 1 in 100 falling towards the Block Section*

### **7.5.2 Reception of Trains**

- (a) Either a minimum of two Stop Signals shall be provided in rear of the Catch Siding points or the First Stop Signal shall be at an adequate distance equal to Block overlap from the catch siding points.
- (b) A train shall first be brought to a stop at the First Stop Signal, before the Catch Siding points are set for the main line and the reception signals shall not be taken 'OFF' unless the following conditions are satisfied:
  - (i) The line on which the train is to be received is clear and the train is to be received on the main line.
  - (ii) The points leading to the Catch Siding as well as all the Points required for a run through train are set for the main line immediately after granting Line Clear to the Block station in rear.
  - (iii) Line clear has been obtained from the Block section in advance.
  - (iv) The gradients in the block section ahead are such that the train can be brought under control easily.

**7.5.3 Setting of Catch Siding/Slip Siding:** The take off points of a Catch/Slip siding shall normally be set and locked for the siding and interlocking between the points and block instruments shall be provided as in [Para 7.5.4](#) and other safeguards as in [paras 7.5.5 to 7.5.7](#).

#### 7.5.4 **Interlocking of Catch/Slip Siding points with Block Instruments**

The interlocking shall be such that the key required to set the siding points is released from the instruments in the "Train Going to" / "Train Coming from" position and once the key is removed from the block instruments, the instrument gets locked in the relevant position. The instrument can be normalised only after the points are set for the Slip Siding / Catch siding and the "Train Going To" / "Train Coming from" key is released from the Points and brought back to release the instrument.

Where a Slip Siding is located at the departure end of a Double Line Station, the interlocking shall be such that the Points can be set towards the Block section only when the block instrument is set to "Line Clear".

*Note: Please refer to SEM [Chapter 18](#) for Block working.*

7.5.5 **Audible Indication:** An audible indication shall be provided at the place of operation of Points as an aid to the Operating staff, indicating that the train has been received or despatched and that the points shall now be normalised for the Catch Siding/Slip Siding. This indication would continue till the points are normalised for the Catch Siding/Slip Siding.

7.5.6 **Safeguards in working:** In all cases where interlocking arrangements stipulated in [Para 7.5.4](#) are provided between the Slip/Catch Siding and the block instrument, the following safeguards shall also, *inter alia* be provided in the Station working Rules:

- (a) Shunting on non-isolated lines shall cease once Line Clear has been granted.
- (b) Points shall remain set and locked for the Catch Siding until Home Signal has been taken 'OFF'.
- (c) Before normalising the block instrument the Station Master /Assistant Station Master, shall verify the complete arrival or despatch of the train, even though he is getting an audible warning, which may be due to reception or despatch of a complete train or part thereof.

7.5.7 An Emergency Key of the Catch/Slip Siding shall be kept in a sealed box under the custody of the Station Master. This is used for operating the Slip Siding/Catch Siding points when either the block instruments have failed, or when the train is still in the Block section and another train is required to be despatched into the Block section.

## **Section 6: Interlocking of Signals with Points and other Equipments**

**7.6.1 Essentials of Interlocking:** Equipments provided for the operation and control of signals, points, etc., shall be so interlocked and arranged as to comply with the following essentials;

- (a) It shall not be possible to take 'OFF' a Main stop signal or a Subsidiary signal, unless all points in the route, including overlap and isolation (as applicable), are correctly set and locked and all interlocked level crossing are closed and locked against public road, and relevant tracks are unoccupied by vehicles and clear for the line on which the train will travel.
- (b) After such signal has been taken 'OFF', it shall neither be possible to move any points nor unlock the route, including overlap and isolation, nor to open any interlocked gates until the concerned signal is replaced to 'ON' position.
- (c) It shall not be possible to take 'OFF' any two signals simultaneously, which can lead to conflicting movements.

**7.6.2 Route Holding (Approach Locking & Back Locking)**

- (a) The route (including overlap, isolation as applicable), locked by a signal, shall be released normally on passage of train or by Emergency Route Release with specified Time Delay. For such route holding, it is essential to provide continuous track circuit/Axle Counters from the signal up to the end of the route at all class of stations.
- (b) Overlap shall be released with, either the passage of Train or with specified Time delay on arrival of Train on berthing Track or Emergency Route Release.
- (c) Approach locking and back locking shall be provided for all routes governed by Main Stop signals and Subsidiary signals. Approach and back locking shall be continuously effective from the approach track which shall commence from an adequate distance in rear of the signal. In the absence of approach track circuit, Dead Approach Locking shall be provided with suitable Time Delay.

**7.6.3 Route Locking/Holding at Stations having Lever Operated Points & Signals**

- (a) Points shall be so interlocked where feasible, as to avoid any conflicting movement.
- (b) At a station, where trains run through at speeds more than 50 kilometres per hour, such arrangements to hold the route are also required in case of trailing points situated more than 180 meters from the signal controlling them. However, such arrangements are not required, if the Points are locked in either position by the signal in advance.

- (c) Stop Signals which are next in advance of trailing points operated from the same cabin, when taken off, lock such point in either position unless route locking is provided or the distance between the Points and the signal is such that the locking interferes with traffic movement.

#### **7.6.4 Train Detection - Track Circuiting/Axle Counters**

- (a) Where continuous track circuiting/Axle Counters are provided, the occupation by a vehicle of any track circuited/Axle Counter section shall control the signals leading to the same line and shall also lock the Points on the route.
- (b) At stations where points and signals are operated through Relay Interlocking/Electronic Interlocking, track circuiting/Axle Counters shall be provided, for entire station section for all lines, where direct reception is provided.
- (c) In case of Cabins with mechanically operated signals & points, all passenger lines or where light engine crossing and shunt movements are frequent or where stop Signals are at a considerable distance from the Cabin, or where the view of the Operator is likely to be obstructed, the provision of track circuits or Axle Counters is essential.

#### **7.6.5 Clearance at Junction Point**

- (a) Where it is difficult under normal conditions of visibility for an Operator to estimate clearance, track circuiting/Axle counter shall be provided in order to define the \*fouling points of junctions, loops, siding connections, crossings etc.
- (b) Where the movement of trains over the Points is not visible to the Operator operating the Points - Occupation of the track between Stop Signal reading over the Points up to the fouling mark ahead of such Points shall be electrically indicated at the place of operation.

*Note (i) \*Fouling means the marks at which the infringement of two fixed Standard Dimensions fouling block occurs, where two lines cross or join one another. (GR).*

*It shall be placed at a location, where centre to centre distance is less than 4265 mm for existing works and 5300 mm for new works/Alteration to existing works. (Reference: SOD for BG Track – Chapter-II-item-1).*

*(ii) Whenever the term Track circuit is used, it shall automatically cover the use of axle counter or any other approved means of train detection.*

#### **7.6.6 Slot controls on signals**

- (a) Where a signal is controlled through slots, it shall not be possible to take 'off' a signal unless all the controls have been exercised by the controlling agencies. But it shall be possible for any one of the controlling agencies to replace the signal to 'ON' position by withdrawal of the control.
- (b) Slot circuits shall be so designed, that a slot once given is effective for only one train and a fresh slot has to be given for a subsequent train.

(c) Station Master's Slot Control on Reception & Dispatch signals.

- (i) The Station Master shall be provided slot control, over the Home, Last Stop Signals, and on Calling-on Signals (where provided);
- (ii) The Station Master's control over Home Signals can be dispensed with only if all the following conditions are satisfied;
  - All reception lines are fully track-circuited from Home Signal to corresponding Last Stop Signal in double line and Home Signal to Home Signal in Single line; or all reception lines are track-circuited from the fouling mark to fouling mark and the non-track circuited portion of the line from the fouling mark to the Home Signal is within the range of visibility of the Cabin, from where signals & points are operated.
  - Station Master does not allot the line; and
  - Assistant Station Master working in the Cabin operates the Points, Block instruments and receptions/despatch signals.

**7.6.7 Interlocking of Last Stop Signal and First Stop Signal with Block Working:**  
Where Absolute block working is in use;

- (a) The Last Stop Signal shall not be capable of being taken 'OFF' until Line Clear has been obtained from the block station in advance;
- (b) It shall not be possible to close the line and grant or receive 'Line Clear' unless the 'ON' aspect of the relevant First Stop Signal is proved.

**7.6.8 Replacement of Stop Signals on passage of Train**

- (a) A stop signal in the 'OFF' position shall be replaced to 'ON' position automatically by the passage of a train.
  - (i) Advanced Starter Signal shall be automatically replaced to 'ON' position by the entry of a train into the block section.
  - (ii) Home Signal shall be automatically replaced to 'ON' position by the passage of a train in advance of the Home Signal.
  - (iii) Starter Signal shall be automatically \*replaced to 'ON' by the passage of train.

*(\* with delay if replacement glued Joint/Insulation joint is close to signal , please refer to [Para no 21.1.21 \(Table-1\)](#))*

- (b) It shall also be possible to replace a manually controlled signal in the 'OFF' position to the 'ON' position manually.

**7.6.9 Signal Passing at Danger (SPAD) mitigation**

To mitigate the adverse effects of a Train Passing Signal at Danger, appropriate devices, circuits, methods may be provided as necessary such as;

- (a) Station staff shall set the relevant facing points to unoccupied line, soon after the arrival of a previous Train, through a provision in Station Working Rules (SWR).



- (b) Train Protection Devices (Refer to [Chapter 13 of SEM](#)).
- (c) Any other approved type of method/Equipment.

**7.6.10 Fail safe Features:** Signal and interlocking circuits (including hardware and software as applicable), shall be so designed and equipment so installed and maintained with its connections, that the relevant signal shall remain at or return to its most restrictive aspect and Points shall remain locked in their last operated positions in the event of failure of any part of its connections and circuits.

## **Section 7: Operation of Signals & Points - Control Panel**

**7.7.1** The Interlocking installations are of two types, Route Setting Type i.e. on the basis of Entry/Exit principle, Non-route Setting Type i.e. Route is set with individual operation of points.

(a) The points and Signals shall be operated from a:-

(i) Control panel for Relay Interlocking.

or

(ii) Control panel and/or Control Terminal (Video Display Unit (VDU)) for Electronic Interlocking.

*Note: Dual VDU shall be provided in lieu of Control Panel and VDU in all future Installations. However, in those existing Installations having one VDU and one Control the same may continue.*

(b) Based on size, complexity of the yard or operational reasons more than one Control panel/Control terminal may be provided for operation of the points and signals. In such cases, necessary inter-slotting controls shall be provided.

### **7.7.2 Control Cum Indication Panel (CCIP)/Control Panel:**

(a) The display of the layout on the front of the Control Panel shall be well proportioned, and each track circuit shall be clearly distinguished by different colours.

(b) A Control cum operations panel with Indications (CCIP or control panel) for route switches/buttons, point switches etc., shall be provided in Geographical order. However a separate Indications panel and a separate operating panel may also be provided for large installations for convenience.

(c) The Route setting shall be on "Entry/Exit" principle for installations of Route Setting type. Each route shall be controlled by means of two push buttons-one at the entrance and the other at the exit of the route. In Non-route setting type installations, after setting of the route by individual operation of points is completed, signal can be cleared by an individual push button in conjunction with a group button or by an individual switch controlling each signal or a common switch for conflicting signals which are not required at the same time, or one push button at the entrance and other at the exit end.

(d) SM's Key control arrangement shall be provided on Control panel/VDU, to prevent any unauthorised operation.

- (e) Provision for emergency route release shall be provided on control panel/VDU. This emergency operation shall be recorded through a Non resettable Counter incrementing for every such operation.
- (f) All Emergency operations shall be two-step process, to safe guard against unintended operations.
- (g) Locking and sealing arrangements shall be provided for the covers of Control Panels/Block Instruments etc., to secure against unauthorised opening. Relay Rooms at stations shall be provided with double lock arrangements.

Further details are given in [Para 21.1.2](#)

7.7.3 Arrangement for switches/buttons for operation of points & signal in Control Panel is given at [Para 21.1.3](#).

7.7.4 **Control Panel Indications:** The control panel shall be provided with; Point Indications, Route Indications, Signal Indications, Track Circuit Indications, Power Supply Indications and other Indications as required. Refer to [Para 21.1.4](#) for details.

7.7.5 **Control Terminal – (Video Display Unit (VDU)):**

- (a) Control Terminal/multiple Control Terminals shall be of appropriate size to display layout of the Yard in well-proportioned dimensions and shall display all functions clearly distinguishable. Control Terminal/multiple Control Terminals shall be provided in redundant mode.
- (b) Operation of Signals, Points and other Controls such as Gate, Crank handle, Siding, Slot etc., shall be carried out through appropriate dropdown menus or other approved means.
- (c) When embedded block working in Electronic Interlocking is used, all indications like TGT, TCF, LC etc required for block working shall also be displayed.
- (d) Same indications as given in Para 7.7.4 above for Control panel , shall be provided for Control Terminal also.

Further details on Control Terminal (Video Display Unit (VDU)) are given at [Para 21.1.15](#).

## **Section 8 : An overview – Design, Installations, Testing, Commissioning & Maintenance of Signalling Equipment**

7.8.1 **Design & Installations:**

- (a) The signalling and interlocking arrangements for the yard shall be in accordance with the approved signalling plans, Control Table, detailed wiring diagram including Control Panel diagram, Relay contact analysis and relay rack arrangements.
- (b) Criteria for Design of Signalling circuit is given in [Chapter 21, Section 1](#).

**7.8.2 Outdoor signalling equipment to be Installed, Tested & Maintained as given below**

- (a) LC Gates as per [Chapter 14](#) of SEM.
- (b) All signalling cables shall be laid, Tested [as per Chapter 15 of SEM](#)
- (c) Train Detection: Track circuits, AFTC, Axle Counters as per [Chapter 17 of SEM](#).
- (d) Signals, IRS Point Machines, Thick web switches as per [Chapter 19 of SEM](#).

**7.8.3 Power Supply & suitability for RE area for equipment and circuitry shall be as given below:**

- (a) Power Supply Arrangements: Power supply systems for Signalling Installations shall be as per [Chapter 16 of SEM](#).
- (b) All signalling equipment and circuitry shall comply with stipulations given in [Chapter 22 of SEM](#) on "Requirements of signalling in 25 KV AC electrified areas".

**7.8.4 Block Instruments, Lightning and surge protection & Earthing, General Arrangements as given below:**

- (a) Block Instruments (where separately required) shall be Installed, Tested, Commissioned & Maintained as per [Chapter 18](#).
- (b) Lightning and surge protection shall be provided to protect Electrical & electronic signalling equipments from lightning & surges as per [Chapter 21, Section 7](#).
- (c) Earthing for Outdoor signalling equipment as per [Chapter 19, Section 11](#).
- (d) General Arrangements in Relay Room: Air conditioning, 'Automatic Fire Detection and Alarm System', Automatic Fire Suppression System' etc shall be as per [Para 21.3.4](#).

**7.8.5 Commissioning of Relay Interlocking**

On completion of Outdoor signalling works as per [Chapter 19](#) and Relay Interlocking works as per [Chapter 21](#), System Integrity Tests (SIT) shall be done as per [Para 19.8.8](#) before commissioning. Recommended Pre-commissioning check list is given at [Annexure:21-A2](#).

**7.8.6 Commissioning of Electronic Interlocking**

On completion of Outdoor signalling works as per [Chapter 19](#) and Electronic Interlocking works as per [Chapter 21](#), System Integrity Tests (SIT) shall be done as per [Para 19.8.8](#) before commissioning.

**7.8.7 Drawings for Guidance on Installation are given at [Appendix II](#). These may be adopted wherever feasible, with required improvements / modifications / customisations as per site specific needs/equipment sizes.**

- 7.8.8 Maintenance Schedules are given at [Appendix I](#) for various signalling equipments. These may be supplemented duly keeping in mind industry's best practices, Safety, Reliability, Availability and sectional needs.
- 7.8.9 Important Minimum Signalling Features which shall be provided at various stations based on standard of interlocking are given in Table -3.



*Note: This Chapter has under mentioned Annexures*

<b>S.No</b>	<b>Annexure</b>	<b>Description</b>
1	<a href="#">7-A1</a>	Extract from "Rules for Opening of Railway Lines" for Isolation (Rule 36)

**Para No: 7.8.9 of IRSEM (Version 3.0) : Table 3: Important Minimum Signalling Features**

S.No	DETAILS	STD I	STD II	STD III	STD IV
1	Maximum permissible speed	Up to 50 Kmph	Up to 110 Kmph	Up to 140 Kmph	Up to 160 Kmph
2	Isolation	See Notes below	Required	Required	Required
3	Point Operation , Locking & Detection	Point Machine	Point Machine	Point Machine	Point Machine & Direct Clamp type with Thick web switches
4	Train Detection (Track circuit /Axle Counters)	On all Run through Lines	On all Running Lines	On all Running Lines	On all Running Lines
5	MACLS Signalling, Movement authority	MACLS	MACLS	MACLS	MACLS, Movement Authority
6	Block Working (Absolute/Automatic Signaling)	Permitted (Including Token Working)	Permitted (Excluding Token)	Permitted (Excluding Token) Or 4A Automatic Signalling	Permitted (Excluding Token) Or 4A Automatic Signalling
7	Double Distant/ Automatic Signalling	Not Compulsory	Required (On sections where Trains have a Emergency Braking Distance of more than 1 Km)	Required Or 4A Automatic Signalling	Required Or 4A Automatic Signalling
8	Last Vehicle verification	Not Compulsory	Required at stations with centralized operation or in high density routes	Required	Required
9	Relay/Electronic Interlocking (RI/EI)	RI/EI	RI/EI	RI/EI	RI/EI
10	Mobile Train radio communication (MTRC) or LTE or any other Technology	Not Compulsory	Desirable	Desirable	Required
11	ATP (ETCS/TCAS/TPWS) with Cab Signalling for SPAD mitigation	Not Compulsory	Desirable	Desirable	Required
12	Centralised Traffic Control (CTC)	Not Compulsory	Desirable	Desirable	Desirable

(Contd..)

S.No	Notes for Table 3
1	<p><b>Isolation:</b> Isolation is not compulsory. Extract from “Rules for Opening of Railway Lines – Rule 36” is given below</p> <p>(2) At no station at which isolation has not been provided through running trains shall be permitted unless the conditions laid down in the second paragraph of the rule 4.11 of the General Rules are complied with.</p> <p><i>Extract of GR 4.11. Limits of speed while running through stations.-</i></p> <p>(1) No train shall run through an interlocked station at a speed exceeding 50 kilometers an hour or such less speed as may be prescribed by approved special instructions unless the line on which the train is to run has been isolated from all other lines by the setting of points or other approved means and interlocking is such as to maintain this condition during the passage of the train.</p> <p>(2) In every case in which trains are permitted to run through on a non isolated line , all shunting shall be stopped and no vehicle unattached to an engine or not properly secured in accordance with General Rule 5.23 may be kept standing on a connected line which is not isolated from the through line.</p> <p>(5) All Passengers running Lines shall be isolated from all Goods lines or Sidings connected thereto.</p> <p>(6) All goods running Lines may be isolated from all sidings connected there to.</p> <p>(7) It is not necessary to isolate one goods receiving line from another.</p> <p>Refer to <a href="#">Annexure: 7-A1</a> for full extract of “Rules for Opening of Railway Lines – Rule 36” along with Diagrams on methods of providing isolation.</p>
2	<p><b>General</b></p> <p>(i) The provisions of the above Table shall apply to future Signalling and Interlocking Installations. Wherever existing installations do not fulfill these requirements, existing speed of operation may be permitted to continue.</p> <p>(ii) In case Block working is achieved directly through Electronic Interlocking, provision of separate block instrument is not required.</p> <p>(iii) This Table does not cover Semaphore Signalling (LQ,MAUQ, MLQ), 2 Aspect Colour Light Signalling, Mechanical Signalling/FPL, Key Locking/Rudimentary Interlocking etc, where existing equipment &amp; mode of operations may continue till their replacement.</p> <p>(iv) Those existing Installations/Plans showing STD I (R), STD II (R), STD III (R), STD IV (R) (as per Previous SEM Part 1, 1988 edition) may continue to show them till their replacement.</p> <p>(v) Wherever Thick web Switches are provided, Direct Clamp Type Point Machines shall be provided.</p> <p>(vi) ‘Attention’ aspect on Home signal shall be provided for run through with speed more than 30 kmph on Loop Lines.</p> <p>(vii) In automatic territory where emergency braking distance is more than 1.0 km is to be catered for, 4 aspect automatic signalling shall be provided. If not provided, suitable speed restriction shall be imposed.</p>

**Extract from “Rules for the Opening of a Railway Lines” for Isolation (Rule 36)****35. Junctions: .....****36. Provisions for isolations at stations:**

- (1) The speed of trains running through stations shall be governed by the General Rules for all open lines administered by the railway administrations, both Government and the non-Government railways and shall be subject also to the restrictions relating to standards of interlocking prescribed in the Signal Engineering Manual.
- (2) At no station at which isolation has not been provided through running trains shall be permitted unless the conditions laid down in the second paragraph of rule 4.11 of the General Rules are complied with.
- (3) At any station where there is a speed restriction for through running trains different from neighbouring stations, a speed restriction board should be erected at the first approach signal or where no signals are provide, at full braking distance outside the first facing point.
- (4) In order to maintain safety for through running, points for trap sidings must not be inserted in the main line or through line, except under approved Special Instructions in accordance with the Signal Engineering Manual, Part I.
- (5) All passenger running lines shall be isolated from all goods lines or siding connected thereto.
- (6) All goods running lines may be isolated from all sidings connected thereto.
- (7) It is not necessary to isolate one goods receiving line from another.
- (8) Isolation may be accomplished by –
  - (a) Connection to another line or long siding;
  - (b) The provision of short dead end siding; or
  - (c) The provision of trap.

*Note:* (i) Whichever may be the method for isolation, a starter signal shall be provided, except when omitted under approved special instructions.

- (ii) When a trap is provided, the trap switch should be located with the heel of the switch in rear of the fouling mark and preferably on the straight. The switch should be in the rail away from the line to be protected.

- (9) The various methods of isolation are illustrated in the diagrams given in Appendix A attached to these rules and the following instructions shall apply to their use in the case of running lines, namely :-

**Method A:** This method shall apply to cases in which the line on which the train will run when the points are set for isolation of the through line, is kept clear for the adequate distance prescribed in Rule 3.40 of the Indian Railways (Open Lines) General Rules, 1976.

**Method B:** When a short dead end siding is provided, it shall not ordinarily be long enough to permit of vehicles being stabled thereon. To obtain the adequate distance prescribed under rule 3.40 of the General Rules the points of the dead end siding shall be set for the across over and against the siding, before a train is admitted on a line trapped by this method. Where it is necessary for the short dead end siding to be extended for the purpose of stabling vehicles, the above rule shall apply, unless a trap is provided on the dead end siding at a distance of not less than 180 meters (120 meters in case of stations provided with multi aspect signalling) from the starter signal where provided or from points leading to the main or through line. A train must be admitted on the running line unless the trap is set and locked against vehicles occupying the further part of the dead end siding.

**Method C:** When a trap is used, a train must not be admitted on to the trapped line unless the trap has been closed, so that the train will not be derailed if the driver over shoots the trap.

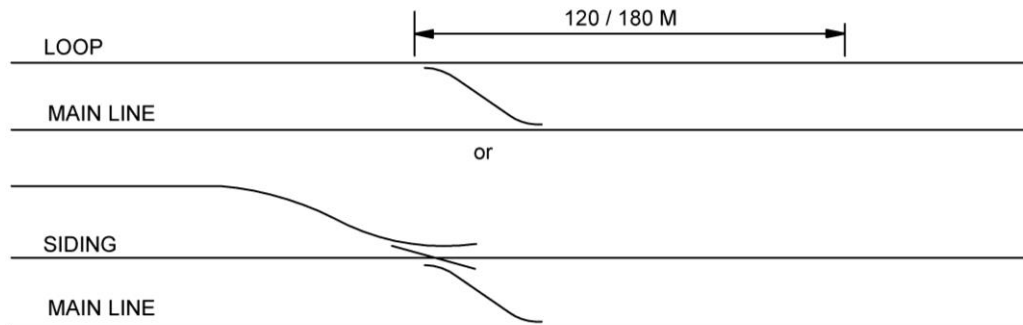
(10) When Method A cannot be used, and for any reason it is not convenient to use Method B or Method C and to provide adequate distance by setting the points of the short dead end siding or trap for the cross over and against the siding or trap, a sand hump of approved design should be used as a substitute for adequate distance as provided in rule 3.40(4) of the Indian Railways (Open Lines) General Rules, 1976. In that case the length of the siding should be at least one rail length and formation should be made up for a short distance beyond the hump.



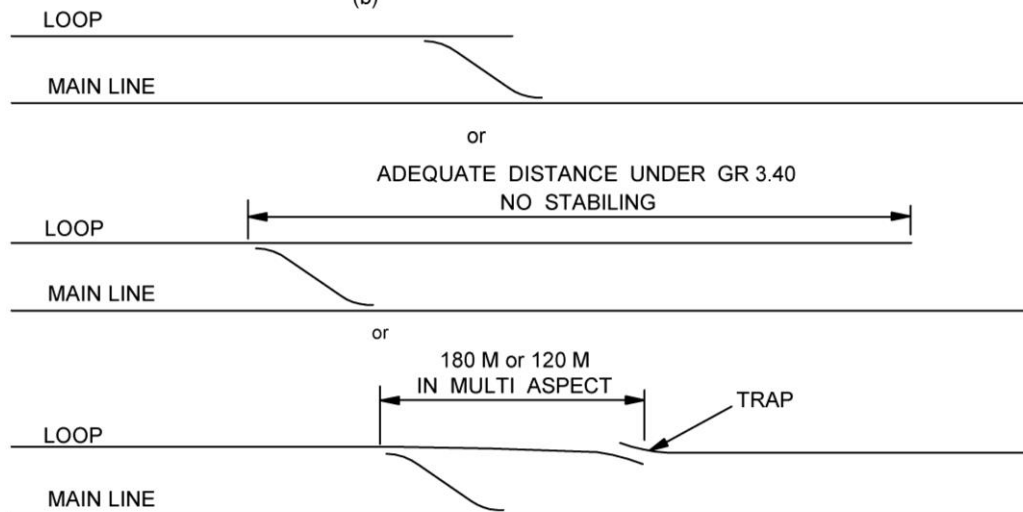
# RULES FOR THE OPENING OF A RAILWAY LINES FOR ISOLATION

## APPENDIX A [See rule 36(9)] DIAGRAM ILLUSTRATING METHODS OF PROVIDING ISOLATION

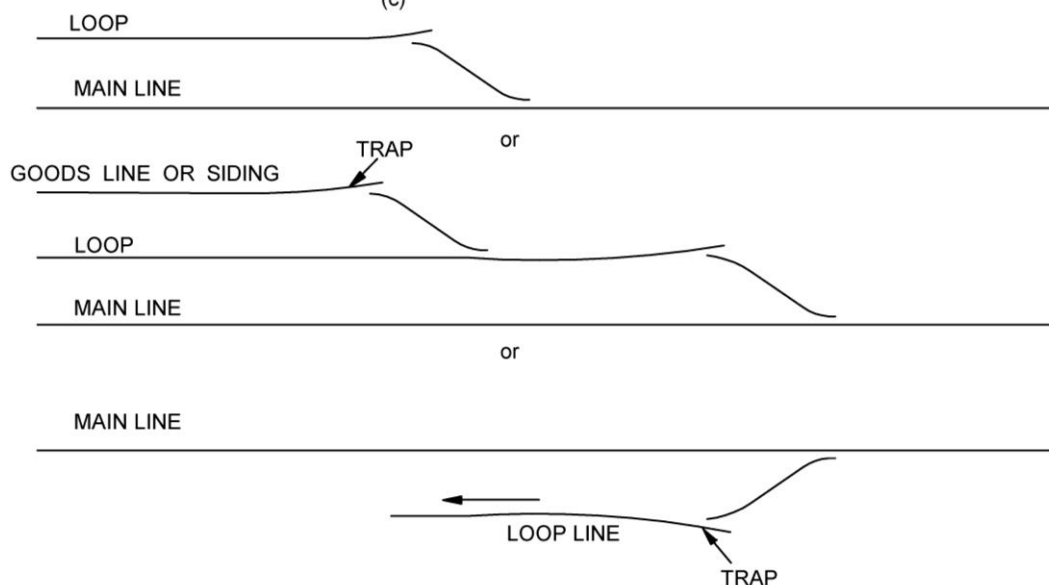
### (a) ADEQUATE DISTANCE OF



### (b)



### (c)



## Chapter 8: Drawings & Specifications

### Section 1: Plans for New and Working Installations

#### 8.1.1 Preparation - General Procedure

- (a) All 'Signalling & Interlocking Plans' (SIP) shall be prepared for Station, Automatic Block Section and LC Gate as required in accordance with the instructions issued by the Principal Chief Signal and Telecommunication Engineer.
- (b) The names of the junction or terminal stations should be noted on plans on both sides, that on the left-hand side being the one from which the kilometer progressively increases along with direction of traffic which shall be based on engineering scaled plan (ESP). On receipt of ESP, the same shall be checked for relevant details as per [Annexure: 8-A2](#). The names of the adjacent block stations and midsection sidings/interlocked level crossing gates/IBSs connected with concerned stations should also be indicated on the plans as also their respective distances from the centre line of the station for which the plan is prepared. Communication to mid-section Manned LC gates shall be shown on the plan of the station to which such communication is established.
- (c) Standard drawings shall not be deviated and Typical drawings shall not be issued without the specific approval of the Principal Chief Signal and Telecommunication Engineer.
- (d) The Signal and Telecommunication Engineer incharge should ensure that drawings submitted with an estimate for a work are complete and include all information necessary.
  - (i) For the proper understanding of the scheme, relevant notes are being written on the drawings.
  - (ii) For proper check of the design and estimate.
- (e) When a part of the work has to be done to a standard plan or to an existing drawing, the fact should be stated. Such drawings need not be reproduced. If a part of the information necessary has to be supplied by another department, the officer incharge should obtain and incorporate the details on the drawing.
- (f) North direction should be shown on every signalling interlocking plan.
- (g) All drawings should be quoted by number in their proper place in the estimate and in the covering letter accompanying the estimate.

- (h) Tentative signalling & interlocking plans (SIP) prepared for estimating purposes should bear the legend: "Tentative - For estimating purposes only". Tentative signalling interlocking plans issued for tender purposes should bear the legend: "Tentative - For Tender purposes only". Draft signalling interlocking plan sent to Divisions for comments should bear the legend: "Draft Signalling interlocking Plan For comments". All tentative/draft plans should be signed by at least a Senior Scale Officer.
- (i) Those signalling plans, which have been superseded, shall be stamped accordingly & visibly as "Superseded by ....." with Date and details. Old signalling plans shall also be Crossed across to avoid it's mistaken adoption.
- (j) History of each station's Signalling plans shall be recorded in chronological order along with CRS/PCSTE sanctions, Date of commissioning, Date of Plan updating, details etc. with remarks for any review required.

### **8.1.2 Plans for Other Departments**

- (a) Divisional/Sr. Divisional Signal & Telecom Engineer/Dy. Chief Signal & Telecom Engineer may at his discretion prepare sketches for officers of other Departments or for Deposit Works. No detailed plans for Deposit Works should be prepared except on receipt of orders from the Principal Chief Signal and Telecommunication Engineer.
- (b) Sr. Divisional Signal & Telecom Engineer/Dy. Chief Signal & Telecom Engineer shall obtain complete details from officers of other Departments when preparing plans that affect those departments and embody their requirements on the plans, if considered necessary. He should arrange for the plans, to be signed by the representative of the department concerned in token of approval.

### **8.1.3 General Practice and Sizes of Drawings**

- (a) The code of Practice for General Engineering drawings and the standard sizes of drawings - IS. 696 shall be followed as far as practicable.
- (b) In preparing plans or making ferro prints, wastage of drawing paper, tracing cloth and ferro paper should be avoided. Multiple ferro copying should be avoided by use of scanning from tracing. All field units should be issued soft copies only in PDF or TIF or JPG from scanned drawings. Field units to take colour prints from scanned soft copies for application to CRS's/ PCSTE's sanction.
- (c) The following considerations decide the size of a drawing
  - (i) Folding, approximately to foolscap size to accompany correspondence and reports.
  - (ii) The commercial size of drawings, tracing and paper rolls.

(d) The plan sizes given below in Table-1 shall be adopted.

**Table-1**

Type of Drawing	Size	Measurement including Border	Border
Sketches	A-4	210 mm x 297 mm	10 mm
	A-3	297 mm x 420 mm	
Locking Table	A-3	297 mm x 420 mm	10 mm
Control Table	A-3	297 mm x 420 mm	10 mm
Circuit Diagram	A-3	297 mm x 420 mm	10 mm
Power Supply Diagram	A-3	297 mm x 420 mm	10 mm
Track Bonding Plan	A-4	210 mm x Any length	10 mm
	A-3	297 mm x Any Length	
Cable Termination Diagram	A-3	297 mm x 420 mm	10 mm
Control Cum Indication Panel (CCIP)	A-3	297 mm x Any Length	10 mm
Signalling Interlocking Plan	A-3	297 mm x Any Length	10 mm
Locking Diagram	A-3	297 mm x Any Length	10 mm
Cable Core Chart	A-3	297 mm x Any Length	10 mm
Cable Route Plan	A-3	297 mm x Any Length	10 mm
VDU Diagram	A-3	297 mm x 420 mm for Standard Yard	10 mm
	A-2	420 mm x 594 mm for Bigger Yard	
Floor Plans for TSAA, Earthing Plan	A-3	297 mm x 420 mm	10 mm
<i>Note: 30 mm margin to be provided on left hand side for binding purpose.</i>			

(e) Drawings for a large project should be bound together, each such drawing should be marked as sheet 1, 2 and so on as also the total number of sheets (e.g., 1/3, 2/3, 3/3) and bear in the proper place, the separate numbers by which each is identified. These numbers should be entered in the Office Register of Drawings and should also be marked on the outside bindings.

#### 8.1.4 Titles and Numbering of Drawings

- (a) The title and number may be placed at the bottom right hand corner of the plan, sufficient space being left for "Notes" to be entered as necessary.
- (b) Drawings pertaining to any station, viz., Signalling Interlocking plans, Locking Tables/Control Tables/Route Control Charts, Locking diagrams, wiring diagrams etc. shall bear the same number SIP.SCR.GTL.VPL.Ø1.
- (c) Document or Drawing type to have standard abbreviations such as SIP/RSP/PD/ST/LT/RCC/WD etc. and for Electronic Interlocking Configuration Diagram (EIC), Relay Disposition Chart (RDC), Inter-Rack Cable Schematic (IRC), Earthing Arrangements (EAR), Equipment Rack Layout (ERL), Signal Equipment Room Layout (SER), Station Master Room Layout (ASM), Power Supply Room Layout (PSR), Interlocking Logic Circuit Diagrams(ILC), Interface Circuits (IFC), Visual Display Units (VDU) etc. All plans/drawings shall be version controlled & updated in the following manner:
  - (i) Any controlled drawing or document needs to be identified uniquely and unambiguously.
  - (ii) Drawing number shall indicate document type, zone, division, station and its version number.
  - (iii) Unique codes are to be assigned for zone, division and station and document type.
  - (iv) Version number is of two digit number XX which can cater for 99 versions.
  - (v) Electronic record copies shall have the file names same as drawing number.
  - (vi) Structure of the drawing number: Doc Type. Zone Code. Div Code. Station Code. Version. For example, SIP of Venkatampalli (VPL) Station, Guntakal (GTL) division of South Central Railway (SCR) may have a drawing number -SIP.SCR.GTL.VPL.Ø1.
  - (vii) When drawings are having multiple sheets such as Interlocking Logic Circuits, Interface Circuits etc., shall have an index sheet.
  - (viii) Structure of the drawing number where multiple drawing sheets are involved - Index Sheet - Doc Type. Zone Code. Div Code. Station Code. Version Sheet - Sheet#nnn. Version For example, Internal Circuit diagrams of Venkatampalli (VPL) Station may have a drawing number ILC. SCR.GTL.VPL.Ø1 Sheet#ØØ1. Ø1.
  - (ix) Drawing number for Part drawing or document sometimes, only part of the drawing may be required for illustration or planning purpose. In such cases, drawing may have suffix '.Part'. SIP.SCR.GTL.VPL.Ø1.Part.

**(d) Version Update**

- (i) If changes are made in some of the sheets in signal interlocking circuit drawings, rest of the sheets are not required to be versioned upwards. However, version of modified sheets and all index sheets will be versioned upwards.
  - (ii) It is not necessary to change version of other document/drawing types when one document type undergoes changes and version update. For example, if changes are made to track bonding diagrams, version will be upgraded only to track bonding diagrams.
  - (iii) A register shall be maintained to keep track of versions for all document types for a signalling installation.
  - (iv) Each Drawing shall bear the current version in the bottom right hand corner.
- (e) If more than one sheet is used for a particular work, each must be distinguished by the sheet number as indicated in [Para 8.1.3\(e\)](#) immediately following the drawing number. The title may be placed below the number. If the drawing cancels the previous one, a note to this effect and the number of the cancelled drawing should be recorded at the right hand top corner of the drawing.
- (f) Every plan/drawing/circuits should bear in small letters at the lower left hand corner, the name and initials with designation of the JE/SSE(D&D) who prepared and officials who checked & approved the plan/drawings/circuits. If plan/drawing/circuits are prepared by contractor, then Contractor's designer name/designation/license number with their initials shall be ensured.
- (g) All signatures in tracings should be in indelible ink. All signature should be dated with date month and year. If feasible, plans/drawings/circuits may be digitally signed.

### 8.1.5 Details on Drawings

- (a) All dimensions and distances shall be written carefully upon that part of the drawing to which they refer. The distance to be embraced by the figures shall be indicated by arrow heads. Figuring and descriptive matter should be so printed that without moving the plan, it can be read with ease.
- (b) The following information should invariably be shown on signalling interlocking plans:
  - (i) Standard of interlocking and Class of station.
  - (ii) Holding capacity of all running lines and sidings.
  - (iii) Direction of reception and despatch on running lines and description of sidings.
  - (iv) Restriction on dead-end sidings (For example: "Not For Stabling") if any.
  - (v) All gradients within the station limits and up to 2.5 kilometres in rear of first stop signal.
  - (vi) Kilometrage and class of level crossings within the station limits, whether interlocked or not.
  - (vii) Type of Block Working with adjacent station and location of block Instruments.
  - (viii) Up and Down directions and names of important junctions on either side.
  - (ix) Reference to condonation of gradient infringements, CRS's dispensation for deviations from General Rules/Signal Engineering Manual, if any.
  - (x) Reference to approved Engineering plan based on which the signalling interlocking plan is prepared.
  - (xi) Note regarding telephone communication provided between ASM/Cabin man and level crossings within and outside station limits.
  - (xii) Aspect sequence chart.
  - (xiii) Whether turnout is 1 in 8-1/2 or 1 in 12 or 1 in 16 or Symmetrical split or Thick web switch etc.
  - (xiv) Details of Detection Table etc. which are not apparent in the plan.
  - (xv) Details of Track Circuits/Axle Counter.
  - (xvi) Signals, Inter-signal distances and distance between Warning Boards and Signals.
  - (xvii) Details of open bridges/RUB/ROB/LHS.

- (xviii) List all Main routes with all overlaps, Calling-On routes & Shunt routes.
- (xix) Custody of spare keys.
- (xx) Date of all previous references of commissioning the installation with their sanction numbers and deviations (if any) and date of commissioning. A sample copy of Signalling Interlocking plan & Control table are at Annexures in appendix II.

#### 8.1.6 Check and Issue of Drawings

- (a) Signalling Interlocking Plans and Locking Tables/Control Tables shall be checked in full at two levels by officer before they are approved and signed by an officer in Junior Administrative grade or above, authorised by the Principal Chief Signal and Telecommunication Engineer.
- (b) Cable plans, power supply distribution diagrams etc. shall be checked in full at two levels by officers before they are approved and signed by Divisional Signal and Telecommunication Engineer/Senior Signal and Telecommunication Engineer.
- (c) All Circuit Diagrams including those submitted by the contractors or Firms (including PSUs) shall be checked in full at two levels by officer before they are approved and signed by Deputy Chief Signal and Telecommunication Engineer. Detailed wiring diagrams for individual stations prepared on the basis of approved typical circuit diagrams should be checked in full by an officer and Divisional Signal and Telecommunication Engineer or Senior Signal and Telecommunication Engineer who may approve and sign them. They are shown below in Table-2.

Table – 2: Levels of Checking & Approvals					
	Type of Drawings	Drawn & Checked by	Level 1 checking	Level 2 checking	Approval
<b>1. HQ level drawings</b>	SIP, TOC, Circuit diagrams	JE/SSE/D&D	ASTE	SSTE/D&D	Dy.CSTE or Above
<b>2. Divisional/ Unit level drawings</b>	Cable core plan, Cable route plan, Power distribution diagram,	JE/SSE/D&D	ASTE	ASTE/DSTE	DSTE/Sr.DSTE/ Dy.CSTE
	Interface drawing for EI. Track Circuit bonding diagram, Location termination particulars, Perimeter earthing for EI.	JE/D&D	ASTE	ASTE/DSTE	DSTE/Sr.DSTE
<i>Note: PCSTE may add more drawings and amend details given above as required</i>					



### **8.1.7 Completion (As Made) Drawings**

- (a) The Signal and Telecommunication Engineer incharge of Construction/Work executing agency should submit site verified signed paper prints to the Principal Chief Signal and Telecommunication Engineer for works completed. These should indicate the work as actually carried out including the dimensional details as actually measured at site, location of signals, details of cables laid, wiring diagram, locking diagram etc. Completion of Signalling interlocking plan shall be based on completion Engineering scale plan if there is any change in ESP. Completion plan/drawings/circuits original tracings shall be signed by ASTE/DSTE of executing unit as confirmation of 1st level check. In case of work done by Railway PSUs then 1st level check should be carried out by PSU's officer equivalent to rank of Executive Engineer and signed by divisional officials before submission to zonal HQ. 2nd level check should be done by railways ASTE/DSTE and approved & signed by an officer in JAG or above, authorised by the Principal Chief Signal and Telecommunication Engineer.
- (b) On receipt of these drawings, the original tracings will be amended in the Office of Principal Chief Signal and Telecommunication Engineer and marked "Completion Drawing". Scanned completion drawings will be sent to division and Requested number of copies of the completion drawing can be printed by Sr. Divisional Signal and Telecommunication Engineer.

### **8.1.8 Supply of Plans**

- (a) Plans of working installations - In addition to the Standard drawings, each Divisional Signal and Telecommunication Engineer/Assistant Signal and Telecommunication Engineer shall have copies of the following diagrams and charts of working installations:
  - (i) Engineering Plan and Signalling Interlocking Plan for each interlocked station including interlocked level crossings situated outside station limits and interlocked mid-section sidings.
  - (ii) Station Working Rule diagram where issued, for each station including interlocked level crossings situated outside station limits.
  - (iii) Locking Table and Locking diagrams of each interlocking frame, Station Master's slide control frame, interlocking key box, power frame with mechanical locking.
  - (iv) Control Tables/Locking Table/Route Control Chart for each station.

- (v) **Control Cum Indication Panel (CCIP) Diagram/VDU Diagram:** VDU diagram shall be submitted to actual size or in proportionate reduced size of the VDU for approval. Track Layout as per approved signalling interlocking plan with symbol for direction of traffic for each line of the layout; nomenclature of each line/siding; boards for BSLB/GWB/STOP; SM's key In/Out indications; SI cancellation Key-In indication; provision of all un-blocking; List of all emergency counters; relevant signalling details such as track section numbers with route set-clear/set-occupied or occupied lit indications in different colour; main/calling-on/shunt signal numbers with timer, locked indication & each aspects indications; points numbers with 'Normal' & 'Reverse' indication slits, locking indications, sub route cancellation symbol in blue colour with white dot; each signal route initiation & signal overlap set/release timer indications; block instruments status LCPR/SR/Block release indications; Crank handle Key-In/Key-Out indications for each crossover; status of active/standby VDU; Link status, health status, OC/CIU status, CRC/Checksum; Date/Time, colour scroll for flashing indication etc. are the least but not limited, to be shown. [Drg. No: 8-D3](#) for typical VDU layout may be referred.
- (vi) Bonding diagrams of track circuits for each yard showing complete layout and diagrams of individual track circuit showing location of insulation joints, jumpers, relay and feed ends, polarity, length, traction bonds etc.
- (vii) Diagrams of connections at track, line and other relays, as necessary for each track circuited yard.
- (viii) Diagram of Relay Interlocking, Electronic Interlocking circuits for each yard.
- (ix) Diagrams of single and double line block instrument circuits.
- (x) Diagrams of Location/Junction boxes showing description of wires at terminals for each yard.
- (xi) Arrangement of relays in relay racks and contact analysis sheet, fuse & terminal analysis sheets for Relay Interlocked/Electronic Interlocked stations.
- (xii) Diagrams showing connections of power supply panels for each power supply installation with perimetric/ring earthing diagram.
- (xiii) Cable route plan showing disposition of underground cables at OHE mast/regular intervals with respect to nearest track centre, for each yard.
- (xiv) Disposition charts of underground cables for control telephones, block instruments, administrative trunks and other railway circuits.
- (xv) Cable core plans of underground cables for signalling circuits under the charge of each SSE/JE(Signal).

- (b) Senior Section Engineers/(incharge) and Sectional Senior Section Engineers/ Junior Engineer (Signal) shall be supplied with copies of the above mentioned drawings and charts.
- (c) At stations provided with centralised operation of points and signals, a set of signalling interlocking plans, locking/selection tables/route control chart, locking diagrams and wiring diagram, cable route plan etc. may be kept at the station for reference by the maintenance staff.
- (d) While signalling interlocking plans, Locking table/Section table/Route control chart and wiring diagrams shall be supplied by Headquarters Office, other plans mentioned in [Para 8.1.8](#) shall be issued by Deputy Chief Signal & Telecommunication Engineer (Construction) or Senior Divisional Signal & Telecommunication Engineer (maintenance) as the case may be. Signalling interlocking plans for non-interlocked stations shall be prepared by Deputy Chief Signal & Telecommunication Engineer (Construction) or Senior Divisional Signal & Telecommunication Engineer (maintenance) as the case may be.

#### **8.1.9 Care and File of Tracings**

- (a) Tracings shall not be used for reference as they are likely to get lost or damaged. Required number of prints taken from scanned tracing should be supplied to Officers and JE/SSEs. Each particular file should contain a print taken from scanned tracing of the works relating to it.
- (b) Should it be necessary to send a tracing from one office to another, it shall be rolled and inserted in a cardboard cylinder.
- (c) Print from scanned tracing should be folded in concertina fashion and shall when folded measure approximately 210 mm x 300 mm. The folding should be arranged so as to make visible the title of the plan without unfolding the plan. When prints are rolled for despatch, they should be rolled with the working side outwards.
- (d) The Records section of each Drawing Branch may file every tracing and original drawing on the basis of the subject classification and the index card filing system. Each drawer of the index card cabinet should be distinguished by a classification number: each card should be complete as regards title of the drawing, other connected drawings, file reference and the drawer number in which the original is stored.
- (e) The storage-drawers should have placards on the outside indicating the contents in each. The plans should be stored flat in shallow drawers of convenient dimensions. Probability of damage by moths or white ants or fire should be guarded against.

## **Section 2: Indian Railway Standard Drawings**

### **8.2.1 Signalling and Interlocking Drawings - IRS (S) & Notation**

- (a) Indian Railway Standard Drawings, designated by the code word I.R.S. have been issued by the Director-General, Research Designs and Standards Organisation, Ministry of Railways, Lucknow. The signal drawings are marked IRS (S) - "S" stands for "Signal". The particulars of the drawings and their reference numbers are detailed in an "Index of Indian Railway Standard Signalling and Interlocking Drawings - IRS (S)". This index shows all the IRS (S) drawings arranged alphabetically, as well as serially, in the order of their numbers. Each drawing number is either prefixed with letters 'SA' or letter 'S'. 'SA' stands for a signal assembly and 'S' stands for a part of a signal assembly.
- (b) New designs and drawings which are accepted for adoption as standards have the word "Advance" suffixed to their number e.g. S-8716 (Advance), pending their final adoption as Indian Railway Standard Drawings. For such drawings the manufacturers shall have a sample approved by the purchaser before undertaking the bulk manufacture.

#### **(c) Supply of Standard Drawings**

RDSO drawings available on RDSO website, shall be referred as and when required. However, a set of RDSO drawings shall be maintained in the office of Sr.DSTE/Dy.CSTE, DSTE/ASTE and by each SSE/JE as required.

## **Section 3: Standard Specifications**

### **8.3.1 Indian Railway Standard Specifications**

- (a) Indian Railway Standard Specifications - Specifications for materials used for signalling purpose are issued by the Signal Directorate, Research Designs & Standards Organisation, Ministry of Railways, Lucknow and are titled as "Indian Railways Standards Specifications". These specifications are issued under a fixed serial number e. g. S-12-54, the letter "S" denoting "Signals" the number "12" representing the serial number of the specifications and the final number "54" indicating the year of original adoption as standard, or in the case of revision, the year of last revision. IRS/RDSO specifications are available on RDSO website.
- (b) Other Specifications: Specifications issued by national/international standards bodies like Bureau of Indian Standards, British Standards Institution, CENELEC (European Committee for Electrotechnical Standardization), IEC (International Electrotechnical Commission), ASTM (American Society for Testing and Materials) International, DIN (German Institute for Standardisation) may also be referred for signalling purposes, where required.

- (c) Each Sr. Divisional Signal and Telecommunication Engineer and Assistant Signal and Telecommunication Engineer should have a copy of all Indian Railways Standard specifications for signalling items in his office. Copies of other specifications issued by national/international standards bodies that are generally required for signalling purpose may also be kept. He should also have a copy of all specifications issued by Principal Chief Signal and Telecommunication Engineer for local use.
- (d) **Availability of Specifications:** Indian Railway Standard Specifications, Indian Standard Specifications, British Standard Specifications are available online, at respective websites.

## **Section 4: Books of References**

### **8.4.1 Books of Reference**

Books of reference should be supplied to Officers, JE/SSEs and Technicians for their personal use, as well as for use in their offices. A statement showing the various books and their distribution is at [Annexure: 8-A1](#). Where soft copies are available such distribution may be dispensed with completely or partially.

### **8.4.2 Each Sr. Divisional Signal and Telecommunication Engineer should arrange to have under mentioned technical literature in the Divisional Library**

- (a) RDSO Specifications with latest amendments
- (b) Other relevant specifications with latest amendments, as required for signalling purpose
- (c) Reports of the Signal Standards Committee
- (d) Current Vendor Directory with latest monthly amendment
- (e) Approved recommendations of Signal Standards Committees
- (f) Approved recommendations of Maintenance Study Groups
- (g) Railway Board's instructions issued time to time
- (h) Updated Codes and Manuals with latest correction slips
- (i) RDSO's guidelines/Technical Advisory Notes (TAN)/Pre-Commissioning Check lists/Amendments issued time to time
- (j) Specifications/Drawings/Instructions/Guidelines issued from Zonal Railway Headquarter with latest amendments
- (k) Technical papers and Journals relevant for signalling, etc.

## **Section 5: Maintenance of Drawings, Specifications and Book of Reference**

### **8.5.1 Folders for Drawings**

- (a) Typical drawings, plans of working installations and specifications should be maintained in a book form separately bound in suitable folders.
- (b) Where Soft Copies are maintained, they shall be securely stored Division Wise, Section wise, Sub section wise, Station wise, with Version number. A secured Computer server with UPS back up & Data back up shall be utilised for such storage.
- (c) Standard Drawings and Plans of working Installations - Railway should publish lists of standard drawing as also lists of plans of working installations for the information of the staff. Addenda and Corrigenda slips should be issued to these lists regularly once in six months incorporating particulars of drawings and plans issued, modified or cancelled.
- (d) **Accountal:** Accountal of Books of Reference and their Addenda & Corrigenda shall be maintained in the same way as tools and plant items.

### **8.5.2 Responsibility**

- (a) All officials to whom books of reference have been supplied shall be responsible for:
  - (i) Their safe custody and good order.
  - (ii) Pasting of all addenda and corrigenda slips promptly and seeing that these are up-to-date to the last slip as modified from time-to-time.
  - (iii) Returning of all books issued to them for personal use prior to retirement.
- (b) Each JE/SSE (Signal) shall be responsible to see that
  - (i) The standard drawings and plans of working installations are properly maintained and kept up-to-date in respect of new drawings issued and old ones cancelled;
  - (ii) The staff working under him understand and carry out work in accordance with standard drawings and plans of working installations. Any mistake in drawings and plans that may come to his notice should be promptly intimated to the Divisional Signal and Telecommunication Engineer for arranging correction; and
  - (iii) The staff under them maintain their books of reference up-to-date and in good order.

- (c) Each Senior Divisional Signal & Telecom Engineer shall be responsible to see that
- (i) The standard drawings, plans and specifications in his custody are kept up-to-date and that the obsolete and cancelled ones are destroyed.
  - (ii) All JE/SSEs(Signals) keep their standard drawings and plans up-to-date.
  - (iii) The staff properly understand and carry out work in accordance with the standard drawings and plans.
  - (iv) Any mistake in the standard drawings, working plans and specifications, which comes to his notice, is promptly intimated to the Principal (or Coordinating) Chief Signal and Telecommunication Engineer for arranging necessary correction.
  - (v) Each Sr Divisional Signal and Telecommunication Engineer shall make periodical check to see that JE/SSEs maintain their books of reference up-to-date and in good order. He should encourage his JE/SSEs and other staff to study reports, proceedings, papers and journals mentioned in [Para 8.4.2](#). So as to enhance their knowledge and to keep themselves informed about the up-to-date developments, methods and technique in Railway Signalling and Telecommunications.
  - (vi) Proper Distribution & Accountal of Documents.

## **Section 6: Indian Railway Standard Equipments**

### **8.6.1 Indian Railway Standard Designs**

- (a) Where Indian Railway Standard Drawing/Specification exist, they should invariably be followed for all new works and no modification of such designs should be introduced without the previous approval of the Railway Board.
- (b) If any defect in Standard Drawing/Specification is noticed under service conditions or if certain modifications to the design are considered desirable, the matter should be brought to the notice of the Director General (Signal), Research Designs & Standards Organisation for examination in consultation with the Signal Standards Committee.

## **Section 7: Detailed Designs**

### **8.7.1 General guidelines**

- (a) The designs shall be suitable for RE as per stipulations in [Chapter 22](#) of SEM on "Requirements of signalling in 25 KV AC electrified areas".
- (b) The designs shall be in accordance with the approved signalling plans, Control Table, Control Panel diagram, Relay contact analysis and relay rack arrangements.

- (c) The designs shall be suitable for the specific type equipment to be installed such as Make of Electronic Interlocking (Distributed or Central), MSDAC, SSDAC, UFSBI Etc and the type of Interfacing & features. Use of dual OFC in Distributed type of Electronic Interlocking, Automatic signalling/Intermediate Block signalling (schemes given at the end of respective chapters and drawings given in Appendix II, are desirable as they provide an alternate path in case of Failures).
- (d) The drawings & designs shall be made, in accordance with Typical templates, RDSO's Standard circuits/templates, guidelines, Board guidelines, Industry's best practices & principles of Reliability, Availability, Maintenance & Safety in mind.
- (e) Uniformity of designs shall be ensured in the same section/station. For example:
  - (i) Same Relay contact may be allocated to same aspect of every signal at a station/section.
  - (ii) Officer incharge shall make out such list of standard practices for guidance of all design staff.
- (f) In case of alterations to existing installations, the following colour code may be adopted for clear understanding of staff for smooth work.
  - (i) **Single drawing method for simple alterations:** Green for deletions & Red colour for additions, in same sheet.
  - (ii) **Two drawing method for major alterations:** Green for deletions & Red colour for additions in separate sheets. Sequence of work & procedure to be followed shall also be mentioned in a descriptive document (with document/File number) to be attached along with drawings and marked as "Procedure for alterations for ..... Work at ..... Station for signalling plan no....".

8.7.2 Control Panels-General: Refer to [Para 21.1.2](#)

8.7.3 Arrangements for control panel: Refer to [Para 21.1.3](#)

8.7.4 Indications to be provided for Control Panel: Refer to [Para 21.1.4](#)

8.7.5 Interlocking and Circuit Requirements - General: Refer to [Para 21.1.5](#)

8.7.6 Route Setting Type - Refer to [Para 21.1.6](#)


8.7.7 Non Route setting Type: Refer to [Para 21.1.7](#)


8.7.8 Route Release Circuits: Refer to [Para 21.1.8](#)

8.7.9 Signal Control Circuits: Refer to [Para 21.1.9](#)



- 8.7.10 Locking of Advanced Starter and Starter Signal at Junction Stations: Refer to [Para 21.1.10](#)
- 8.7.11 Level Crossing Gates circuits: Refer to [Para 21.1.11](#)
- 8.7.12 Point Control Circuits: Refer to [Para 21.1.12](#)
- 8.7.13 Crank Handle & Siding Control Keys: Refer to [Para 21.1.13](#)
- 8.7.14 Cross Protection features: Refer to [Para 21.1.14](#)
- 8.7.15 Control Terminal (Video Display Unit (VDU)): Refer to [Para 21.1.15](#)
- 8.7.16 Precautions for design of circuits using Electronic devices: Refer to [Para 21.1.16](#)
- 8.7.17 Train Detection (Track Circuits & Axle Counters): Refer to [Para 21.1.17](#)
- 8.7.18 Interface with Electronic Interlocking: Refer to [Para 21.4.3](#)
- 8.7.19 Version control of Softwares of Electronic Interlocking: Refer to [Para 21.4.7](#)
- 8.7.20 Lightning & Surge protection for Signalling systems: [Refer to Chapter 21, section 7](#)

 <i>Note: This Chapter has under mentioned Annexures</i>		
<i>S.No.</i>	<i>Annexure No.</i>	<i>Description</i>
1	<a href="#">8-A1</a>	<i>Various Books of Reference and their Distribution among the Staff</i>
2	<a href="#">8-A2</a>	<i>Check List for Engineering Scale Plan (ESP)</i>

 <i>Note: This Chapter has under mentioned Drawings in <a href="#">Appendix II</a></i>		
<i>S.No.</i>	<i>Drg No.</i>	<i>Description</i>
1	<a href="#">8-D1</a>	<i>Signalling Interlocking Plan for Double Line Station</i>
2	<a href="#">8-D2</a>	<i>Control Table for Double Line Station (Sheets-4)</i>
3	<a href="#">8-D3</a>	<i>VDU Layout Plan for Electronic Interlocking (EI)</i>

### Various Books of Reference and their Distribution among the Staff

Sl. No	Publications	Scale						
		Office of			Personal Possession of			
		Sr.Divl. S&T Engineer	Asst. S&T Engineer	SSE (Signal) Incharge	Sr.Divl./ S&T Engineer	Asst. S&T Engineer	SSE (Signal) Incharge Sectional SSE/JE	Technician (Signal)
1	2	3	4	5	6	7	8	9
1	Rules for the opening of a Railway for the Public carriage of passengers.	1	1	--	1	1	--	--
2	General and Subsidiary Rules	1	1	1	1	1	1	1
3	Schedule of Dimensions (B.G).	1	1	1	1	1	1	--
4	Signal Engineering Manual	1	1	1	1	1	1	1
5	Telecommunication Manual	1	1	1	1	1	1	
6	Block Working Manual	1	1	1	1	1	1	1
7	Accident Manual	1	1	1	--	--	--	--
8	A.C. traction Manual	1	1	1	--	--	--	--
9	Permanent Way Manual	1	1	--	--	--	--	--
10	Track Manual	1	1	--	--	--	--	--
11	Indian Railway Code for the Engineering Department.	1	1	--	--	--	--	--
12	Indian Railway Establishment Code.	1	1	--	--	--	--	--
13	Indian Railway Financial Code	1	1	--	--	--	--	--
14	Indian Railway Code for Stores Department.	1	1	--	--	--	--	--
15	Indian Railway code for Accounts Department.	1	1	--	--	--	--	--

Sl. No	Publications	Scale						
		Office of			Personal Possession of			
		Sr.Divl. S&T Engineer	Asst. S&T Engineer	SSE (Signal) Incharge	Sr.Divl./ S&T Engineer	Asst. S&T Engineer	SSE (Signal) Incharge Sectional SSE/JE	Technician (Signal)
16	Schedule of Powers of Divisional/district and Assistant Officers in other than Establishment matters (as published)	1	1	--	--	--	--	--
17	Pass Manual	1	1	1	--	--	--	--
18	The Hours of Employment Regulations with modifications as issued	1	1	1	--	--	--	--
19	Payment of Wages Act with Notifications as issued.	1	1	1	--	--	--	--
20	Working Time Table and Appendix thereto.	1	1	1	1	1	1	1
21	Alphabetical list of Railway stations.	1	1	1	--	--	--	--
22	Catalogue of stores	1	1	1	--	--	--	--
23	Indian Railways Act	1	1	--	--	--	--	--
24	Indian Workmen's Compensation Act.	1	1	--	--	--	--	--
25	Indian Electricity Act	1	1	--	--	--	--	--
26	Indian Petroleum Act	1	1	--	--	--	--	--
27	I.R.S Drawings	1	1	*1	--	--	--	--
28	I.R.S. specifications (as required)	1	1	--	--	--	--	--
29	Railway Standard Drawings.	1	1	*1	--	--	--	--

\* As Required.

Note: Where soft copies are available, such distribution of physical copies may be dispensed with completely or partially.

**Check List for Engineering Scale Plan (ESP)**

S. No.	Description of the Item	REMARKS OF		
		JE/SE/SSE/Drg	ADSTE	SSTE/DSTE
1.	Complete layout of the yard should be shown by the Engg. Dept. even for works for minor nature. Alteration/Modification should not be shown in a part plan.			
2.	Plan should be prepared in 1:1000 scale			
3.	North Point should be shown on the top of the sheet.			
4.	Kilometerage and Chainage (0.00 m) of the station building should be clearly indicated.			
5.	Direction of Train movement i.e. UP & DN should be clearly indicated at the top centre as well as at the ends of the yard.			
6.	Name of the adjacent Block Stations with their distances at both ends and name of the Junction Stations to be indicated. The Kilometerage shall start incrementing from left hand side to right hand side & mid section siding if any to be shown.			
7.	All Gradient at the yard must be shown and should be in sequence. Gradient & its chainages upto 2.5 km from first stop signal both ends should be shown.			
8.	a) Gradient of new Stn. Yard within 50 m from outermost point should be 1 in 1200. Permitted upto 1 in 400 with out condonation. b) Allowed upto 1 in 400. CRS's Dispensation required for gradient steeper than 1 in 400 upto 1 in 260. Rly.Bd's Condonation required for gradient steeper than 1 in 260. Dispensation or condonation obtained/to be obtained should be indicated clearly in Engg Scale Plan.			
9.	There must be no change of grades within 30 meters of any points & crossing.			
10.	If any alteration is proposed for the existing yard, the portion of the yard where alteration is proposed shall be marked with Red colour, and the portion of the yard where alteration is not proposed is tallying with the existing sigg. Plan			
11.	All Lines should be designated for identification and reference. All lines No. to be written starting line No.1 from station Bldg. side.			

S. No.	Description of the Item	REMARKS OF		
		JE/SE/SSE/ Drg	ADSTE	SSTE/ DSTE
12.	The clear standing room of all lines e.g., running lines, Sdg. Lines, should be mentioned. CSL should be minimum 720 m for New lines and 686 m for existing lines.			
13.	Platforms should be provided on lines on which it is intended to receive passenger trains .Platform level e.g, RL, LL, HL etc. to be indicated.			
14.	The classification, kilometerage, chainage from Centre of station building, Manned/ Unmanned and number of each level crossing should be shown. Classifications of L.C. Gates are to be revised according to present TVU. Spl- >50000, A->/=30000 & <50000, B1->/=25000 & <30000, B2->/=20000 & <25000, C-up to 20000.			
15	a) Level crossing gate should be located clearing Block Overlap ahead of the first-stop signal and Signals Overlap ahead of the starter signals as far as practicable.  b) LC Gate within berthing track shall be avoided.			
16.	a) The angle of turnouts and type of Switches (ST or CS) of each point in the yard should be shown.  b) Passenger lines turnouts shall be <u>1 in 12 or 1 in 16</u> .			
17.	The distance between center of tracks in Stn. Yds. should be shown. Minimum Track Centres as per SOD.			
18.	As far as possible, Turn-Outs should be taken off clearing the Fouling of adjacent T.O. Distance between SRJ's of two crossovers shall be normally 13 m minimum and with Glued joints 7 m minimum.			
19.	Location of cabins/Goomties/Stn Bldgs:  (a) They should not be in front of a trap, or dead end.  (b) Where two cabins are provided, they should be so located on either side of the track so that Cabin men can ensure complete arrival of trains.			
20.	All running lines must be isolated from sidings (i.e. non-running lines).			
21.	All passenger lines must be isolated from goods running lines.			
22.	Traffic yard should be isolated from the private siding, loco Yard or Engg. siding, if any.			

23.	At junction station where trains run through on the main line at speed exceeding 50 KMPH, the main line should be isolated from all other lines of the yard.			
24.	Sidings should take-off from the loop line, and not from the main line.			
25.	Chainages of all Points, De-railing switches, Dead Ends, Fouling Marks, LC Gates, Platform ends etc., should be shown.			
26.	Reference of the Work is to be mentioned i.e. sanction particulars.			
27.	Drawing No. shall be indicated.			
28.	The stations in busy section are to be provided with simultaneous reception and dispatch facilities.			
29.	Details of open bridges: Span more than 6.1 meters, insulated or not.			
30.	Note regarding PSC Sleepers			
31.	Points in the vicinity of LCs (SRJ shall be 25 meters away from Center Line of LC).			
32.	Distance between Buffer Stop/Derailing Switch to LC Gate shall be 60 meters.			
33.	Any Cup-shape (<50 m) movement in the yard to be restricted.			
34.	Any other station specific items.			
35.	Details of ROB/RUB/FOB with its length, and distance/Chainage from C/L of Station. (Details of Steel/Concrete bridges)			
36.	CSR's of lines shall be checked from starter to starter or Fouling Mark to Fouling Mark, keeping 24 M from SRJ on either side for locating Starter signals. Clearance from SRJ/Trap to be indicated.			
37.	Provision of Slip Siding/Catch Siding as required. a) If the Gradient steeper than 1 in 100 falling towards Block, Slip Siding is to be provided b) If the Gradient steeper than 1 in 80 falling towards Station side, Catch Siding is to be provided.			
38.	Details of LC Gates with their class, Kilometerage, Gate Lodge position, Manned/Unmanned, Interlocked/Non interlocked, Lifting Barriers/Swing Gates, etc. upto 2.5 km. on both sides.			
39.	A Single Goods line should not be sandwiched between two passenger lines or between Main line and passenger line since the passenger lines cannot be safely isolated from the Goods line.			

40.	Electronic Weigh Bridge if any in Track Circuit portion, to be shown.			
41.	<p>Color schemes for drawings as per Indian Railways Works Manual 2000 chapter IX, para No.907 is as follows:</p> <p>a) Existing work that is to remain should be in full line – Black.</p> <p>b) All proposed works - Vermilion Red or Scarlet Lake variety.</p> <p>c) All future proposals- Emerald Green.</p> <p>d) Work that is to be dismantled should in thin dotted lines – Yellow.</p> <p>e) Phase-I – Red</p> <p>f) Phase-II – Green Dotted</p> <p>g) Sanitary Works – Blue</p>			

Signature of:

JE/SSE/D

Name

ADSTE

Name

DSTE

Name

1.0 The above check list after scrutiny of the ESP has to be submitted by division to HQs under covering letter for further action at Headquarters.

2.0 Same format of the check list shall be followed at HQs for scrutiny of the ESP before obtaining the approval of competent authority till further amendment.

Signature & Designation	ASTE/D&D/HQ	SSTE/D&D	Dy.CSTE/D&D
Name			

Note: (1) The above list is not exhaustive, zonal railways may add or modify as per local requirements.

(2) Where electronic form of checking/approvals are in place, they may be adopted.

# Chapter 9: Procedure for Commissioning of Signalling Installations

## Section 1: General Instructions

### 9.1.1 Reference to Rules

- (a) The safety of the travelling public is ensured by the Rules laid down in
  - (i) The Indian Railway Act.
  - (ii) The General Rules & Subsidiary rules for all Open Line Railways.
  - (iii) The Rules for Opening of a Railway or section of a Railway for the public carriage of passengers.
  - (iv) The Indian Railway Schedule of Dimensions.
- (b) The rules provide for the legal authorisation that shall be obtained for any work which affects the running line, before the work is started or brought into use and before a new section of a line is opened for public traffic.

**9.1.2 Notification to Railway officials before opening works:** No signalling work affecting the running of trains or working of traffic at a station shall be brought into use, until staff of all concerned Departments have been notified by means of a circular issued by the Operating Department. Timely intimation of the date of commencement of work, duration of work, arrangements for working of trains during the progress of the work, date of opening of work, etc. shall be given to the Operating Department, whenever any new or revised traffic working instructions are to be brought into use to enable operating Department to give the station and running staff due notice.

**9.1.3 Approved plans, Drawings and Specifications:** All works shall be carried out strictly in accordance with the approved plans, standard drawings and specifications and should conform to the provisions of this manual where such are applicable. Deviations, if any, shall have the prior approval of the Principal Chief Signal and Telecommunication Engineer. All deviations shall be marked on the completion drawings and forwarded to the Principal Chief Signal and Telecommunication Engineer for correction of the tracings and issue of revised prints.



#### 9.1.4 Responsibilities of Engineer Incharge

- (a) The Signal Engineer incharge shall ensure that no work is commenced without
  - (i) Proper men and materials being available for its execution.
  - (ii) Approved signalling plans, locking tables and diagrams, selection tables and circuits/Application Logic, standard drawings and specifications.
  - (iii) Sanction of Commissioner of Railway Safety or Principal Chief Signal & Telecom Engineer (as applicable) in the case of works on lines already opened for passenger traffic.
  - (iv) Station working Rules and temporary working instructions.
  - (v) Sanction to the detailed estimate for the work with necessary allotment of Funds. (This does not apply to works started on urgency Certificates).
- (b) The Engineer incharge shall, besides authorising commencement of works
  - (i) Be responsible for proper and efficient execution of works,
  - (ii) Make frequent inspections and issue detailed instructions to the JE/SSE's.
  - (iii) See that the progress of work is satisfactory and submits progress reports to the Principal Chief Signal and Telecommunication Engineer.
  - (iv) Be responsible for correct booking and control over expenditure within the funds allotted.
  - (v) Assist the Operating Department in preparation of the Station working Rules.
  - (vi) Arrange for sighting of new Signals by sighting committee [Annexure: 19-A1](#) before commissioning the same.
  - (vii) Fix a date for opening jointly with other concerned officials and notify the same to all concerned.
  - (viii) Arrange to issue safety certificate and joint message to the Commissioner of Railway Safety.

**(c) Responsibilities of the SSE(Signal)/Incharge**

The SSE incharge of the work shall, besides ensuring the conditions stipulated in [Para 9.1.4\(a\)](#) be responsible for ensuring that:

- (i) A work is not started unless authorised by the concerned Officer.
- (ii) All necessary steps are taken for the safety of trains movements during the execution of the work.
- (iii) There is no avoidable detentions to trains and if any detentions do take place particulars are advised promptly to the Engineer incharge.
- (iv) The station staff have received the necessary notice and Station working Rules.
- (v) The work is tested and found correct by him before requesting the Engineer incharge to test and commission the work.
- (vi) All precautions are taken to prevent accidents to staff or damage to equipment and
- (vii) All accidents are promptly reported.

**9.1.5 Joint Inspection/Handing Over of new assets**

- (a) Joint inspection by Divisional open line and construction/Work Executing agency both at SSE(Signal)/Incharge & officer level shall be undertaken before taking up Non-interlocking of a station in connection with yard re-modelling/interlocking changes or commissioning of Signalling works for a new line/gauge converted line. ([Annexure: 9-A7](#))
- (b) The non interlocking of the station/commissioning of any signalling work shall be undertaken after the items considered essential for safety of train operation are completed. ([Annexure: 9-A7](#))
- (c) Within 15 days of commissioning of Signalling works, another Joint inspection both at SSE/Incharge & Officer level by Divisional Open line and/Construction/ Work Executing agency shall be undertaken. The deficiencies noted during these inspections shall be listed as; ([Annexure: 9-A7](#)).
  - (i) Category A – Items which shall be complied before handing over.
  - (ii) Category B – Petty items (like painting, labeling etc.) which may be complied after handing over as per MOU to be entered between open line and construction organisation/Work Executing Agency.
- (d) All the new signaling equipments and associated gadgets shall be handed over/taken over within 2 months period after commissioning of the signalling works. After expiry of 2 months period, however the responsibility of maintenance shall devolve on divisional open line organisation after commissioning.
- (e) In order to ensure that handing over/taking over of signalling assets is accomplished in a smooth manner, a specific handing over/taking over procedure as detailed in [Annexure: 9-A7](#) shall be followed.

## **Section 2: Obtaining Sanction for Works on Lines Opened to Traffic**

### **9.2.1 Works Requiring Notice to and Sanction of the Commissioner of Railway Safety**

Under Section 20 of the Indian Railways Act and Chapter VI, VII of the "Rules for the Opening of a Railway or Section of a Railway for public Carriage of Passengers" the approval of Commissioner of Railway Safety is required for the execution of any work on the open line which will affect running of passenger trains and any temporary arrangement necessary, for carrying it out, except in cases of emergency.

The following signal and interlocking works, when they are connected with or form part of a Railway already opened for carriage of passengers require the sanction of Commissioner of Railway Safety, before they are commenced or opened:

- (a) Additions/extensions or alterations to existing Block, Signalling and interlocking installations.
- (b) Change in block, Signalling and Interlocking scheme.
- (c) New stations temporary or permanent.
- (d) Interlocking of level crossing, catch siding and slip sidings etc.
- (e) Closing of Manned Level Crossing gates after approval of district administration obtained by Engineering department.

### **9.2.2 The following works shall, which enhance level of safety, however, do not require the sanction of the Commissioner of Railway Safety:**

- (a) Provision of Telephones at already manned level crossings.
- (b) Provision of electrical & mechanical lifting barrier including emergency interlocking arrangements, sliding boom at already interlocked Level Crossing Gates.
- (c) Interlocking of existing LC Gates within already existing interlocked station yard by existing signals in the same or shifted location.
- (d) Provision of all categories of track circuits, axle counters including dual detection.
- (e) Replacement/Modification of signalling assets without any change in the yard layout or signal interlocking scheme either in station or at mid section Level Crossing Gates.
- (f) Replacement of Block instruments by any other approved type of instrument or provision of block proving through Axle counters or Track Circuiting using existing Block instruments.

- (g) The replacement of block instrument without any change in the system of block working.
- (h) Providing Electronic Interlocking/Panel Interlocking/Route Relay Interlocking in Non passenger Line section.
- (i) Changing from Control Panel to Control Terminal/VDU in Electronic Interlocking.

9.2.3 Personal approval of the PCSTE will be required for sanction of the works mentioned at [Para 9.2.2](#).

PCSTE of Railway will submit Safety certificates & quarterly statement of all such sanctions accorded by him to the concerned CRS, PCSTE's sanctions are not given in a routine manner but following laid down procedure.

It is therefore, suggested that while giving sanctions by PCSTEs, following must be ensured:

- (a) All relevant documents that are prepared by field units (for submission to CRS for his sanction) for commissioning of the works would be submitted to PCSTE for his sanction. This includes Engineering scale/Signalling Plans, SWR diagrams and SWR.
- (b) Application in format as per [Annexure: 9-A8](#) shall be submitted duly signed by JA grade officer, incharge of the work for applying for PCSTE's sanctions. Similarly, PCSTE's sanction shall also be communicated in the defined format enclosed as [Annexure: 9-A9](#).
- (c) Application for CSTE's sanction received in Head quarter's office shall be scrutinised as per the check list laid down as [Annexure: 9-A10](#) by Dy. CSTE/Incharge of design or CSTE(planning) and put up for sanction of the PCSTE.
- (d) Personal sanction of PCSTEs would be required and it shall not be delegated to any lower level.
- (e) Sanctions would be recorded by PCSTEs as a numbered sanction maintaining a register for the same similar to sanction numbers being maintained by CRS.
- (f) The validity of the PCSTE's sanction shall be for a period of 1 year. Re-validation of the sanction after 1 year may be considered based on valid reasons.

#### **9.2.4 Application to the Commissioner of Railway Safety/PCSTE for sanction for Works**

- (a) Applications to the Commissioner of Railway Safety/PCSTE for sanction for carrying out works listed in [Para 9.2.1, 9.2.2](#) shall be submitted in the following manner:
- (i) When the work is executed by the Divisional organisation, the application shall be signed by the Sr. Divisional Signal & Telecom Engineer for Signalling works. For joint works or work by Railway's PSU the application shall be signed by Divisional Railway Manager.
  - (ii) When the work is executed by an extra Divisional Organisation e. g. Construction Organisation, the application shall be signed by an officer of the rank of Deputy Chief Signal and Telecommunication Engineer for signalling works. For joint works the application shall be signed by officers of Junior Administrative grade of the concerned departments executing the work.
  - (iii) Station Working Rules obtained from the Operating Department shall accompany the application.
  - (iv) The application shall be made on the prescribed form 1606/1 "Application for Sanction" ([Annexure: 9-A1](#)) and shall be complete in respect of all documents mentioned therein.
  - (v) The application for sanction shall ordinarily be made at least fourteen days in advance of expected commencement of the work. When a sanctioned work is not taken on hand within twelve months of the date of sanction, a fresh sanction shall be obtained.
- (b) If any material deviation from the plan approved by the Commissioner of Railway Safety/PCSTE which affects the yard layout or signalling and interlocking arrangements or system of train working is found necessary, his prior approval to such deviations shall be obtained with reference to application made initially.
- (c) The Commissioner of Railway Safety/PCSTE in according his sanction may or may not propose to inspect the works.
- (d) If the Commissioner of Railway Safety/PCSTE decides to inspect the work prior to opening, he will, after inspection in the company of the officers concerned, communicate in writing his sanction to open the work.

#### **9.2.5 Safety Certificate**

- (a) If the Commissioner of Railway Safety decides not to inspect the work prior to the opening, the Engineer incharge shall submit the Safety Certificate on the prescribed form ([Annexure: 9-A2](#)) signed by him prior to the opening of works and in case of joint works, signed also by Engineer incharge of other departments concerned.

- (b) Before signing the Safety Certificate the Engineer-incharge shall,
  - (i) Test the new works and see that installation has been carried out correctly.
  - (ii) Fully satisfy himself, that the work can be opened for the public carriage of passengers without endangering the safety of the travelling public or of the employees of the Railway.
- (c) After fully satisfying himself, he shall bring the installation into use by issuing a message in the form given on the sanction Application ([Annexure: 9-A1](#)) to the Commissioner of Railway Safety with copy to all concerned.
- (d) In case of joint works, the message shall also be signed by the Engineer-incharge of the concerned Departments for their portion of the work.
- (e) The Safety Certificate shall be countersigned by the Officers, who had applied for the sanction of Commissioner of Railway Safety/PCSTE. A certificate from Operating Department, stating that the necessary Station Working Rules have been issued and giving reference to sanction of deviations (if any) from General and Subsidiary Rules, shall also be attached.
- (f) Copies of the Safety Certificates shall be sent to the Divisional Railway Manager and the Principal Chief Signal and Telecommunication Engineer and also to the Principal Chief Engineer/Principal Chief Electrical Engineer if the Engineering/Electrical Department is/are involved in the work.

### **Section 3: New Lines & Electrification**

#### **9.3.1 Application to the Commissioner of Railway Safety**

- (a) In the case of new lines or electrification, prior sanction of the Commissioner of Railway Safety for commencement of the work is not necessary but when it is proposed to open the line for passenger traffic or to initiate electric traction on a line already opened, the following documents are to be furnished by the General Manager of Railway to the Commissioner of Railway Safety at least one month before the date by which the line is expected to be ready for opening.

These documents collectively are termed as the Opening Documents.

- (i) Tabulated details.
- (ii) Index plan and section of Railway.
- (iii) Drawings of works.
- (iv) List of questions and answers duly filled in.
- (v) Certificates.
- (vi) List of infringements of maximum and minimum dimensions.
- (vii) Diagram of proposed testing train.
- (viii) Station working rules to be enforced at each station.

(b) Of the above, the following items pertain to signalling and interlocking:

- (i) Tabulated details Form No. VIII of Rules for Opening of a Railway. (An example at [Annexure: 9-A3](#) for station machinery).
  - (ii) Drawings of works, plans of station yard showing gradients, the layout of tracks and signals and interlocking including Locking and Selection tables/Route Control chart.
  - (iii) List of Questions and Answers ([Annexure: 9-A4](#)).
  - (iv) Station working Rules (assisting the Operating Branch in their preparation).
  - (v) Certificate for introducing or extending electric traction, containing details of maximum value of Traction current ([Annexure: 9-A5](#)).
- (c) The new line shall be opened for passenger traffic or electric traction shall be initiated only after the Commissioner of Railway Safety authorises the Railway to do so after his inspection.

*Note: If any part of the work relating to a new line or electrification affects any existing signalling or interlocking installation, prior sanction of the Commissioner of Railway Safety shall be obtained for that part of the work and the work executed on the basis of instructions contained in Section '1' of this Chapter.*

## **Section 4: Introduction of New Types of Locomotives or Rolling Stock for Increasing Speed**

### **9.4.1 \* Introduction of New Types of Locomotives or Rolling Stock or Increase in Sanctioned Maximum Speed of Existing Locomotives or Rolling Stock:**

- (a) The Research, Design and Standards Organisation shall apply, for introduction of new types of locomotives or rolling stock different from those already running on any section or division of railway administrations for use by any railway administration, to the Central Government through the Commissioner.

Explanation: For the purposes to this rule, any increase in sanctioned maximum speed of existing locomotives or rolling stock shall be treated as introduction of new types of locomotives or rolling stock.

(b) The application under Para 9.4.1(a) shall be accompanied by:

- (i) Such diagrams as may be necessary to give full particulars of the axle loads, wheel spacing, length over buffers and other principal dimensions of the rolling stock for which sanction is required;
- (ii) Provisional speed certificate or final speed certificate, as the case may be, issued by the Research, Design and Standards Organisation; and
- (iii) The maximum number of motive power units proposed to be coupled together for multiple operation shall be specifically mentioned.

- (c) The application shall be scrutinized by the Commissioner and his recommendations thereon shall be submitted to the Central Government for its orders.
- (d) No new type of engine or rolling stock which would cause stresses exceeding those specified in the IRS Bridge Rules, 1964, or the Standard Codes of Practice, or in the absence of any such reference, the design criteria approved by the Central Government for existing structures or excessive stresses in track shall be ordered until the sanction of the Central Government has been received through the Commissioner for doing so.
- (e) The Commissioner may, for permitting new designs of locomotives, require oscillation trials to be conducted and call for the records for his scrutiny.
- (f) A rolling stock having different principal dimension or a different bogie design or new designs of braking system or suspension details like axle load, track loading density, unsprung mass being different shall be regarded as new rolling stock:

Provided that any minor change or equipment design or change of internal equipment layout on the rolling stock or minor change of axle load or minor change of track loading density or minor change in unsprung mass shall not be regarded as new rolling stock, unless such changes are likely to significantly affect weight distribution, center of gravity or riding behavior of the rolling stock: Provided further that any modification in the design of the coach which alters the system of operation and control over the rolling stock, like change in the braking system or change in the principle of traction shall be regarded as a material modification in the type and design of the rolling stock.

- (g) In case of any difference of opinion in the Research, Design and Standards Organisation, whether or not any change or modification is to be regarded as a new rolling stock, the Research, Design and Standards Organisation shall, through the Commissioner, refer the matter to the Central Government for final decision thereon.

\*Amended vide GSR945(E), dated 01.10.2018.

#### 9.4.2 \* **Use of New Types of Locomotives or Rolling Stock by Railway Administration**

- (a) The General Manager of a Government railway may sanction the use of any locomotive or rolling stock already introduced on Indian railway by the Central Government under the provisions of Para 9.4.1, on any section or division of railway under his control:

Provided that the railway administration other than the Government railway shall require the approval of the Central Government through the Commissioner for use of any locomotive or rolling stock already introduced on Indian railway by the Central Government under the provisions of Para 9.4.1, on any section of railway under its control.



(b) The proposal for sanction of the General Manager of a Government railway under Para 9.4.1(a) shall be accompanied by:

- (i) Such diagrams as may be necessary to give full particulars of the axle loads, wheel spacing, length over buffers and other principal dimensions of the rolling stock for which sanction is required;
- (ii) The provisional speed certificate or final speed certificate, as the case may be, issued by the Research, Design and Standards Organisation;
- (iii) The sanction of the Central Government for introduction of the locomotives or rolling stock or increase in sanctioned maximum speed of existing locomotives or rolling stock under Para 9.4.1;
- (iv) The calculations and stress sheets showing
  - the conclusions arrived at;
  - the external forces on which the stress calculations are based;
  - the stresses which will be produced in the various bridges over which the proposed rolling stock will run; and
  - the effects which the said rolling stock will have on various structures or tracks as compared with those caused by the rolling stock already in use, or allowed by the existing Government orders:

Provided that the calculations and stress sheets under this clause must show as to what allowance has been made for any secondary or deformation stresses in addition to the primary stresses caused by external forces and what relief of stress, if any, has been included;

- (v) The cost of modification to signaling and telecommunication installations necessitated by the use, if any, of chopper or thyristor control systems;
- (vi) An approximate estimate of the cost of such improvements in existing structures or track as the use of the proposed rolling stock is likely to render necessary on the concerned railway, whether immediately or in the near future; and
- (vii) A certificate on Form [Annexure: 9-A6](#) signed by the Chief Engineer, the Chief Mechanical Engineer and the Chief Electrical Engineer (for electric stock) of the concerned railway in the following Performa, namely:

(c) The Certificate referred to in clause (vii) of Para 9.4.2(b) shall indicate

- (i) Clearly that the speed certified does not exceed the limits laid down by the Research, Designs and Standard Organisation; and
- (ii) Specifically the maximum number of motive power units proposed to be coupled together for multiple operation.

- (d) The General Manager of the Government railway shall communicate the sanction to the Commissioner for his information ten days in advance of the actual use of locomotive or rolling stock over the railway.
- (e) The provisions of this rule shall, *mutatis mutandi*, apply to every proposal of a railway administration other than Government railway for seeking approval of the Central Government through the Commissioner, for the use of any locomotive or rolling stock already introduced on Indian railway by the Central Government under the provisions of rule 28, on any section of railway under its control.

*\*Added/amended vide GSR 945(E), dated 01.10.2018*

#### 9.4.3 **\* Introduction of new passenger carrying trains or change in speed of existing passenger carrying trains:**

A Railway administration may introduce a new passenger carrying train or allow any change in speed of existing passenger carrying train in accordance with the instructions issued by the Central Government in this regard, from time to time.

Provided that a railway administration shall require the approval of the Central Government through the Commissioner, at the first introduction of a new passenger carrying train above 130 kilometer per hour or first increase in speed of existing passenger carrying train above 130 kilometer per hour in a section of such railway.

*\*Added/amended vide GSR 945(E), dated 01.10.2018*



*Note : This Chapter has under mentioned Annexures*

S.No.	Annexure No.	Description
1	9-A1	Application for CRS Sanction
2	9-A2	Safety Certificate
3	9-A3	Station Machinery
4	9-A4	List of Questions & Answers
5	9-A5	Safety Certificate for S&T works for Introducing Electrification
6	9-A6	Joint Safety Certificate (for New Types of Locomotives or Rolling Stock)
7	9-A7	Handing Over/Taking Over of Signalling Assets
8	9-A8	Application for PCSTE Sanction
9	9-A9	PCSTE Sanction
10	9-A10	Check List for PCSTE Application for Sanction for Signalling Works

**Application for CRS Sanction**

.....RAILWAY

Office.....

Department.....

Dated:.....

No.....

From:

The.....

Designation.....

To

The Commissioner of Railway Safety,

.....

Sir

I hereby apply for your sanction to

(\*Name of work: .....  
 .....)

being commenced and opened for the public carriage of passengers when ready.

2. With reference to Chapter VI of the Rules for the Opening of a Railway, I have to enquire whether you wish to inspect the work prior to its opening for the public carriage of passengers in which case intimation will be given of the date of completion.

3. In the event of your deciding not to inspect the work prior to opening, the Engineer-in-charge will, on completion of the work, submit the Safety Certificate, duly signed by him, prior to the opening of the work for public carriage of passengers and when required, also dispatch a communication \* to your address intimating that the work has been opened and the Safety Certificate has been signed by him.

4. The application for the use of Locomotives and Rolling-stock to be drawn or propelled thereby on the proposed line, in accordance with Section 16 (1) of the Indian Railway Act, 1989 is sent herewith/not required.

5. The following documents are enclosed: (Tick (✓) where enclosed, cross (X) where not enclosed.

**(I) Temporary works:**

- (a) Description of proposed works.
- (b) Drawing of Temporary work.
- (c) List of infringements to Schedule of dimensions.
- (d) List of deviations from the Signal Engineering Manual.
- (e) List of deviations from General and Subsidiary Rules.
- (f) Restrictions
- (g) Rules for Traffic Working.
- (h) Documents for Bridges as per Chapter-VII of the Rules for the Opening of Railways.

**(II) Permanent works:**

- (a) Description of proposed works.
- (b) Drawing of Permanent work.
- (c) List of infringements to Schedule of dimensions.
- (d) List of deviations from the Signal Engineering Manual.
- (e) List of deviations from General and Subsidiary Rules.
- (f) Restrictions.
- (g) Rules for Traffic Working.
- (h) Documents for Bridges as per Chapter-VII of the Rules for the Opening of Railways.

*@If any of the document are not sent, then "NIL" to be written against such items. Working rules for extensive remodelling scheme may be sent in not later than one month before the date on which the work is to be brought into use, and in such cases "will follow" should be written instead in "NIL".*

6. Certified that a detailed examination of the strength and arrangement of the materials to be used in the temporary/permanent works in above connection, have been made and that the design and the materials to be used are upto the loads, which they will be required to carry and that their opening for public carriage of passengers will not be attended with any danger.

(Delete permanent/temporary work, as the case may be).

Yours faithfully

Signature.....

Designation.....

Dated.....

No.....

From

The Commissioner of Railway Safety.

.....

To,

Your No.....

(1) Sanction is accorded to the above work being carried out. #Validity of sanction is \_\_\_\_\_ months from date of sanction.

(2) I propose to inspect the work prior to its opening for public carriage of passengers. Advice of the date, when the work will be ready for inspection should be intimated at least 14 days before it is proposed to open it.

OR

(Strike out paragraph not applicable)

I do not propose to inspect the work prior to its opening for the carriage of passengers. When ready, it may be opened on a safety Certificate (vide paragraph 3 of your letter) which should be submitted to me direct without any delay.

Commissioner of Railway Safety

\*Form of communication "Reference Sanction No. .... dated ..... work open for public traffic on ..... First train to pass ..... No Danger to public. Certificate signed.

#Validity of sanction is 12 months unless otherwise specified.

..... RAILWAY

**Safety Certificate**

When the Commissioner of Railway Safety does not inspect the work prior to opening, this certificate must be signed before opening temporary or new works.

From,

The Divisional Railway Manager/Deputy Chief Engineer (Construction)/Deputy Chief Signal and Telecommunication Engineer (Construction).....Division.

To,

The Commissioner of Railway Safety,

.....

Description of work .....

.....

With Reference to Application.....dtd.....sanctioned under Commissioner of Railway Safety No.....dtd.....to commence and open the above work.

Following permanent /temporary work has been done

.....  
.....

I/We do hereby certify that, in the work above mentioned:

- (i) The schedule of dimensions has not been infringed \*except in regard to the items sanctioned under letter \* No.....dated.....
- (ii) Engineering work has been carried out in accordance with Plan No.....\*except in regard to the alterations sanctioned under letter No.....dated.....
- (iii) The weight of rails, strength of bridges and general structural character of the works are such as have been prescribed under the rules.
- (iv) The \*Signalling and \*Interlocking and \*Block Signalling has been carried out in accordance with Signalling Plan No..... and the requirements and instructions laid down in the Signal Engineering Manual have been completed \* except in regard to the items sanctioned under letter No.....dated.....

The work has been carried out in accordance with the documents already supplied.

2. A certificate from the Divisional Safety Officers/..... stating that the necessary working rules have been issued and giving reference in regard to sanction to deviation (if any) from General and Subsidiary rules is attached/not required.

\* To be scored out if not applicable.

3. I/We hereby certify that on ..... 20..... I/We have carefully inspected and tested the above work and that I/We have satisfied myself/ourselves that it has been properly completed and is in good working 'order'\*and that the work can be opened for Public carriage of passengers without endangering the safety of the travelling public, or of the employees of the Railway, subject to the following speed restrictions:

@ Temporary.....Kmph ..... due to .....

.....  
@Permanent.....Kmph ..... due to.....  
.....

4. The work is being opened on.....

\*Necessary in case of signaling and interlocking works only.

@To be scored out if not applicable.

Signature	#Countersigned by:
Name	Signature .....
Assistant Engineer/	Name .....
Dated.....	Dated.....

Signature	#Countersigned by:
Name	Signature .....
Assistant Signal & Telecommunication Engineer	Name .....
Dated.....	Dated.....

Other officers concerned	#Countersigned by:
Signature	Signature .....
Name	Name .....
Designation	Dated.....

No.....Dated.....

#To be Countersigned by the officers who had applied for sanction and forwarded to Commissioner of Railway Safety for information:

Forwarded by

Divisional Railway Manager/  
Chief Engineer (Construction)

Para no. 9.3.1(b)

Annexure: 9-A3

## Station Machinery

### FORM VIII [See rule 5(1)(h)] STATION MACHINERY

SECTION: LAKSHMIKANTPUR-KULPI

Railway  
GAUGE: 1.676 M

LENGTH: 9.19 km

Names of Station	INTERLOCKING		SIGNALS						Type of Block working in use	Weigh Bridge No. & Capacity
	Interlocked	Non-Interlocked	Isolated	Warners/ Distant	Outers	Home	Starters	Advance Starter		
1	2	3	4	5	6	7	8	9	10	11
LAKSHMIKAKTPUR	Yes	-	-	Yes	-	Yes	Yes	Yes	Single line Block Instrument	Nil
UDAYRAMPUR	No	Yes	-	-	-	-	-	-	Halt One Train only	Nil
KULPI	No	Yes	-	-	-	-	-	-	Working System	Nil

*Note: The particulars furnished in this form are Illustrative.*

**List of Questions & Answers**  
(Form XV of Rules for opening of Railway)

S.No.	Question	Remarks
(1)	(2)	(3)
	<b><u>SIGNALLING AND TELECOMMUNICATION/BLOCK WORKING</u></b>	
42	Have the requirements and Recommendations for signalling and interlocking, and the catechism for signalling interlocking installations vide Chapter VII of these rules and the appendix thereto, being fully complied with, according to the class of signalling and interlocking installed? If not, in what respect do the arrangements provided fall short of them?	
43	Have the requirements and Recommendations for signalling and telecommunication installations in accordance with the instructions issued for the installations of S&T equipment in 25 kV 50 Hz electrified sections been complied with? If not, in what respect the arrangements provided fall short of them?	

*Note: Further details please refer to Appendix 'B'(page 76 to 87) and Appendix 'C'(page 88 to 91) of Rules for opening of Railway.*



**Safety Certificate for S&T Works for Introducing Electrification**

It is hereby certified that the Signalling and Telecommunication works to be executed for the purpose of introduction of 25 KV single phase, 50 cycles A.C. traction between ..... and ..... on ..... Railway have been carried out properly and that electric traction can be introduced for public carriage of passengers without endangering the safety of the travelling public or of the employees of the Railway.

Signature	
Name	
Designation	

### Joint Safety Certificate (For New Types of Locomotives or Rolling Stock)

Certified that it is safe to run ..... (Particulars of locomotives and rolling stock proposed to run) not exceeding ..... units in the case of locomotives) coupled together on the section (station) ..... to ..... (station) from ..... (km.) to ..... (km.) of the ..... Railway at a maximum speed of ..... (kmph) against a maximum speed of ..... (kmph.) certified by R. D. S. O. and subject to the following speed restrictions and conditions:

(a) Speed Restrictions:

SL. No	From Km to Km	Nature of speed restriction	Brief reason for restriction

(b) Special Conditions:

1. ....
2. ....
3. ....
4. ....

To be signed by

P.C.M.E.

P.C.E.

P.C.E.E

P.C.S.T.E

P.C.O.M

*Note 1: The Chief Operating Manager and the Chief Signalling and Telecommunications Engineer should be associated when the increase in the speed of a locomotive or rolling stock is contemplated over the maximum sanctioned speed for a specific category of train (passenger or goods) over a particular section of the railway.*

*Note 2: Over the railways where both the shop maintenance and open line maintenance of electric locos and electrical multiple unit rolling stock are under the control of the electrical department only, the Chief Electrical Engineer, otherwise the Chief Mechanical Engineer shall also sign.*

*Note 3: When Motive power with chopper control is to be used, the Chief Electrical Engineer and the Chief Signalling and Telecommunication Engineer shall sign this certificate.*

## Handing Over/Taking Over of Signalling Assets

### Procedure Order for Handing Over/Taking over of Newly Created Signalling Assets

1.	Dy. CSTE/Con or Project or Rly PSUs incharge of the work in field shall submit the programme of commissioning the works during the year to Sr. DSTE of the division in the beginning of the financial year.
2.	The works shall be carried out as per the standard drawing, extant instructions and the quality manual/guidelines. Any deviation from the extant instructions will require the approval of PCSTE.
3	The Station Working Rules (SWR) shall be prepared by the concerned Construction/Project Officer or Rly PSUs Officer and signed by the Divisional S&T and Operating Officers.
4	All the works to the extent possible should be completed during pre non-interlocking period ((Pre NI). Outdoor works such as preparation of ground connections and fixing of point machines on points and its testing, re-allocation and termination of cables, re-allocation of outdoor signaling gears etc. shall invariably be completed by the Construction/Project organisation or Rly PSUs after taking disconnection/block. The reconnection of the existing gears shall be given only after the gears have been fully tested by the concerned maintenance staff of open line so as to ensure that the gears are in proper safe working condition.
5	<p>CSTE/Con or CSTE/Proj or Rly PSUs incharge of the work shall discuss the modalities with PCSTE/OL before non- interlocking of major station yards for signalling works, similarly for medium and wayside stations the Dy.CSTE/Con or Project or Rly PSUs in-charge of the work shall discuss the modalities of the works to be done during NI period with Sr. DSTE incharge of the concerned division.</p> <p>Joint inspection by Divisional open line and construction or Project or Rly PSUs both at SSE/Incharge &amp; officer level shall be undertaken before taking up Non-interlocking of a station in connection with yard re-modelling/interlocking changes for commissioning of Signalling works.</p>
6	No major work shall be undertaken by the S&T construction organisation or Rly PSUs incharge of the work inside the relay room/cabin/cabin basement at any station unless the maintenance of signaling equipment at the station is taken over by Executing agency (Construction organisation/Project organisation (where assigned in case of PSU)). The maintenance in such cases shall extend to all signaling gears in the yard. However, minor alterations inside the relay room/cabin/cabin basement etc. can be undertaken in presence of the maintenance staff of the Open Line without taking over the maintenance of the station.
7	When maintenance is taken over by such Executing agency referred in para 6, all the maintenance staff for that station shall be put under the administrative control of such Executing agency for the required period.

8	During the period the maintenance of the station is with such Executing agency, it shall be responsible for safe working of gears. All safety instructions issued from time to time shall be scrupulously followed by such Executing agency. Dy.CSTE Concerned shall analyse all the signal failures at the stations under his maintenance and keep the Sr.DSTE of the division informed about the causes of failures and corrective action shall be taken.
9	The Open Line inspectors and Officers shall associate themselves during the work execution stage of the new/alteration works with a view to acquaint themselves with these works and also point out any deficiency that is required to be removed in the interest of proper functioning of the gears. The observations shall be jointly agreed and recorded in the "Site Inspection Register" to be kept at the station for this purpose.
10	No work shall be done in the existing location boxes without the presence of Open Line maintenance staff.
11	The cable route plan should be got approved from the division before undertaking the work of trenching & cable laying. Instructions laid down in the joint procedure order issued by the Board vide letter No. 2004/Sig/G/7 dtd. 17/12/2004 and Rly. Bds Circular no.17/2013 dtd. 24.06.2013 should be followed meticulously.
12	Power supply equipment proposed to be installed by construction organisation or Rly PSUs for the works shall be in accordance with the latest policy/ circular/ instructions issued from time to time. For any deviation, approval of PCSTE/OL should be taken.
13	The open line organisation shall carry out the cable insulation test, power supply auditing and the functional tests before permitting such Executing agency referred in para 6, prior to commencement of any non-interlocking working. In case any alteration is done in the wiring diagram by the staff of such Executing agency, after carrying out the final function test by the open line staff, this shall be brought to the notice of open line officials for conducting the test again on the altered portion.
14	Such Executing agency shall complete the requisite work in all respect and carry out the continuity test, wire count, break down test and the functional tests before offering the installation to the open line in writing for joint tests.
15	Sr.DSTE shall plan the positioning of the maintenance staff immediately after the construction/Project organisation or Rly PSUs gives the programme of commissioning for the year. It will help positioning of staff well in time so that maintenance of the station can be taken over immediately after commissioning.
16	Record of functional test carried out on a selection table/locking table/route control charts, contact break down test and continuity test shall be submitted to Open line immediately after commissioning. Open line official shall keep these documents at the respective station in a sealed packet carrying the details of the documents and signature of Sr. DSTE/DSTE of the division.
17	The details of the works to be undertaken at the stations shall be advised by the construction/Project organisation or Rly PSUs to the concerned Sr.DSTE of the division in advance. Dy.CSTE/C or Rly PSUs in-charge of work and Sr.DSTE of the division shall have periodical meetings to review the progress of ongoing works and decide the dates of joint inspection of the works nearing completion. Minutes of such meetings shall be recorded jointly & issued to all concerned for guidance & follow up.

18	<p>Within 15 days of commissioning of Signalling work, another joint inspections both at supervisor and at officers level by Open Line and Construction organisation or Rly PSUs shall be undertaken. The deficiencies noted during this inspections shall be listed in two categories as under:</p> <p>Category-A: Items shall be complied before handing over.</p> <p>Category-B: Items that shall be complied after handing over with the target dates mutually agreed in writing.</p>
19	<p>Sr. DSTE of the division shall ensure that Open line staff actively associate with the construction activities particularly in the following areas:</p> <ul style="list-style-type: none"> <li>(i) Site plan and size of RRI/Panel</li> <li>(ii) Cable Route Plan and cable laying</li> <li>(iii) Signal locations</li> <li>(iv) Power supply sources and equipment plan</li> <li>(v) Cable testing.</li> </ul>
20	<p>While handing over the maintenance of the works executed by the construction organisation or Rly PSUs, the following completion documents and maintenance accessories shall be handed over to the division. All the drawings should be in standard size as laid down in Para 8.1.3 of Signal Engineering Manual.</p> <ul style="list-style-type: none"> <li>(i) Approved SIP of the station</li> <li>(ii) Completion wiring diagrams</li> <li>(iii) Control Table/Selection Table/Locking Table/Route control chart and Dog-Chart</li> <li>(iv) Panel diagram/VDU diagrams (in case of panel or EI installations)</li> <li>(v) Sighting Committee certificate on proper Performa as per SEM.</li> <li>(vi) Approved as well as updated 'As Laid' Cable route plan.</li> <li>(vii) Cable termination plan/diagrams in relay room and location boxes, power supply room.</li> <li>(viii) Wire counts details n case of RRI.</li> <li>(ix) Power supply arrangement plan.</li> <li>(x) Cable insulation test record.</li> <li>(xi) Signal infringements at the station.</li> <li>(xii) Track circuit bonding plan.</li> <li>(xiii) Battery history card, track circuit test card and earth resistance measurement record.</li> <li>(xiv) The tools and plants and spares.</li> <li>(xv) 3 sets of DVDs containing all completion drawings.</li> <li>(xvi) Floor Plans of Relay room, IPS room, Battery room, ASM room, OFC/Telecom cable room, Maintainer room.</li> <li>(xvii) Earthing Plan of Relay room, IPS room &amp; Control Panel/VDU ASM's room</li> <li>(xviii) Earthing value joint measurements records.</li> </ul> <p>One laminated copy of the documents mentioned at i, ii, iii, vi, vii, ix, x, xi, xii, xiii, xvi, xvii above shall be kept at the station for reference of the maintenance staff.</p>

21	The safety certificate shall be also be handed over to the Division at the time of handing over of the maintenance of the station. In addition, technical documents of the new equipment, if installed, shall also be handed over.
----	--

**Application for PCSTE Sanction**

No.....

Office.....

From,

Dated.....

The .....

Designation.....

To,

The Principal Chief Signal &amp; Telecommunication Engineer,

.....

Sir,

I hereby apply for your sanction to \_\_\_\_\_

\_\_\_\_\_ being commissioned and opened for public carriage of passengers when ready as CRS sanction is not required as per para 9.2.2 of SEM.

The documents are enclosed as per checklist ([Annexure: 9-A10](#))**Modus Operandi**

The work.....shall be carried out after disconnection/non-interlock & traffic block if required at site. After completion of the work reconnection memo shall be issued. The work will be commissioned by..... on receipt of the PCSTE sanction and after signing the safety certificate and when required, also dispatch a communication to your address intimating that the work has been opened and the safety certificate signed and issued.

Yours faithfully

Signature.....

Designation.....

Dated.....

**PCSTE Sanction**

..... Railway

No .....

Dated .....

From,

Principal Chief Signal & Telecommunication Engineer,  
.....

To,

The .....

Designation.....

Sub:.....

Ref: Your Application No.....dtd.....

1. In response to your application No.....dated.....Sanction is accorded to the work.....being carried out. #Validity of sanction is ..... months from date of sanction.

2. I do not propose to inspect the work prior to its opening for the carriage of passengers. When ready, it may be opened on a Safety Certificate which should be submitted to me direct without any delay.

(or)

I propose to inspect the work prior to its opening for the public carriage of passengers. Advice of the date, when work will be ready for inspection should be intimated at least 14 days before it is proposed to open it.

(Strike out paragraph not applicable)

Principal Chief Signal & Telecommunication Engineer  
.....

No.....

Dated.....

#Validity of sanction is six months unless otherwise specified.



**Check List for PCSTE Application for Sanction for Signalling Works**

\_\_\_\_\_ RAILWAY

**(1) List of documents/drawings enclosed:**

	YES/NO/NA
(a) Description of proposed works.	
(b) Signalling and Interlocking plan no.	
(c) Mid section LC Gate drawings (if any)	
(d) Panel Front Plate/VDU diagrams Diagram No. (If it is Panel or EI installations)	
(e) Route Control Chart/Control Table/Locking Table no.	
(f) Station Working Rule (SWR) with SWR diagram No.	
(g) List of infringement to Schedule of Dimensions.	
(h) List of deviations from the manuals of instruction for signaling and interlocking and Block signaling.	
(i) List of deviations from General and Subsidiary Rules.	
(j) Restrictions (if any)	
(k) The work will be executed by unit .....	

**(2) Other drawings enclosed:**

(a)
(b)
(c)
(d)

Signature of officer concerned \_\_\_\_\_

Name :

Designation :

Unit :

Mobile No :

*Note: Actual check list (if any) may be obtained from office of CRS/PCSTE concerned & submit accordingly.*

## Chapter 10: Contracts for Works

### Section 1: General

**10.1.1 Code References for Contracts:** The procedure and rules for the calling for tenders and entering into contracts for execution of works and supply of materials are contained in Chapter XII of the Indian Railway Code for the Engineering Department and Chapters III, IV and VII of the Indian Railway Code for the Stores Department.

#### 10.1.2 Basis for Inviting Tenders and Entering into Contracts

- (a) Tender schedules shall be prepared keeping in view scope of work, tentative drawing issued, existing installation and after careful site survey. Where ever feasible, works shall be dovetailed to avoid infructuous expenditure uniformity of equipment in a section/division shall be kept in view.
- (b) The documents which form a contract are as follows:
  - (i) Instructions to parties tendering,
  - (ii) Tender form, if any,
  - (iii) Specifications – Standard and special,
  - (iv) Schedule of items and quantities, rates, etc.
  - (v) Conditions of contract – General and Special,
  - (vi) Agreement Form,
  - (vii) Scope of the work, Time scales,
  - (viii) Location particulars of the work, Equipment details in case of Annual maintenance contract (if any).

*Note: Items above shall be comprehensive and explicit so that there is the least possibility of conflicting, even differing, interpretations being placed on the intentions of the contract.*

- (c) Each Sr Divisional Signal and Telecommunication Engineer shall be in possession of copies of items mentioned in [Para 10.1.2\(b\)](#) and acquaint himself with the provisions contained therein. SSE/JE (Signal) may be supplied with copies of these where necessary.
- (d) Copies of items mentioned at [Paras 10.1.2\(b\)](#) shall be available in the Office of the concerned Chief Signal and Telecommunication Engineer/Construction/Projects and the Senior Divisional Signal and Telecommunication Engineer/Deputy Chief Signal and Telecommunication Engineer/Field unit for information to contractors who shall be advised to make themselves conversant with the provisions contained therein before tendering for works or supply of materials. This information may be given in Electronic Form for e-Tenders.

- (e) Amendments when considered necessary to any para, clause or items of the regulations for tenders and contract, the general conditions of contract, the specifications for materials and works and the schedule of rates shall be authorised solely by the Principal Chief Signal and Telecommunication Engineer and intimated to the Executive Officers and supervisors who shall acknowledge receipt of the same.

*Note: Where ever schedule of Rates is available, the same shall be adopted. Quantities shall be arrived at after site survey and as per plans, drawings issued.*

## **Section 2: Tenders/E-Tenders**

**10.2.1 Calling for Tenders:** Tenders/e-Tenders may be invited for any of the works required to be carried out under contract. When calling for tenders for works, the provisions contained in para 1211E of Engineering code shall be observed. Tenders may be invited by the Sr Divisional Signal and Telecommunication Engineer, Deputy Chief Signal and Telecommunication Engineer/Construction, Divisional Railway Manager or the Chief Signal and Telecommunication Engineer depending on the contract value or works (s) according to the procedure that may be prescribed by the Administration for the purpose. The common methods of obtaining tenders are by advertisement (Open Tenders), by direct invitation to a limited number of contractors (Limited Tender) and in exceptional cases by invitation to one contractor (Single Tender).

### **10.2.2 Tender Notices/e-Tender Notices**

- (a) Notice for inviting tenders (NIT) shall be in the Format prescribed by the Administration and shall embody the stipulations contained in para 1239E.
- (b) When open tenders are invited, Tender Notices shall be available for participation for all subject to eligibility criteria mentioned. In addition, if so prescribed by the Administration, tender notices shall be published in the newspapers on the approved list of the Government of India, and/or on official web portal for on line tendering, it being left to the authority inviting tenders to select the newspapers and the number of insertions for this purpose.

**10.2.3 Tender Forms:** Tender forms shall embody the contents of the contract document either directly or by reference. Documents pertaining to Technical & financial eligibility criteria if any and special conditions should also be available. Tender forms shall be down loaded from the official web portal by paying prescribed fees on line by the tenderers. Tenderers shall be required to submit evidence regarding their financial status, previous experience and ability to execute the works and an authorised copy of the Income Tax clearance Certificate along with other documents mentioned in Tender Notice, at the time of submitting their bid online without which their tenders shall not be considered.

### **10.2.4 Drawings and Specifications**

- (a) Unless otherwise agreed to specifically, the execution of works and supply of materials on contract shall be according to the Railway's Drawings and the Specifications.

- (b) If no specification exists for any item of work or supply, a complete specification of the item and of the materials to be used shall be prepared and incorporated in the contract documents or made available for referencing by intending tenderers.

#### **10.2.5 Earnest Money, Security Deposit and Performance Guarantee**

- (a) The tenderer shall be required to deposit earnest money along with the tender offer at the rates prescribed by the Administration as initial security. In case of acceptance of the tender, the earnest money will be retained by the Railway as a part of the security for the due and faithful fulfillment of the contract and the balance to make up the security deposit at the rates stipulated by the Administration or will be recovered by percentage deductions from the Contractor "on account" bills.
- (b) The earnest money of all unsuccessful tenderers shall be refunded as expeditiously as possible as per extant instructions from Railway Board issued from time to time. The successful bidder will have to submit a Performance Guarantee (PG) as per conditions laid down in GCC.

#### **10.2.6 Opening of Tenders & Tender Committees:** At the advertised time and place Tenders/ e-Tender shall be opened. The Administration will specify;

- (a) The constitution and functions of Tender Committees, Convenor for the purpose of evaluation and submission of recommendations to competent authority, should be as per latest Railway Board guidelines/SOP.
- (b) The powers of acceptance of tenders and entering in to contract and signing of contract agreement etc., shall be exercised by the competent authority as per latest Railway Board guidelines/SOP.
- (c) The conditions in regarding to acceptance of single tenders.

*Note: (1) When a single tender is received in response to a call for limited or open tenders, the urgency of the work shall be the criterion for its acceptance, provided the tendered rates are considered as reasonable.*

*(2) If the rates in a single tender are considered inordinately high, negotiations may be carried out by the Tender Committee with the tenderer in the interest of work.*

#### **10.2.7 Acceptance of Tenders**

- (a) Tenders opened and duly initialled at the Tender Committee Meeting shall be valued in the office of the Chief Signal and Telecommunication Engineer, Divisional Railway Manager, Deputy Chief Signal and Telecommunication Engineer as the Divisional Signal and Telecommunication Engineer as the case may be, the stipulations made, if any, being duly assessed and a comparative statement prepared. The comparative statement together with a note shall be sent to the Accounts Department for vetting. Based on the vetted comparative statement, the tenders will be adjudged by the Tender Committee and recommendations made to the authority empowered to accept the tender.

- (b) Ordinarily the lowest eligible tender may be accepted by the Railway unless such acceptances would not be in the public interest. The acceptance or rejection of any tender is left entirely to the discretion of the authority empowered to deal with the matter and no explanation can be demanded by any tenderer as to the cause of rejection of his tender.

**10.2.8 Entering into Contracts:** No contract shall be entered into unless authority exists for commencement of the work. No authority shall enter into a contract beyond its own powers of sanction.

**10.2.9 Execution of Contract Documents**

- (a) The tenderer whose tender is accepted shall be required to appear at the office of the concerned Chief Signal and Telecommunication Engineer/ Construction/Projects or Sr. Divisional Signal and Telecommunication Engineer/Dy. Chief Signal and Telecommunication Engineer as the case may be, in person or if a firm or corporation, a duly authorised representative shall so appear, and execute the contract within stipulated time period. Failure to do so shall constitute a breach of the agreement effected by the acceptance of the tender in which case the earnest money accompanying the tender may be forfeited.
- (b) In the event of any tenderer, whose tender is accepted, refusing to execute the contract documents the authority may determine that such Tenderer has abandoned the contract and thereupon his tender and the acceptance thereof shall be null and void and the earnest money accompanying the tender shall be forfeited.

**10.2.10 Form of Contract Documents**

- (a) Every contract shall be complete in respect of the documents it constitutes.
- (b) The contract agreement required to be executed by the successful tenderer shall be in the form prescribed by the Administration for the purpose. The draft of the contract agreement shall be vetted by the Accounts Department.

**10.2.11 Copies of Contract Documents**

- (a) Sufficient number of copies of the contract documents shall be available for use in the offices of the Sr Divisional Signal and Telecommunication Engineer/ Dy. Chief Signal and Telecommunication Engineer and the SSE/JE (Signal)/ incharge. If materials are to be inspected by an agency other than the consignee, a copy of the contract documents shall be supplied to the inspecting agency also. No deviations in the contract documents shall be permitted without the sanction of the competent authority.
- (b) The executive Officers and incharge supervisor shall thoroughly study the contract documents for works to be carried out and shall adhere to the provisions contained therein.

#### 10.2.12 Items of Works not Included in Contract Documents

- (a) Officer/incharge & supervisor/incharge of the work shall ensure that no item of work that is not included in the contract is carried out without the sanction of the competent authority.
- (b) Items of work not included in a contract may, if deemed expedient, be executed under the contract at the rates mutually agreed on by the contracting parties.

**10.2.13 Modifications to Contract:** In the event of any of the provisions of the contract requiring to be modified after the contract documents have been signed, the modifications shall be made in writing and signed by the Railway and the contractor and no work shall proceed under such modifications until this has been done. Any verbal or written arrangement abandoning modifying, extending, reducing or supplementing the contract or any of the terms thereof shall be deemed conditional and shall not be binding on the Railway unless and until the same is incorporated in a formal instrument signed by the Railway and the contractor, and till then the Railway shall have the right to repudiate such arrangement.

**10.2.14 Issue of Departmental Materials to Contractors:** When so specified in the contract, cables and other S&T materials shall be issued to contractor and receipts obtained for the same, It shall be ensured that the Contractors takes reasonable care of all materials made over to him and that on completion of the works the unused balance of the same are handed over by him in good order.

### Section 3: Measurements and Measurement Books

**10.3.1 Code References:** The rules regarding the recording of measurements in measurement books, care and custody of measurement books and the preparation of contract bills are given at Para 1313 E. ([Annexure 10-A1](#)) of Engineering code.

#### 10.3.2 Measurement Books

- (a) Each measurement book shall have;
  - (i) Instructions printed at the commencement.
  - (ii) An Index which should be posted up-to-date. A form of measurement book is attached as [Annexure: 10-A1](#).
- (b) Measurement books shall be issued to the SSE/JE(Signal)/incharge of the work, by the Sr Divisional Signal and Telecommunication Engineer/Dy Chief Signal and Telecommunication Engineer as required, duly numbered thus M. B. No ..... of yyyy. As few books shall be issued as can conveniently meet the requirements.
- (c) A register of measurement books shall be maintained by the Sr Divisional Signal and Telecommunication Engineer/Dy Chief Signal and Telecommunication Engineer where in the contents and the movement of each measurement book shall be indicated.

- (d) Measurement books shall be sent from one Office to another in the personal custody of a responsible person.
- (e) Completed measurement books and those not in use although not completely exhausted, shall if they are no longer required, be sent to the Sr Divisional Signal and Telecommunication Engineer/Dy Chief Signal and Telecommunication Engineer to be filed in his Office.
- (f) If a measurement book is lost, immediately after the loss is discovered, the matter shall be reported to the Sr Divisional Signal and Telecommunication Engineer/Dy Chief Signal and Telecommunication Engineer, who will obtain sanction to write off the book from the registers of Measurement Books.

### **10.3.3 Recording Measurements**

- (a) Every entry in a measurement book shall be commenced with a Statement as to how it is to be billed. The instructions for recording measurements contained in [Annexure: 10-A1](#) shall be followed.
- (b) The pages of every measurement book shall be machine numbered, no page on any account shall be torn out, nor shall any entry be erased or defaced so as to be illegible.
- (c) Entries shall be recorded continuously in the measurement book. No blank pages shall be left. Any page left blank inadvertently shall be cancelled by diagonal lines drawn across the pages, the cancellation being attested.
- (d) When any measurements are cancelled, the cancellation shall be supported by the initials with date of the Officer ordering the cancellation or by the Official who made the measurements. The reasons for cancellation shall be recorded.
- (e) Should it be found necessary to make any additions to measurements already taken owing to omission at the time of the measurements, such additions shall be detailed in a subsequent page of the book, giving reference to the page containing the original measurements and explaining the reasons for the same.
- (f) Entries of the measurements shall be made direct into the measurement book at the site of the work in the presence of the contractor or his agent. The copying of entries from a rough note book or other record is forbidden.
- (g) The Contractor or his authorised agent shall be present at the time of all on account and 'final' measurements and should sign the measurements recorded in the measurement book as acknowledgement of his acceptance of the accuracy of the measurements and the classification of materials. The contractor shall be given due notice of the time and date on which the measurements are to be taken. Failing his attendance, the work may be measured up in his absence and such measurements shall not withstanding such absence, be binding upon him whether or not he shall have signed the measurement book provided that any objection to any measurement that is made by him in writing within seven days of the date of such measurements shall be duly investigated and considered.

- (h) After the contractor's dated signature has been obtained, the official recording the measurements shall attest his full signature and designation at the end of the measurements. RTGS/NEFT – mandate Form must be collected.

#### **10.3.4 'On Account' Measurements**

- (a) For measurements against which on account bills are prepared and which are subject to adjustment in final bills, the official incharge may use percentage measurements for the part the work completed.
- (b) Quantities for payment' on account' shall never exceed the estimated quantities of actual work done upto the time of payment. In order to ensure this, the following certificate shall be recorded by the official incharge in the measurement book for all' on account' measurements.

"I hereby certify that not less than the quantity of work paid for has actually been done and that the measurements are from plans/approximately estimated".

#### **10.3.5 Responsibility of the Assistant/Divisional Signal and Telecommunication Engineer for Measurements of Works**

The Assistant/Divisional Signal and Telecommunication Engineer shall be responsible for the correctness of the measurements Quantity and adherence to clauses & specifications laid down in the contract for all works in his charge. He shall ensure that the measurements are made Timely in the specified manner and recorded by the SSE/JE(Signal)/incharge of the work. Test check of works as per extant norms shall be done by ASTE/DSTE and recorded, accordingly on the measurement book.

#### **10.3.6 Computation of Quantities**

After measurements for a work are recorded, the quantities shall be computed and entered in the 'contents' column of the measurement book. This may be done by the official recording the measurements himself or in the office.

#### **10.3.7 Preparation of Abstracts in Measurements Books**

- (a) After the quantities are computed, an abstract shall be prepared in the measurement book in the office of Sr. Divisional Signal and Telecommunication Engineer/Dy Chief Signal and Telecommunication Engineer. The abstract shall be headed thus "Abstract of pages.....to.....". The abstract shall show the correct description of the item, total quantity done up-to-date, rate and the total value for each item measured/checked, in connection with the work. The total of the values of all the items will be the total value of the work done up-to-date.
- (b) In the case of a first and final bill, this amount will not be subject to any deduction and will be paid in full to the contractor, except Security Deposit and other taxes.



- (c) In the case of an 'on account' bill, the prescribed percentage of the value of the work done since the last certificate shall be deducted as security deposit towards the due fulfillment of the contract. The balance will be the amount payable to the Contractor and this amount must be written clearly in words as well as in figures.
- (d) On satisfactory completion of the work, the security deposit will be refunded to the contractor after the final payment for the work is made. Part of the security deposit may be kept with the Railway in specified cases whenever it is necessary to watch the results of the work and to ensure that there will be no failure of the work for the period stipulated in the contract.
- (e) The abstract shall be signed and dated by the Assistant/Divisional Signal and Telecommunication Engineer.
- (f) Each paragraph of the measurement book to which the abstract pertains shall be crossed in Red Ink diagonally thus.
- (g) See Abstract pages .....
- (h) At the foot of each abstract the relevant bill number and date of preparation of the bill shall be entered.

**10.3.8 Submission of Bills:** After the abstract is prepared in the measurement book, the bill shall be prepared in the Sr. Divisional Signal and Telecommunication Engineer's/Dy. Chief Signal and Telecommunication Engineer's Office on the prescribed form or submitted by firm.

#### **10.3.9 Checking of Bills**

- (a) The quantities in measurement books submitted by the Assistant Signal and Telecommunication Engineer/Divisional Signal and Telecommunication Engineer shall be checked for arithmetical accuracy in the Sr. Divisional Signal and Telecommunication Engineer's/Dy. Chief Signal and Telecommunication Engineer Office where it will be verified that;
  - (i) The description of items is according to the contract schedule.
  - (ii) There are no delays in recording measurements.
  - (iii) The quantities executed are according to sanctioned plans and estimates.
  - (iv) Where measurements are not recorded, correct reference to the standard measurements is clearly given, and
  - (v) The quantities recorded in the bill agree with those shown in the measurement book and rates higher than those sanctioned are not allowed.
- (b) An endorsement shall be made at the end of Assistant/Divisional Signal and Telecommunication Engineer's abstract in the measurement book under the signature of Sr. Divisional Signal and Telecommunication Engineer/Dy. Chief Signal and Telecommunication Engineer giving reference to the particulars of the bill passed.

- (c) RTGS/NEFT mandate form shall be obtained from contractor for enabling electronic payments.
- (d) The Railway Administration may lay down a time schedule for preparation and checking of bills.

#### **10.3.10 Bill Registers**

The Sr. Divisional Signal and Telecommunication Engineer's/Dy. Chief Signal and Telecommunication Engineer's Office shall maintain Bill Registers in which all bills prepared in their office shall be recorded. The Register shall be kept upto date and complete information with reference to agreements, work orders, abstracts in measurement books and amounts.

#### **10.3.11 Disputes with Contractors**

Every effort must be made to ensure supply of drawings, handing over of site, deputing of staff for supervision, materials (if any), budget for work, Timely payments to contractor, to avoid disputes with the contractor.

- (a) On the completion of every work, 'No claims certificate' shall be obtained from the Contractor according to the relevant clause or clauses in the condition of contract. Every month or when 'on account' bills are made out, the contractor shall be instructed to submit a list of outstanding claims, if any.
- (b) If there is any likelihood of a dispute with a contractor, all documents, measurements and letters bearing on the case shall be at once collected and stored in safe custody with the officer responsible for the case. In all such cases care shall be taken to commence all correspondence with the contractor with head line 'without prejudice'. The contractor shall be instructed to submit complete details of his claims in writing with a certificate to the effect that these are final.
- (c) In spite of all reasonable efforts as per agreement, if the contractor refuses to sign the final contract certificate, the final contract certificate shall be forwarded to the Accounts Officer to make payment. The contractor may accept payment, if he wishes under protest.
- (d) Disputes arising out of the contract for a work, between the contractor on the one hand and the Railway Administration on the other, shall be referred for arbitration in accordance with the relevant clause in the General Conditions of Contract.

#### **10.3.12 Completion Reports**

- (a) After completion of a work as per its scope, Completion report shall be drawn by the Sr. DSTE/Dy. CSTE incharge of the work. All expenditures like stores, contract, adjustment memos, work shop debits, D&G charges etc., shall be properly accounted.
- (b) Finance concurrence of Completion estimate shall be obtained from associated finance and sanction from the competent authority.
- (c) Work shall be deleted from list of the works and same shall be intimated to PCSTE/CSTE(C).



*Note: This Chapter has under mentioned Annexures*

<i>S.No.</i>	<i>Annexure No.</i>	<i>Description</i>
<i>1</i>	<i>10-A1</i>	<i>Instructions for Recording Measurements</i>

### Instructions for Recording Measurements

1. The measurement book is the basis of all accounts of quantities of work done by contract and shall be so kept that the transactions may be readily traceable into the accounts by the entry of the number and date of bill in this book when the bill has been prepared and the entry of the number and page if the measurements affected shall then be crossed red ink diagonally thus

**See abstract pages**

2. All measurements are to be taken down in ink in this book and in no others. The description of work must be lucid so as to admit of easy identification and check. The measurements shall show the quantities of work done as par last measurement and the total to date. A reference to the pages of the measurement book, where the previous measurements are to be found, also be given.
3. No erasures are allowed. If a mistake is made, the wrong wordings or figures shall be neatly scored out and correct entries made. Every such correction shall be initialled.
4. For large works, a separate measurement book may be specially set apart, or if found convenient, even two or more books may be set apart for different classes of works.
5. The measurements book must be looked upon as important records; they shall be carefully checked by the Engineer-in-charge to set that they are kept up as complete records of each kind of work done for which certificates have been granted. The eventual return of all books to the Sr Divisional Signal and Telecommunication Engineer's Office or Dy. Chief signal and Telecom Engineer's office for record shall be insisted upon.
6. Whenever an Divisional/Assistant Signal and Telecommunication Engineer is required to submit his measurement book to the Sr Divisional Signal and Telecommunication Engineer's Office or Dy. Chief signal and Telecom Engineer's office a Second book may be provided for his use where necessary.
7. Whenever progress on a work is reported in lump sum quantities under sub-heads of works, the number and page of the measurement books shall invariably be quoted.
8. It will be found convenient to keep the measurement relating to one work together and to effect this, the number of pages likely to be wanted for a work for sub-head shall be estimated and set apart for the purpose of recording the measurements consecutively.

9. Before detailing the measurements relating to a work the following information shall invariably be given at the top of the first page of such measurements, each item being underlined in red ink:
  1. Final/on account contract certificate No.
  2. For previous on account bill see page.....of measurement Book No.
  3. Name of work.
  4. Situation of work.
  5. Agency by which work executed.
  6. Reference to Agreement of work order.
  7. Date commenced.
  8. Date completed.
  9. Date of measurement.
10. For facility of reference and to assist in carrying out the instructions given in para 8 above, the index shall be kept up-to-date.

# Chapter 11: Dataloggers and Predictive Maintenance Systems

## Section 1: Dataloggers

### 11.1.1 Purpose of Dataloggers

- (a) To monitor of signalling equipment and to provide real-time alerts/offline reports for taking necessary action by concerned staff.
- (b) Assist in collaborative working of various agencies/persons responsible for upkeep of signalling system by sharing of data.
- (c) To provide Data evidence for investigation of unusual incidences.
- (d) To provide Data to Train operation Applications (as required).

### 11.1.2 Assets for Status Monitoring

The following equipments shall be monitored (not limited to)

- (a) Relays – potential free contacts.
- (b) Power supplies – voltages, Currents.
- (c) Electronic Interlocking – Signalling elements data, Diagnostic data of EI.
- (d) Earth leakage detectors for Signal & Power Cables.
- (e) Wherever Potential free contacts are available for any signalling equipment like SPD, fire detection system, IPS etc, the same shall be monitored through Datalogger.
- (f) Diagnostic Data from MSDAC, IPS, Trackside ATP, Fire Alarm etc.
- (g) Door Opening/Closing of Relay Rooms.

### 11.1.3 General Requirements: The Datalogger system shall;

- (a) Perform the following functions;
  - (i) Sensing the parameters of signalling equipments and acquiring diagnostic data from other processor based equipments.
  - (ii) Communicating the data to a central location, analyzing the data and providing actionable decisions as alarm.
  - (iii) Dissemination of alarms to the concerned staff for taking necessary action.
  - (iv) To send short messages to concerned staff for taking appropriate actions.
- (b) Chronologically monitor and record the status of various field functions like track circuits, points & signals through their indoor repeater relays, operator's push buttons/switches (digital Inputs) and level of various analog signals like DC and AC supply voltages.
- (c) Be capable of receiving both Digital Inputs & Analog Inputs at regular intervals by scanning them for change of state/Values.

- (d) Be suitable for working on non-electrified, AC electrified areas.
- (e) Be capable of working in any type of signalling installations on Indian Railways.
- (f) Dataloggers shall be suitable for deployment in the outdoor locations such as LC gates, goomties of Distributed Electronic interlocking, Automatic Block signalling goomties and IB Signal Huts using Remote Terminal Unit (RTU) which shall be connected to Datalogger system through suitable communication media.
- (g) Datalogger system shall provide data driven decisions to various agencies involved with asset management/usage.
- (h) Be re-configurable to any changes required by user, whenever modifications are carried out in the yard.
- (i) Validation of Datalogger for accurate correspondence of Inputs, Outputs, Alerts & yard layout display both at the time of Initial Installation & after every yard/signalling alterations shall be done.
- (j) The following outputs shall be available from Datalogger system at Test rooms and remote locations
  - (i) Online alarms
  - (ii) Online simulation
  - (iii) Reports of alarms, events in textual and graphical form.
  - (iv) Historic simulation display
- (k) Datalogger shall provide real time inputs (with appropriate interfaces) on train arrival/Departures for improving Train operations.

#### **11.1.4 Technical Requirements**

- (a) For monitoring digital inputs, potential free contacts shall be used. Analog signals shall be connected directly to Datalogger which in turn will convert to digital data for further processing.
- (b) The Datalogger shall have built in Real Time Clock for time stamping the receipt of particular information.
- (c) It shall be feasible to store the data in an external device.
- (d) Synchronisation with Indian Regional Navigational Satellite System (IRNSS) Clock or any Satellite Based approved clock is required for clock synchronisation with the network.
- (e) Existing telecom services shall be used to send alerts to required staff.
- (f) Interoperability among various makes shall be ensured.
- (g) RDSO's Latest Specifications shall be followed.

### 11.1.5 Network Requirements

- (a) Datalogger shall be capable of working with different transmission media like underground telecom cable, microwave (Digital or Analog) & OFC. The modem can be either in-built or external. The external modem will be housed within the Datalogger cabinet.
- (b) It shall be possible for networking and remote monitoring of several Dataloggers from the central location. All features like on-line Simulation, Off-line simulation, failure management, exception logics and Synchronization should be feasible from the central location.
- (c) It shall be feasible to provide IP based networking.
- (d) Data storage and management infrastructure: To support the requirements of local and remote access of online and offline data and alarms and reports – an approved robust IT infrastructure shall be provided.
- (e) Approved system of Data security and safety shall be provided to protect from viruses and unauthorised access.
- (f) Path Redundancy for the networks shall be provided.

## Section 2: Applications of Datalogger

### 11.2.1 Fault & Asset Management

- (a) Datalogger system provides data driven decisions to various agencies involved with asset management and usage. An approved process for using full potential of Datalogger system by integrating its results with the existing process shall be provided with appropriate software.
- (b) **Generation of Exceptional Reports:** These reports shall be generated by a computer connected to Datalogger at the station (and at a central location also in case of networked Dataloggers). Special software loaded in the computer, shall implement defined logics and generate exceptional reports as alarms. As per their category, they shall be sent as messages to required Officials for prompt action. Please see [Annexure: 11-A1](#) for guidance.

### 11.2.2 The following users may be provided with exception Reports/Alarms

- (a) Maintenance staff of signalling equipments
- (b) Electrical maintenance Staff
- (c) P - way maintenance Staff
- (d) Traffic staff/controllers
- (e) Operating staff at station/cabins

## Section 3: Remote Diagnostic and Predictive Maintenance System (RDPMS)

- 11.3.1 The objective of providing Remote Diagnostic and Preventive Maintenance system is to assist maintenance team in taking appropriate maintenance action in advance to prevent the failure of signalling gears.

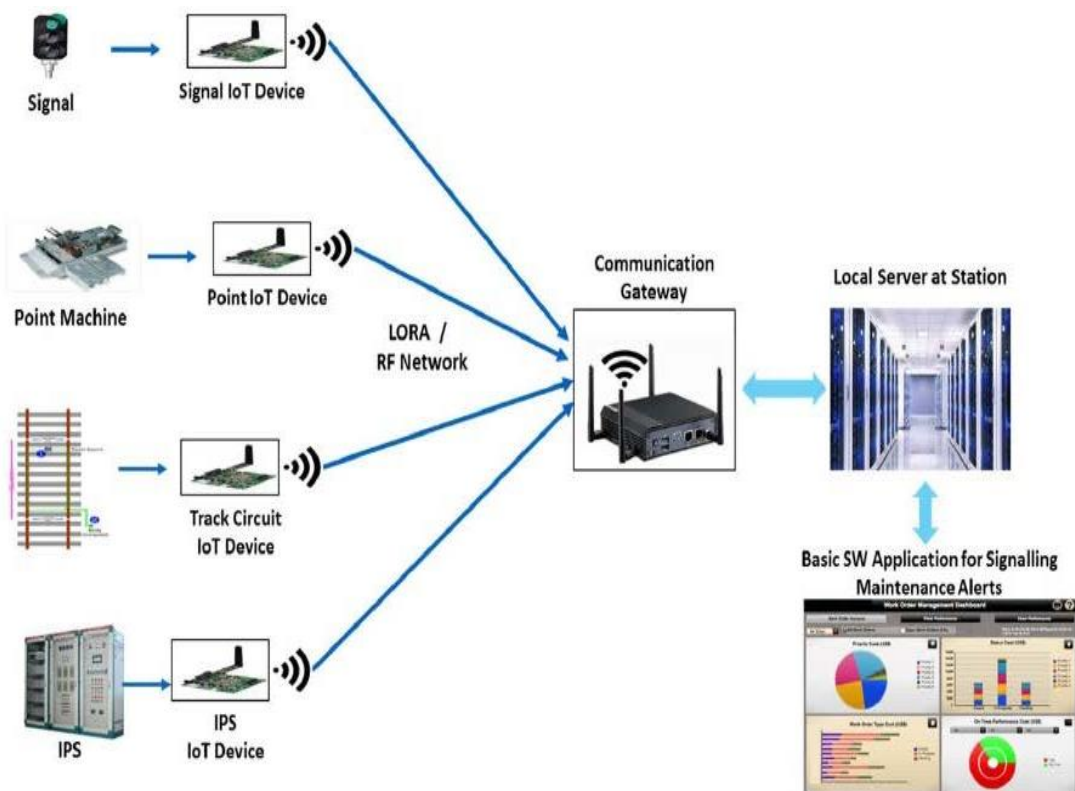


At functional level the system is broadly divided into two categories:

- (a) Remote Diagnostic of Equipment:** To reduce MTTR and providing aid to maintenance staff in rectifying the signal failures. This is achieved by automated analysis of parameters of Signal gears collected remotely using IoT (Internet of Things) devices. The system shall be able to give probable cause of failure to aid the maintenance staff for early restoration reducing MTTR.
- (b) Predictive Maintenance:** To facilitate predictive maintenance by advance computing of Big data using Machine Learning and Artificial Intelligence. The data of all the stations shall be continuously analysed by system for developing the supervised and unsupervised machine learning. The system shall be able to send automatic alerts for Signalling gears which are likely to fail based on the system learning. This will assist the maintenance staff to take necessary action to eliminate failure before it occurs.
- (c) Data Acquisition from Field & Indoor Equipments:** The data from each signalling gear at the station shall be collected on real time basis using the inbuilt diagnostic ports of the signalling gears and/or the external sensors. Sensors of proper rating to be used as per monitoring range of various parameters of signalling gears to be monitored.

### 11.3.2 IoT System

The IoT device shall be software embedded system preferably COTS (commercially off the shelf) and will do the basic function of capturing the parameters from the signalling gears using the sensors and diagnostic ports and transmit the data to Local Server through Gateway at the station.



### 11.3.3 Network Requirements

Communication from IoT device (in station yard near point, signals and other equipments) to Gateway at station may be on Wireless/Optical fiber/Copper cable/Wi-Fi communication. Indoor signalling gears will also be suitably interfaced for monitoring. For communication from Station to Cloud, optical fibre network with redundancy may be used.

### 11.3.4 Cloud Based Predictive Maintenance Algorithms

- (a) The exchange of information from IoT device to Local server and to Centralized Cloud shall be on standard format for interoperability between different systems.
- (b) The time synchronization between various IoT devices is an important requirement for data interpretation in machine learning. For master clock, the IRNSS (Indian Regional Navigation Satellite System) clock may be taken for reference at each station.
- (c) Transfer of raw data from site using IoT devices to local server at station. The data from local servers at every station will be sent to centralized cloud. This data complemented by historical data and trends will be processed using advance computing through data analytics (Artificial Intelligence/Machine Learning) to anticipate any issues or failures before they occur.
- (d) It is proposed that there may be integrated single cloud for all stations of Indian Railways. However, if it is not feasible due to any reason, the cloud can be as per Zonal Railway or a group of Zonal Railways. A mirror cloud may also be setup for data backup.
- (e) An automated alert mechanism will send information to Signal Control of concerned Division and the concerned maintenance staff over SMS/mobile app. The monitoring terminals shall display real-time alerts on the screen.

### 11.3.5 Power Supply Requirement for RDPMS at Station

- (a) The power supply for IoT devices near the outdoor equipments shall be taken from signalling equipment supply with suitable rating fuse, wherever feasible. Where power is not existing, 24 V DC may be extended from nearby location.
- (b) The power supply for IoT devices in Indoor i.e. relay room shall be provided from 24 V DC of IPS (preferably dedicated module in N+1 configuration).
- (c) The power supply for all other equipments i.e. Gateway, Local server, etc. may be provided from 230 V UPS. The input to UPS shall be from same source of IPS i.e. selective AT after auto-changeover of IPS. The backup time of UPS to be decided based on the power-cut duration at particular station.



*Note: This Chapter has under mentioned Annexures*

S.No	Annexure No	Description
1	<a href="#">11-A1</a>	Datalogger Fault Logics – An Example
<i>Note: This Chapter has under mentioned Maintenance schedule in Appendix-I</i>		
S.No	Annexure No	Description
2	<a href="#">11-MS1</a>	Maintenance Schedule of Datalogger

**Datalogger Fault Logics – An Example**

	Fault Name	Ref:	Fault Information	Momentary	Confirmed	Example of Fault Message
1	Signal Bobbing	RDSO	The time difference between ECR (UP to DN to UP) is in between 500 msec. to 2 Sec which should be taken as 1 count and for satisfying the fault logic 2 to 3 counts should happen within 10 Sec.	M		S1 HE CR Signal Bobbing
2	Track Bobbing	RDSO	The time difference between TPR (UP to DN to UP) is in between 50 msec to 1 Sec which should be taken as 1 count and for satisfying the fault logic 2 to 3 counts should happen within 10 seconds.	M		61 TPR Track Bobbing
3	Point Bobbing	RDSO	The time difference of (NWKR/RWKR) (UP to DN to UP) is in between 500 msec. to 2 Sec which should be taken as 1 count and for satisfying the fault logic 2 to 3 counts should happen within 10 Sec. At that time TPR is UP.	M		59 NWKR Point Bobbing
4	Point Failure	RDSO	1. If NWKR, RWKR both are down for more than time interval then it is point failure. 2. In case of Siemens – WKR1 is Down for more than the given time interval.	M	C (120 Sec)	59 Point Failure
5	Sluggish Operation of Point	RDSO	1. In case of siemens – The time difference between WKR1 Down to Up is in between the set time interval. 2. Other than siemens – time interval of NWKR down to RWKR up OR RWKR down to NWKR up is more than set time.	M		51 NWKR Point Sluggish Operation

	Fault Name	Ref:	Fault Information	Momentary	Confirmed	Example of Fault Message
6	Track Circuit Failure	RDSO	<p>T1,T2,T3 are sequential tracks,</p> <p>a) When T2 is DN.</p> <p>b) T1 and T3 UP.</p> <p>c) The time difference between T1 UP and T2 DN is more than 5 Sec.</p> <p>d) The time difference between T3 UP and T2 DN is more than 5 Sec.</p> <p>e) T2 is not bobbing and is DN for more than 10 Sec.</p>	M	C (120 Sec)	S1 TPR Track Circuit Failure
7	Fusing of Signal Lamp	RDSO	<p>When 110 V supply to signals has not failed (i.e. analog voltage value is used in fault logic)</p> <p>a) Yellow (three aspect): After HR picks UP and DR is DOWN, if HECDR is not picked UP within 10 seconds. HR is triggering signal</p> <p>b) Green (three aspect): After HR and DR pickup if DECDR has not picked UP within 10 seconds. HR and DR is triggering signal.</p> <p>c) Red: After HR/DR is DN, if RECDR has not picked UP within 10 seconds. HR/DR is triggering signal.</p> <p>d) Yellow/green (two aspect): After HR/DR picks UP, if HECDR/DECDR has not picked UP within 10 seconds. HR/DR is triggering signal.</p>	M	C (120 Sec)	S1 HHG Fusing of Signal lamp
8	Signal Blanking	RDSO	When 110 V supply to signals has not failed and all ECDRs are down (i.e. analog voltage value is used in fault logic).	M	C (120 Sec)	S1 Signal Blanking

	Fault Name	Ref:	Fault Information	Momentary	Confirmed	Example of Fault Message
9	Signal Flying Back to Danger	RDSO	When RECR is up continuously for more than 2 seconds - in that condition if UCR/LR/U(R)S is up and HR/GR2 is down and signal replacement track(TPR) is up and EGGNR down, then it is Signal Flying back to danger.	M	C (120 Sec)	S1 Signal Flying back to Danger
10	Timer Setting More	RDSO	The TIME difference between JSLR UP and NJPR UP is greater by more than 10% (more than 132 seconds for 120 seconds timer) of the prescribed time.	M		S1 Timer setting More
11	Button Stuck Up		Button relay is up for more than specified time 20 Sec		C	101 WNR Button Relay Stuck Up
12	Point Loose Packing	RDSO	In between two sequential TPRs Down to Up (To ensure it is train movement) if the status of NWKR or RWKR Changes more than 2 times and status of EWNR not changed (Point emergency operation not done) then it is Loose Packing.		C	59 Point Loose Packing
13	Signal Bobbing without Design Problem (i.e Signal Control Relay not Dropped)		If HR/DR is up and HECR/DECR changes its status from Up to Dn to Up is in between 500 msec to 2 Sec and HECR/DECR is not operated along with HR/DR then it is Sig Not Applicable Bobbing without design problem. ECR is triggering sig Not Applicable.	M		S1 HECR Signal Bobbing without Design Problem
14	Signal Bobbing with Design Problem (i.e Signal Control Relay Dropped)		If HR/DR is up, HECR/DECR changes its status from Up to Dn to Up is in between 500 msec to 2 Sec and HECR/DECR is operated along with HR/DR then it is Sig Not Applicable Bobbing with design problem. ECR is triggering sig Not Applicable.	M		S1 HECR Signal Bobbing with Design Problem
15	Signal not Lowered even Operation is Valid		Same as Logic no.19		C	

	Fault Name	Ref:	Fault Information	Momentary	Confirmed	Example of Fault Message
16	Power Supply Failure Alarm	RDSO	Use analog voltage monitoring where LVR is not provided.	M	C (120 Sec)	Power Supply Failure & Power Supply Restored
17	Fuse Blown Off (Additional Hardware to be used to Detect Fuse Failure)	RDSO	Additional hardware to be used to detect Fuse Failure.		C	
18	ELD Detected Low Insulation of Supply (Potential Free Contact of ELD to be Wired as Input to Datalogger)	RDSO	Potential free contact of ELD.		C	Earth Leakage appeared in 110V AC Supply, Earth Leakage disappeared in 110V AC Supply
19	Route not set when Operation is Valid giving the Sequence of Relay Operations. (1. Possible in case of panels where button/switch relays pick up with operation of button/switch even-though the operating conditions are not favourable 2. Sequence of relays shall be provided by railways 3. Not possible for switch type non route setting type panels)	RDSO	GNR, UNR are Up, EGGNR is Dn then after given time interval if HR is in down then check the Route.		C	Route Failure

	Fault Name	Ref:	Fault Information	Momentary	Confirmed	Example of Fault Message
20	Point Burst	RDSO	If the train arrives on the track2 proving the sequence of track1 DN and ahead track to point zone track is down, the point setting in the unfavourable position and then the NWKR/RWKR both are DN for 2min.	M	C (120 Sec)	101 Point Burst
21	Clearing of Signal without Route Locking	RDSO	At the time of HR/DR/ HECR/DECR up, signal lock relays i.e all G(R)LR's/G(R)R/ASR/ALSR in the possible Routes from signal are in down state then it is Failure.		C	S1 Signal Cleared without Route Locking
22	Timer setting Less	RDSO	The TIME difference between JSLR UP and NJPR UP is less by more than 10% (less than 108 seconds for 120 seconds timer) of the prescribed time.		C	S1 Timer setting Less

	Fault Name	Ref:	Fault Information	Momentary	Confirmed	Example of Fault Message
23	Check for Passing of Danger Signal	RDSO	<p>a) When track 2 is DN after track 1 is DN and RECR is UP.</p> <p>b) The time difference between T2 DN and T3 UP is more than 5 Sec.</p> <p>c) The time difference between T2 DN and RECR UP is more than 5 Sec.</p> <p>d) T2 is not bobbing and is DN for more than 1.2 Sec.</p> <p><b>SPAD CASES</b></p> <p>1. Multiple signals (stop, shunt and calling on) on the same post (When RECR is Up, SH/HECR, COECR are Down, Corresponding Point indication and TPR1, TPR2 are Down, TPR3 is Up and time difference between TPR2 Down (triggering) and TPR3 Up is more than time T1, and the time difference between TPR2 Down and RECR Up is more than the given time interval T1, TPR2 is continuously Down for T2. T2 is triggering.</p> <p>2. Two signals on different lines ex. starters) with first controlling track common and point selection. Point selection to be used for each signal apart from the above logic.</p> <p>3. Two signals on the same line reading to the same line on different posts (home and shunt) home signal ASR/ALSR/G(R)LR to be used in shunt signal SPAD logic.</p> <p>4. Two opposite signals (ex. starter and opposite shunt from siding) with one track circuit in between and no approach track circuit for shunt signal -- in starter signal SPAD logic use shunt GNR/UNR not operated condition or Conflicting HR Down.</p>		C	S1 Check for Passing of Danger Signal



	Fault Name	Ref:	Fault Information	Momentary	Confirmed	Example of Fault Message
24	Route Released without Sequential Route Relays in Route Picking up	RDSO	a) ASR UP / G(N)LR Up and b) Concerned route TSSLR DN or TPZR DN or TLSR DN or TRSR DN or UYRs Down or U(R)Ss Up. c) Emergency route cancellation, NJPR DN, AJTR3 /JR Dn.		C	S1 Route released without sequential route relays in route picking up
25	Signal assuming Green with Points in the Route Reverse	RDSO	At the time of DR/DECR is picked up, RWKR in the corresponding Route are picked up then it is Fault.		C	S1 Signal assuming Green with 31 Point Reverse
26	Home/Main Line Starter Signal assuming Green with Adv Starter Danger	RDSO	When DR/DECR Of Home/Main Line starter Signal is up and if the Advance Starter RECR is up then it is Fault.		C	S1 Home Signal assuming Green with S2 Adv Starter Danger
27	Advance Starter Off without Line Clear		HR/DR UP and concerned Line clear relay DN.		C	S2 Advance starter Off without Line Clear
28	Over Speeding	RDSO	T1, T2 and T3 are track circuits in sequence. Length of T2 is fed in the logic option a) Counter starts when T2 goes DN with T1 already DN. b) Counter stops when T3 goes DN with T2 already DN. c) Time interval between (a) and (b) is less than length of T2 divided by maximum permissible speed by more than 10%.	M		Over Speeding at 1TPR On Main line/Loop line

	Fault Name	Ref:	Fault Information	Momentary	Confirmed	Example of Fault Message
29	Failure to set Point Against Occupied Line	RDSO	After complete arrival of the train, if the point is not set against the line on which the train is received within a pre determined time. On Double line rear end points and on single line both front and rear end points are to be considered. <i>Note: 1. Implementation of this logic on big yards is not possible as the options are too many. 2. There can be a case where it is not possible to set the point as all lines are occupied.</i>		C	Rear end Point not set against 01T Occupied line from S1-S4
30	Relay Room Opening (75,76)	RDSO	If Relay Room Door Relay is Down then it is Relay room opened.		C	Relay Room Door Opened, Closed
31	Emergency Route Cancellation	RDSO	Operation of required buttons/switches.		C	S1-S2 Emergency Route Cancellation
32	Point Emergency Operation When Point Controlling Track(S) Fails	RDSO	Operation of required buttons/switches.		C	101 Emergency Point Operation
33	Axle Counter Resetting	RDSO	Operation of required buttons/switches.		C	Axle Counter Reset
34	Train Passing Blank Signal	RDSO	Approach track drop,1st controlling track drop,2nd controlling track pick up & RECR,HECR,DECR,CO ECR,SH ECR drop for specific time.		C	Train Passed at S1 Blank Signal
35	Late Start of Train	RDSO	a) Berthing track DN and b) HECR/DECR UP and c) Signal replacement track DN and d) Time difference between time of occurrence of b and c is more than time defined by user.	M		Late start of Train at S1 Signal

	Fault Name	Ref:	Fault Information	Momentary	Confirmed	Example of Fault Message
36	Late Lowering of Home signal	RDSO	The time difference between signal approach track circuit down and signal HECR/DECR/HHECR/COECR Up time is more than set time. Time difference to be displayed in case signal is cleared late compared to set time.	M		Late Operation of S1 Home Signal
37	Premature Operation of Double Line Block to TOL	RDSO	If LCPR Dn before DR/DECR Dn and SR is Up.		C	Premature Operation of Block Instrument
38	Late Closure of LC Gate	RDSO	Possible in case the design of circuit is such that route gets locked after operation of the signal before gate closing and the signal clears as soon as the gate is closed.	M		Late Closing of LC-131 Gate in the Route S1-S3
39	Calling On Operation		At the time of COECR (input1) (triggering) Up, if COJSLR (input2) is in up state then it is Calling On Operation.	MM		S1A Calling on operation
40	Emergency Route Released		In between ASR (input1) Down to Up if JSLR (input2) Operated then it is Emergency Route Release. ASR Up is triggering (or) GNR (input1) Up, UNR (input2) Up EUUYNR (input3) Up after given time interval if ASR (input4) Up then it is Emergency Route Released.GNR, UNR, EUUYNR are triggerings.	OM		S1-S2 Emergency Route Released
41	Emergency Sub Route Released		If EUYNR (input1) Up and WNR (input2) Up then it is Emergency Sub Route Released. Both are triggering.	OM		S1-S2 Emergency Sub Route Released
42	Emergency Overlap Cancellation		If UNR (input1) is Up and if OVYNR (input2) Up then it is Emergency overlap cancellation. Both are triggering signals.	OM		S1-S2 Emergency Overlap Cancellation

	Fault Name	Ref:	Fault Information	Momentary	Confirmed	Example of Fault Message
43	Emergency Signal Cancellation		If GNR (Input1) is Up & EGGNR (input2) is Up then it is Emergency Signal Cancellation. GNR, EGGNR are triggering.	OM		S1 Emergency Signal Cancellation
44	Point Repeated Operation		In Between WNR (input1) Up to Up, if NWKR (input2), RWKR (input3) are not Up then it is Point Repeated Operation. WNR is triggering (or) In between NCR/RCR up to Down if Point (NWKR/RWKR) is not set then it is Point repeated operation, NCR/RCR (Down) triggering.	OM		13 NWKR Point Repeated Operation
45	Panel Failure due to AC Power Failure		All RECR's (Conflicting signals) are down then it is Panel failure due to AC Power Failure. All are triggering inputs.	MM		Panel Failure Due to AC Power Failure
46	Panel Failure due to DC Power Failure		All ASR's (Conflicting signals) are down then it is Panel failure due to DC Power Failure. All are triggering inputs.	MM		Panel Failure Due to DC Power Failure
47	Shunting with Permission		When RECR (input1) is Up and TPR1 (input2), TPR2 (input3) are Down, TPR3 (input4) is Up and time difference between TPR2 Down (triggering) and TPR3 Up is more than time T1, and the time difference between TPR2 Down and RECR Up is more than the given time interval T1, TPR2 is continuously Down for T2., SHKR Down status considered in extra variable.	MM		S1 Shunting with Permission

	Fault Name	Ref:	Fault Information	Momentary	Confirmed	Example of Fault Message
48	SPAD at Adv Str without Shunt Permission		When RECR (input1) is Up and TPR1 (input2), TPR2 (input3) are Down, TPR3 (input4) is Up and time difference between TPR2 Down (triggering) and TPR3 Up is more than time T1, and the time difference between TPR2 Down and RECR Up is more than the given time interval T1, TPR2 is continuously Down for T2., SHKR Up status considered in extra variable.	SC		S1 SPAD at adv str without shunt permission
49	IPS Failure	RDSO	DC-DC Converter, Inverter-1,2,3...., SMPS, CALL S&T, 50% DOD, MAINS FAIL, FRFC FAIL.	MC	(120 sec)	IPS Failure
50	IPS Restored	RDSO	DC-DC Converter, Inverter-1,2,3...., SMPS, CALL S&T, 50% DOD, MAINS FAIL, FRFC FAIL.	MM	(120 sec)	IPS Restored
51	TFR Relay Stuckup		IF TFR IS PICKED UP THEN IT IS TFR RELAY STUCKUP.	MM		
52	Wrong Operation		If Buttons (GNR, UNR) are pressed in wrong combination Then it is WRONG OPERATION. Both are triggering signals.	MM		S1-S2 Wrong Operation
53	Route not Released	RDSO	At the time of Point zone track (input1) Up, if Platform track (input2) Down, Before Point zone track (input3) Up and after time interval if G(R)LR (input4) is Up then Check the following. Backlock tracks are in Up state and G(R)LR is Up. If any of above relays are not in required state then it is Fault. Point zone track is triggering.	MM		S1-S2 Route not Released

*Note: (i) RDSO Latest guidelines to be followed*

*(ii) User may define & configure some more Logics as per Specific need*

## Chapter 12: Installation, Testing & Maintenance of Mechanical Signalling Equipment

### Section 1: Installation

#### 12.1.1 Lever Frame

**Conformity to Drawings and Specifications:** Interlocking frames shall conform to approved drawings and specifications.

#### 12.1.2 Marking of Parts

- (a) Standards, quadrants, quadrant supports, levers shoes, locking boxes and covers, shafts and intermediate supports shall be marked with identifying letters or figures painted on them.
- (b) Plungers, interlocking bars, mechanical interlocking locks and other parts constituting the 'Locking' shall be stamped as under:
  - (i) Plungers shall be marked with their relevant lever numbers and number of the 'locking' box;
  - (ii) Interlocking bars shall bear the number beginning from the first left hand side lock to last right hand side lock, the number of the channel of the locking box, and its position in the channel; and
  - (iii) Mechanical interlocking locks (popularly called 'dogs') shall be marked with their respective lever number and the number of the channel of the locking box.

#### 12.1.3 Assembling Mechanical Locking:

Mechanical locking shall be assembled in accordance with approved Locking Diagram. Approval shall be obtained for any alteration, constructional or technical, found essential during the course of assembling locking. Some important instructions for assembling locking are detailed below:

- (a) Locking boxes shall be correctly aligned.
- (b) All pin joints shall be made a proper fit with no slackness. This is of particular importance in catch handle type of locking where a number of pin joints are provided to work the locking through the catch handle. For newly fitted locking frames there shall be practically no lost motion in connections or locking. Levers shall be straightened where required to maintain proper alignment. It shall be ensured that all parts of the lever frames including spare levers and their tappets are intact.
- (c) Notches shall be marked off in accordance with the locking diagrams. Marking shall be done with the help of templates and the outline punch marked.
  - (i) In the case of catch handle locking, it is most important that the catch rod and links are in correct position before marking.

- (ii) It is a good practice to operate the catch handle several times, both in the normal and the reverse positions, in the case of catch handle locking and operate the lever several times in the case of Direct Lever Locking before the notches are actually marked. While doing so, the catch block shall be properly held against the quadrant.
- (d) Notches shall be cut to proper sizes and shapes as marked. Normal and reverse notches for point levers and those signal levers which have back tails or long leads may be cut with a small clearance up to 1 mm. Notches of straight edge locks may have a clearance up to 3 mm for the straight edge of the lock.
- (e) Joints in interlocking bars shall be avoided as far as possible. Where necessary, the joints shall be made smithy welding. The welded bars shall be kept truly straight and perfect in shape.
- (f) All locks and driving pieces shall be securely fixed square to the interlocking bar. Locks (dogs) shall have free movement in the channels of the locking box.
- (g) Unsupported and long interlocking bars spanning more than 10 levers in SA 1101 Lever Frame and 7 levers in SA 530 Lever Frame shall be provided with a carrier lock or dummy pieces.
- (h) Any top piece fixed in the plunger shall be ordinarily rivetted except when it is accessible from outside, it shall be welded on to the plunger.
- (i) Each assembled interlocking bar shall be checked and tested to see that -
  - (i) It is in accordance with approved Locking Diagram.
  - (ii) The locking provided through each bar is in accordance with approved interlocking table.
  - (iii) The lost motion of a lever, which is locked, shall be such that the lever block cannot be moved more than 12 mm over the lever quadrant in the case of locking operated directly by the lever. In the case of catch handle operated locking, it shall not be possible to raise the catch handle block more than 10 mm.
  - (iv) The locking shall be strong, durable and accurate. It shall not be possible for any mechanical lock to enter a notch other than that for which it is intended or to force the locking.
  - (v) The locking in the lever frame shall be effected just at the commencement of the movement of the lever or the catch handle as the case may be.
  - (vi) The release locking shall not be effected before the completion of the movement of the lever.
  - (vii) The locked lever shall not be free before the releasing lever has completed its travel proving thereby that there are no conflicting notches.
- (j) Plungers, interlocking bars and locks (dogs) shall be marked as detailed in [Para 12.1.2.](#)

- (k) Locking strips shall be in accordance with approved plans.
  - (l) Locking box covers shall be securely fixed so that it is not possible to force the locking by displacing the locks or bars. The covers shall be padlocked and sealed.
  - (m) After assembling locking, it shall be carefully checked and compared with the approved Locking Diagram.
- 12.1.4 **Checking of Components:** The SSE/JE (Signal) shall carefully check the components of a new interlocking frame on receipt against plans and take necessary action.
- 12.1.5 **Erection:** Interlocking frames shall be erected in accordance with approved plans and locking fitted in accordance with the approved Locking Diagram. The locking shall then be carefully checked and compared with the approved Locking Diagram and tested by pulling of individual levers against the approved Interlocking Table as per instructions laid down in [para 12.26.7](#).
- 12.1.6 **Subsequent Additions and Alterations**
- (a) Any additions and alterations to interlocking frames shall be carried out only in accordance with the approved revised plans and interlocking tables.
  - (b) The SSE/JE (Signal) shall requisition all requirements of materials in accordance with the additions and alterations shown on the approved revised plan and locking diagram and when requisitioning new plungers shall quote correct drawing number and if that is not available, state the type of frame and length of plunger required. When requisitioning new mechanical interlocking locks (dogs), the locks (dogs) required must be specified by quoting the type number shown against each lock on the standard drawings.
  - (c) After carrying out additions and alterations, locking shall be checked completely as detailed in [para 12.26.7](#).
- 12.1.7 **Information to the Divisional Signal & Telecommunication Engineer:** The SSE/JE (Signal) shall inform the DSTE/ADSTE incharge of the section when a new interlocking frame or an alteration to the existing interlocking frame is ready for his test and introduction.

## **Section 2: Point Rodding and Fittings**

- 12.2.1 **Point Rodding:** Point rodding shall be solid and shall be in accordance with I.R.S Specification No. S 5.
- 12.2.2 **Alignment:** Point rodding shall be straight before being laid. Runs of rodding shall normally be in a straight alignment.
- 12.2.3 **Distance from the Centre of Track:** The distance from the nearest rod to the centre of the nearest track shall not be less than 1905 mm on BG lines and 1370 mm on MG/NG lines except when platform walls or other structures render this impossible.



- 12.2.4 **Branching Off:** Where practicable, rods in a main run shall be arranged so that they branch off on the track side in regular order.
- 12.2.5 **Rodding Running Under Track:** When practicable, rodding running under tracks shall be arranged to permit the standard spacing and packing of sleepers. The top of the rodding shall not be less than 25 mm below the bottom of the rails. Whenever possible, the running of rods under rail joints shall be avoided.
- 12.2.6 **Fixing Roller Standard:** The top of roller standards adjacent to tracks shall not be fixed more than 64 mm above rail level.
- 12.2.7 **Spacing of Rollers:** Runs of rodding shall be supported on rollers spaced not more than 2.2 metre apart for solid rodding and 1.85 metre apart for tubular rodding. On curves the distance apart shall be 1.85 metre for both types.
- 12.2.8 **Offsets in Roddings:** Offsets in rodding shall be limited, wherever possible to 60 mm. Offsets of 90 mm may, however, be made where solid rodding is used. The minimum length of the offset shall not be less than twice the amount of the offset. Where more than one offset is necessary, a guide shall be provided. When making offsets in joints, the pin shall be kept in place to keep the pin holes true.

### **Section 3: Point Operation in Mechanical Signalling**

- 12.3.1 **Essential requirements before Interlocking of a Point:** Before any newly laid point is connected to the lever frame or a point machine and interlocked, it shall be ensured that the SSE/JE (P-Way) has taken necessary steps as detailed in [Annexure:12-A1](#).
- 12.3.2 **Adjustment of Point Switches:** Point switches and switch and lock movements shall be so adjusted that the lever operating them is sprung equally in the normal and reverse positions. This springing shall normally be 12 mm on the lever quadrant.
- 12.3.3 **Permissible Distances:** The distance at which Points may be worked by rodding must not exceed 320 meters except where the stroke at the lever tail is not less than 200 mm, in which case the above distance may be increased to 460 meters. For special type of switches, the Chief Signal and Telecommunication Engineer may stipulate the permissible distance.

### **Section 4: Facing Point Locks, Switch & Lock Movements and Spring Point Levers**

- 12.4.1 **Layout**
- (a) Facing Point layouts shall be installed in accordance with approved plans.
  - (b) Facing Point lock shall be fitted on the gauge tie plate where steel sleepers are not provided.
  - (c) A key lock shall be so placed as to be inaccessible during the passage of a train unless the arrangement is such that a key is used to release the signals and cannot be brought back to the points until such signals have been put to the 'ON' position.

- (d) The FPL may be fitted nearer to the closed switch rail leading to higher speed movement.
- 12.4.2 **Notches:** Notches in stretcher blades shall be cut clean and square and to correct size.
- 12.4.3 **Facing Point Lock - Plunger Type**
- (a) Facing Point lock plunger shall be square ended and installed 12 to 20 mm clear of the stretcher blades when the points are unlocked.
- (b) The plunger shall have a stroke of at least 150 mm.
- 12.4.4 **Obstruction Test:** Facing point locks shall be tested by 'obstruction test' with a test piece of 5 mm thickness placed between the switch and stock rails at 150 mm from the toe. With the obstruction in, it shall not then be possible for the lever working the facing point lock to be latched.
- 12.4.5 Switch and lock layouts are not permitted in new installations. Spring point levers self-reversing shall be installed in accordance with approved plan.

## **Section 5: Location of Signals in Mechanical Signalling**

- 12.5.1 **Placement of Signal**
- (a) Signals shall be so located that they do not infringe the Schedule of Dimensions. Deviations shall be sanctioned by the competent authority.
- (b) Signal posts shall normally be on the left side and adjacent to the line to which they refer, and signals shall be located so that they are normally on the left of, or above the line to which they apply, unless authorised by special instructions.
- (c) Signals shall be inspected by a Signal sighting committee consisting of officials of Signal, Traffic and Mechanical/Electrical Departments before being brought into use.
- 12.5.2 **Fixed Green Light of Warner Signal:** The fixed green light above a Warner Signal on a post by itself shall be provided and shall be repeated.
- 12.5.3 **Fixing Signal arms:** All signal arms shall be fixed on the left hand side of the post.
- 12.5.4 **Placement of Warner Signal:** A warner Signal may be placed, either
- (a) on a post by itself with a fixed green light by night 1.5 metres to 2 metres above it at an adequate distance (not less than 1200 metres unless otherwise permitted by approved special instructions) outside the First Stop Signal or Gate Stop Signal; or
- (b) on the same post, but 1.5 metres to 2 metres below the arm of the outer Signal; and

- (c) on the same post as, but 1.5 metres to 2 metres below the Last Stop Signal of a station in rear.
- (d) **Warner Signal below a Stop Signal:** When the Warner Signal is placed below a Stop Signal, the variable light of the Stop Signal shall take the place of the fixed green light of the Warner Signal and the arrangements shall be such that the Warner Signal cannot be taken 'OFF' while the Stop signal above it is 'ON'.

#### 12.5.5 Stop Signals

- (a) **Semaphore arm:** The Semaphore arm of a Stop Signal shall be square ended. The front of the arm shall be red with a white bar. The back of the arm shall be white with a black band. The bars shall be parallel to the end of the arm.
- (b) **Day and night indications:** By day the arm of a Stop Signal shall be horizontal in the 'ON' position and 45° to 60° below the horizontal in the 'OFF' position. By night, the signal shall display a red light in the 'ON' position and a green light in the 'OFF' position.

#### 12.5.6 Location of Stop Signals

- (a) **Outer Signals:** The outer signal where provided or the Home Signal, where an outer Signal is not provided, shall be placed not less than 400 metres in rear of the Points up to which the line may be obstructed after Line Clear has been given to the Station in rear.
- (b) **Home Signals:** The Home Signal shall be placed in rear of all connections, if any, on the line to which it refers.
- (c) **Routing Signal:** A Routing Signal shall be placed in the rear of the Points, which it protects.
- (d) **Starter Signals**
  - (i) A starter Signal shall be placed at not less than 400 metres in advance of the Home Signal.
  - (ii) Where a Starter Signal is provided for each converging line, it shall be placed as to protect the adjacent running line or lines.
  - (iii) Where one starter Signal only is provided for two or more converging lines, it shall be placed outside the connections on the line to which it applies.
- (e) **Intermediate Starter:** An Intermediate Starter Signal shall be placed clear of fouling marks in rear of the points, if any, which it protects.
- (f) **Advanced Starter:** Unless approved under special instructions, an Advanced Starter Signal shall be placed outside all connections on the line to which it applies. It shall be placed at not less than 180 metres from the outermost point in the case of single line section. This distance shall be reckoned from the starter in the case of double line section. On special nominated sections, the portion between the fouling mark to block section limit shall be track circuited when

- (i) visibility of the portion between fouling marks to block section limit is obscured from the place of operation; or
- (ii) frequent shunting involving main line takes place; or
- (iii) Advanced Starter is placed at a distance of full train length beyond the trailing points.

12.5.7 Where Signals are carried on gantries, left hand signal in each case shall refer to the left hand line, the second signal from the left shall refer to the next line from the left and so on. The Signal for the main line shall be placed at a higher level than the signal or signals referring to the other running line or lines.

12.5.8 **Calling-on Signal Semaphore arm:** The Semaphore arm of a Calling-on Signal shall be a short square ended arm. The front of the arm shall be white with a red bar. The back of the arm shall be white with a black bar. The bars shall be parallel to the end of the arm.

(a) **Day indication-By day, the arm shall be**

- (i) Horizontal in the 'ON' position;
- (ii) 45° to 60° below the horizontal in the 'OFF' position.

(b) Calling-on Signal shall be placed below a Stop Signal governing the approach of a train. Under approved special instructions, a Calling-on Signal may be provided below any other Stop Signal except the last Stop Signal.

12.5.9 **Shunt Signal**

(a) Under special instructions, a shunt Signal may be a miniature Semaphore arm.

(b) Miniature Semaphore Signal:

- (i) The Semaphore arm of a shunt Signal shall be square ended. The front of the arm shall be red with a white bar. The back of the arm shall be white with a black bar. The bars shall be parallel to the end of the arm.
- (ii) By day the arm of a Stop Signal shall be horizontal in the 'ON' position and 45° to 60° below the horizontal in the 'OFF' position. By night, the signal shall display a red light in the 'ON' position and a green light in the 'OFF' position.

(c) **Diverging routes:** More than one shunt signal may be placed on the same post and when so placed, the top most Shunt Signal shall apply to the extreme left-hand line and the second shunt signal from the top shall apply to the next line from the left and so on. One shunt Signal with or without a route indicator may also be provided for a number of diverging routes.

12.5.10 **Repeating Signal**

(a) A repeating signal is a signal placed in rear of a fixed signal for the purpose of repeating to the driver of an approaching train aspects of the fixed signal in advance. It shall be provided with a marker consisting of a white-enameled disc with letter 'R' in black.

(b) A repeating signal shall be of a square ended Semaphore arm.

- (i) The arm of a semaphore repeating signal shall be square ended. The front of the arm shall be yellow with a black bar. The back of the arm shall be white with a black bar. The bars shall be parallel to the end of the arm.
- (ii) By day, the arm shall be horizontal in the 'ON' position and 45° to 60° below the horizontal in the 'OFF' position. By night the signal shall exhibit a yellow light in the 'ON' position and a green Light in the 'OFF' position.

**12.5.11 Co-acting Signals:** Co-acting signals are duplicate signals fixed below Stop Signals and are provided where, in consequence of the height of the signal post or of there being an over-bridge or other obstacle, the main arm or light is not in view of the Driver during the whole time that he is approaching it.

### **Multiple Aspect Signalling**

#### **12.5.12 Distant Signals**

- (a) **Electric Lighting of Distant Signal:** Distant Signals shall be electrically lit on all the Trunk routes and important main lines.
- (b) **Location:** On both double and single line sections, the Distant Signal shall be placed at an adequate distance in rear of the First Stop Signal, the adequate distance being not less than 1 kilometre.
- (c) **Semaphore arm:** The Semaphore arm of a Distant Signal shall be fish-tailed. The front of the arm shall be yellow with a fish-tailed black bar. The back of the arm shall be white with a fish-tailed black bar.
- (d) **Day and night indications**
  - (i) By day, the arm of a Distant Signal shall be horizontal in the 'ON' position displaying the 'Caution' aspect. It shall be 40° to 45° above the horizontal in the 'OFF' position displaying 'Attention' aspect. It shall be 85° to 90° above the horizontal in the 'OFF' position displaying the 'Proceed' aspect.
  - (ii) By night, the signal shall display one yellow light for the 'Caution' aspect, two yellow lights in a vertical line 1.5 metres apart for the 'Attention' aspect and one green light for the 'Proceed' aspect.

#### **12.5.13 Stop Signals**

- (a) The Semaphore arm of a Stop Signal shall be square ended. The front of the arm shall be red with a white bar. The back of the arm shall be white with a black band. The bars shall be parallel to the end of the arm.
- (b) **Day and night indications**
  - (i) By day, the arm of a Stop Signal shall be horizontal in the 'ON' position displaying the 'STOP' aspect. It shall be 40° to 45° above the horizontal in the 'OFF' position displaying the 'Caution' aspect. It shall be 85° to 90° above the horizontal in the 'OFF' position displaying the 'Proceed' aspect.

#### 12.5.14 Location of Stop Signals

- (a) **Home Signal:** The Home Signal shall be placed in rear of all connections, if any, on the line to which it refers. The Home Signal shall be placed not less than 180 metres in rear of the points upto which the line may be obstructed after line clear has been granted to the station in rear.
- (b) **Routing Signal:** A Routing Signal shall be placed as in [Para 12.5.6 \(c\)](#).
- (c) **Starter Signals:** When one Starter Signal is provided for each converging line, it shall be so placed as to protect the adjacent running line or lines.
- (d) **Intermediate Starter Signal:** An Intermediate Starter Signal shall be placed clear of fouling marks in rear of the points, if any, which it protects.
- (e) **Advanced Starter Signal:** Unless approved under special instructions, an Advanced Starter Signal shall be placed outside all connections on the line to which it applies. It shall be located at a distance of not less than 120 metres from the outermost points in the case of Single Line Section. This distance shall be reckoned from the starter in case of Double Line Section. On special nominated sections the portion between the fouling mark to block section limit shall be track circuited when
  - (i) visibility of the portion between fouling mark to block section limit is obscured from the place of operation; or
  - (ii) frequent shunting involving main lines takes place; orAdvanced Starter is placed at a distance of full train length beyond the trailing points.

#### 12.5.15 Calling On signal

- (a) **The Semaphore arm of a Calling-on Signal:** By day, the Semaphore arm of a Calling-on Signal shall be-
  - (i) Horizontal in the 'ON' position, and
  - (ii) 40° to 45° above the horizontal in the 'OFF' position.

#### 12.5.16 Holding Route

- (a) Signals governing movements over Points shall be placed as close as possible to the Points. Where a signal is more than 180 meters from the Facing points it controls, arrangements shall be made to keep the Points locked until the train has passed them. Similar arrangements shall also be made to hold consecutive Points, where the distance between them should be more than 180 meters.
- (b) At a station where trains run through at speeds more than 50 kilometres per hour, such arrangements to hold the route are also required in case of trailing points situated more than 180 meters from the signal controlling them. However, such arrangements are not required if the Points are locked in either position by the signal in advance.

- (c) Route holding arrangements for facing or trailing points are however not necessary, if due to the manipulations required in the system of control, it is impossible under normal working conditions for the Points to be operated before the train has passed.

## Section 6: Signal Wire Run

### 12.6.1 Single Wire/Rope

- (a) Galvanised steel wire strand No.7/1.40 mm (dia) to IS Specification No. 2265, or galvanized solid steel wire 3.35 mm (dia) to IRS Specification No. SI62, shall be used for signal connections.
- (b) Coils of wire shall be run out from a creel. Twists, kinks and nicks shall be avoided.

12.6.2 **Galvanized wire rope:** Galvanized steel wire rope for signalling purposes ordinarily used for single wire runs shall be to IRS Specification No. S-3.

12.6.3 **Wire rope round wheels:** Wire rope when used for making turns on wheels shall not be less than 2 meter in length.

12.6.4 **Wire rope on cabin wire adjusters:** Wire rope when used on cabin wire adjusters and draft wheels shall be in a continuous length.

## Section 7: Painting of Mechanical Signalling

12.7.1. **Equipment to be painted:** The following are the main items of mechanical signalling equipment that need regular painting:

- (a) Signal arms, Point Indicators, boards and markers;
- (b) Signal posts and Signal fittings;
- (c) Interlocking frames, their levers & fittings;
- (d) Ground and miscellaneous gear, such as rodding, guide roller assembly, cranks, compensators, turnout wheels;
- (e) Lifting barriers, if maintained by Signal and Telecommunication department.

12.7.2 **Colouring Scheme:** Items detailed in [Para:12.7.1](#) shall be painted in accordance with colouring scheme shown for the respective item as in [Drg No:12-D1](#).

12.7.3 **Interval of Painting:** The general principles for fixing intervals shall be the following:

- (a) Signal arms, indicators etc. which are required to be painted to conventional shapes and/or colours shall be painted once a year.
- (b) Signal posts which are to be kept conspicuous and cabin levers which are to be distinguished by colours, shall be painted once in three years;
- (c) Rodding, guide roller assembly etc. which only need a protective covering, shall be painted once in six years.

*Note: The intervals mentioned above may be reduced in areas where, on account of weather or other local conditions painting at shorter intervals is necessary.*

#### 12.7.4 **Record of Painting**

- (a) Each SSE/JE (Signal) shall maintain a Painting Register, one page or more being allotted to each station or cabin on his section. Record of the painting work done with dates of commencing and completing the work shall be regularly entered in this register.
- (b) Each SSE/JE (Signal) shall also record the date of painting with particulars of the programme carried out in the Signal Incidences Book maintained at each station. This should be done on the very first inspection by him after painting work has been completed.

#### 12.7.5 **General Instructions on Paints/Painting**

- (a) **Storage:** Paint shall be stored in a cool dry place away from flame or naked light.
- (b) All containers shall be kept securely closed when not in use, to avoid loss of material due to skinning and contamination. Paints, especially quick drying paints, shall not be left open to the atmosphere.

#### 12.7.6 **Mixing of Paints**

- (a) Paints from pigments and pastes shall be prepared in accordance with standard specifications.
- (b) Linseed oil or turpentine shall not be added to ready mixed paints. Mixing of kerosene with paints is forbidden.

#### 12.7.7 **Painting of Steel Works**

- (a) The surface of metal shall be clean and free from dirt, scale, deteriorated old paint and rust and shall be perfectly dry before application of paint. Painting shall be done preferably during dry weather.
- (b) For a new steel work, three coats of paints shall be applied. First coat shall be 'Red Lead', the second 'Red Oxide' and the third of the specific paint recommended for the structure. When repainting a structure, if the old paint does not show any signs of blistering, scaling or cracking, it need not be scraped off. It may be used as foundation for the new coat.
- (c) When there are patches of blistering, scaling or cracking, these patches shall be cleaned down to the steel and treated in a manner as recommended for a new structure.
- (d) The surface of metal shall be cleaned by scraping, chipping or scrubbing with brickbats. No chemical of any kind shall be used. Old paint may be burnt, if necessary and then scraped off.
- (e) Paint shall be applied with brushes and spread evenly, smoothly and as thin as possible. Rags or waste cotton shall not be used for the application of paint.
- (f) Brushes shall be thoroughly cleaned in proper driers after use.



### 12.7.8 Enamel Signal Arms

- (a) Enamel signal arms shall be scrubbed with soap to clean them. If corroded in places, these shall be touched up with enamel paints.
- (b) Signal arms which are not enamelled, shall be painted with enamel paints.

### 12.7.9 Numbering of Points and Signals

- (a) The cabin lever number of points and facing point Lockbars shall be painted in 50 mm letters on the web and close to the toe of the switch rail.
- (b) The number of the cabin lever operating the signal shall be painted in 50 mm letters at the back of the signal arm blade.

### 12.7.10 Numbers shall be written in codes as under: (table)

i)	Points - 20 W	'20 W' stands for lever No. 20 West Cabin
ii)	Points & Facing Point lock (P32 L33E)	'P32' stands for points lever No. 32 and 'L33E' stands for lock bar lever No. 33, East Cabin
iii)	Signals - 51 A - 52 B - 53 GFA	'51A' stands for lever No. 51 'A' Cabin, '52B' stands for lever No. 52 'B' Cabin '53 GFA' stands for lever No. 53 Ground Frame 'A'.

- (a) Numbers of interlocking frame levers shall also be painted on the front and back side of the main girder supporting the frame opposite each lever in 50 mm white letters.

12.7.11 **Dates of Painting:** The year and the month of painting work shall be clearly and neatly shown on all interlocking frames, signal posts, block instruments, Station master's slide control frames and instruments. Suitable entries shall also be made in the Register maintained for this purpose.

## Section 8: Maintenance of Mechanical Signalling

12.8.1 **Cabin equipment:** All cabins shall be equipped with

- (a) A Cabin Diagram showing the location and normal position of all points. Facing point locks, Signals and Level Crossings, with their respective cabin lever numbers;
- (b) A lever pull chart suitably exhibited;
- (c) Lever collars;
- (d) A suitable staging with ladder for attending to interlocking frame;
- (e) Telephones, as necessary;

(f) All equipments as required to be provided by concerned Departments including a clock, and

(g) A name board of sufficient size.

*Note: The lever pull chart, referred in (2) above, need not be provided in Cabins where the number of release lever concerned are indicated on the lever name plates to guide the Cabin man in following the correct sequence for pulling the levers.*

**12.8.2 Numbering of levers:** All levers, including spares, shall be numbered consecutively through the frame from left to right. Each lever shall be provided with a number plate. This will show the function in the order of operation which must precede to release when no lever description board is provided.

**12.8.3 Cabins-Cleanliness, Repair and Fittings**

(a) Ground floor of cabins shall be kept clean and tidy.

(b) Cabins including battery room and repair room shall be kept in good condition and periodically painted/distempered. The roof shall be so maintained as to prevent leakage. "Ghara" stands shall be kept properly drained off. Wash basins, where provided, shall be kept in perfect repair. Any repair required shall be promptly notified to the SSE/JE (Woks).

(c) SSE/JE (Signal) shall bring to the notice of his Sr.DSTE or DSTE or ADSTE incharge of the section when repairs to cabin are delayed.

(d) Windows of cabins shall be kept clean. This is the duty of the operating staff.

(e) Each SSE/JE (Signal) shall see that the cabin diagram, pull chart, Cabin man's instructions and Maintained programme provided in the Cabin are up-to-date and their glazed frames are in proper repair.

**Section 9: Maintenance of Lever Frame**

**12.9.1 Responsibility:** Each SSE/JE (Signal) is personally responsible for efficient maintenance of the locking of the interlocking frames under his charge. Locking box covers shall be kept padlocked and sealed with his personal seal supplied to him for the purpose.

**12.9.2 Instructions for Technicians**

(a) All accessible working parts of interlocking frames shall be thoroughly lubricated and cleaned.

(b) All split pins shall be checked to ensure that they are intact and properly open. Also all nuts and bolts shall be checked and tightened wherever necessary.

(c) Handles of levers of interlocking frames shall be kept clean and bright by the Transportation Staff.

### 12.9.3 Instructions for SSE/JE (Signal):

- (a) The SSE/JE (Signal) shall ensure that the interlocking frames are kept clean and lubricated.
- (b) Locking of all interlocking frames shall be tested as per instructions contained in [para 12.26.7](#).
- (c) During the testing of interlocking frames, careful note shall be taken of slack locking and if the slack locking exceeds the limits laid down in [Para no's.12.1.3\(i\)](#), overhauling shall be taken up forthwith.
- (d) Locking of all interlocking frames shall be overhauled at least once every three years or earlier, if necessary, as per instructions laid down in [para 12.25.5](#).

## Section 10: Maintenance of Lead outs (Rodding)

12.10.1 All lead outs shall be examined regularly and kept clean and well oiled.

12.10.2 All connections, especially the down rods, shall be examined to detect cracks and worn out threads. The whole of the apparatus shall be kept rigidly and solidly connected.

## Section 11: Maintenance of Point Rodding and Fittings

### 12.11.1 Examination

- (a) All runs of rodding shall be regularly examined to see that all joints make good and solid connections.
- (b) All couplings, adjusting screws and adjustable joints shall be examined for looseness, worn out threads or slack nuts.
- (c) Rodding shall be examined for detecting weak places due to rust, corrosion or other causes.

12.11.2 **Alignment:** The rods shall be kept in true alignment and free from all obstructions.

12.11.3 **Rollers:** Rollers shall fit properly in the standards and move freely. Broken roller standards, missing rollers and pins shall be replaced.

12.11.4 **Roller Foundations:** Roller foundations shall be realigned if found to have shifted or sunk and shall be renewed when necessary.

12.11.5 Points, Locks and Bars shall not be operated by wire but by rodding or by electrical means.

12.11.6 **Operation of Facing Point lock:** The operation of the facing point lock shall depend on the correct operation of the Lockbar. This Lockbar shall form a part of the transmission and be in series with it.

## **Section 12: Maintenance of Cranks, Compensators, Screws, Bolts, Nuts, Pins and Cotters**

### **12.12.1 Examination**

- (a) All cranks and compensators shall be examined regularly and working parts well oiled.
- (b) The position of the compensators shall be carefully checked when a point or Lockbar does not work properly or where the stroke at the adjusting crank has to be unduly increased.

**12.12.2 Replacement of cracked or broken parts:** Cracked or broken parts of cranks, compensators shall be repaired or renewed.

**12.12.3 Cleaning of oil holes:** Oil holes shall be cleaned before oil is applied. Oil shall not be used in excess as it collects dust.

**12.12.4 Screws, bolts and nuts:** All screws, bolts and nuts shall be in place and shall be kept tight.

**12.12.5 Adjusting Screws:** Threads of point adjusting screws shall be oiled regularly and kept free from dust. Lock nuts of adjusting screws and set screws of adjusting cranks shall be kept tight.

### **12.12.6 Pins**

- (a) All pins of cranks, wheels, etc., shall be in place and kept oiled regularly. All pins shall be raised slightly where possible, and oil applied underneath so as to ensure proper distribution.
- (b) All badly worn pins shall be replaced by new pins.
- (c) Tight pins can often be loosened with kerosene; if this is not possible, pins shall be driven out and thoroughly cleaned. Pin holes shall never be filed.

**12.12.7 Keys and Cotters:** All keys and cotters shall be examined regularly. Keys and cotters shall be in place and properly spread, split ends shall be spread not less than 10 mm. Keys and cotters shall be of proper size and in good condition, old nails or pieces of wire shall not be used.

## **Section 13: Maintenance of Points**

**12.13.1** Visual inspection of the condition of insulation of insulated rod joints shall be done during maintenance inspections.

### **12.13.2 Responsibility of SSE/JE (P-Way) & SSE/JE (Signal):**

- (a) Maintenance of switches, gauge tie plates and bolts and cotters for pad locks is the responsibility of the SSE/JE (P-Way). In addition, all non-interlocked switches, leading and following stretcher bars connecting rods, self reversing levers, hand points, spring loaded points are also maintained by him. Connections to switches other than those specified above such as facing point locks and bars, detectors, point and trap indicators are maintained by the SSE/JE (Signal).

- (b) S&T Staff shall not take on themselves the responsibility of disconnecting the permanent way fittings or making adjustments thereof.
- (c) The primary responsibility of points layout and its allied equipments binding with the concerned departments who own the equipment/gears.

#### **12.13.3 Damaged Switches and Packing of Sleepers**

- (a) Advice of switches found chipped or damaged shall be promptly given in writing to the SSE/JE (P way).
- (b) Sleepers under interlocked points and cross overs shall be kept well packed. Advice of loose packing shall be given promptly to the SSE/JE (P-Way). When packing of sleepers of interlocked points is being done by the permanent way staff, signal technician shall also be present there.

#### **12.13.4 Testing and Adjustment**

- (a) All switches shall be frequently tested to see if they are in correct adjustment. For testing, the switches shall be moved slowly and it shall be ensured that-
  - (i) the switches are set properly against the stock rail, and
  - (ii) the lever operating the points springs a little, equally in the normal and the reverse positions before being latched.
- (b) When two or more switches are operated by a single lever, all switches shall be adjusted correctly.
- (c) The switches get out of adjustment on account of wear in fittings and pins, creep of track and poor track maintenance. When the slackness in fittings becomes excessive, slack fittings shall be replaced. Where creep and maintenance of track is affecting the adjustment of signalling gear at the points, it shall be promptly reported to the SSE/JE (P-Way). After adjustment/replacement of fittings/switches, Obstruction test as per [para 12.4.4](#) shall be done.

### **Section 14: Maintenance of Facing Point Locks, Switch & Lock Movements and Spring Point Levers**

**12.14.1 Facing Point Locks:** Facing point lock plunger shall be kept lubricated and free from rust. The end of the plunger shall be square. It shall be adjusted to be at least 12 mm clear from the stretcher blades, when the points are unlocked. The edges of notches in stretcher blades shall be kept square and sharp.

#### **12.14.2 Switch & Lock Movement for existing installations:**

- (a) All sliding parts of switch and lock movements shall be thoroughly lubricated.
- (b) Switch and lock movements shall be kept adjusted so that the Lockbar shall rise to two-thirds of its full height before the switch points start to open.

- 12.14.3 **Loose or cracked parts:** Switch and lock movements and facing point locks and bars shall be examined closely to detect loose or cracked parts. Loose or cracked parts shall be replaced at the earliest.
- 12.14.4 **Cross Slides:** In the case of facing point bolt locks provided with cross slides or plunger detection, there shall be no undue play between the cross slide and the facing point detector connections.
- 12.14.5 **Testing Switch and Lock movements and Facing Point Locks:** Switch and lock movements and facing point locks shall be given an obstruction test by inserting a test piece of 5mm between the switch and stock rails at 150 mm from the toe of the switch. The obstruction shall;
- (a) In the case of facing point bolt lock, prevent the lever working the facing point bolt lock from being latched;
  - (b) In the case of facing point lock, key type, prevent the extraction of the key; and
  - (c) In the case of switch and lock movement, prevent the signal governing the movement over the switch and lock movement from being cleared.
- 12.14.6 Spring Points if used, in the facing direction must be fitted with facing point locks. They may be operated from a Cabin or from a ground lever. In the later case, the ground lever shall be of such a type that it will not move when the Points are being trailed through.

## **Section 15: Maintenance of Lockbars**

- 12.15.1 **Length of Lockbars:** The length of Lockbar shall exceed the greatest distance between any two adjacent axles of any vehicle likely to be used on the section.
- 12.15.2 Lockbars shall not be less than 12800 mm long for Broad Gauge and 12200 mm for Metre Gauge and Narrow Gauge lines.
- 12.15.3 **Adjustment**
- (a) Lockbars shall be so installed that with the operating lever normal
    - (i) An outside Lockbar lies practically level with the top of the rail.

*Note: In new installations, outside Lockbars shall not be used;*

    - (ii) An inside Lockbar lies 38 mm below the top of the rail and the bar does not lean away from the rail.
    - (iii) Whenever practicable, the end of the Lockbar shall not be more than 25 mm clear of the toe of the switch, when the points are bolted.
  - (b) Each Lockbar shall be provided with not less than twelve clips and three stops located in such a manner that the maximum inter clip distance is 1220 mm. A Lockbar clip shall be fixed as near the end of the bar as possible but not more than 225 mm.

(c) Lockbars shall not be installed over a check rail portion as a matter of course. Under special circumstances and only if other electrical means cannot be provided, Lockbars can be installed over check rail portion when they are fitted with a special type of check rail joint.

(d) Lockbars shall preferably be installed on the rail associated with straight track.

#### 12.15.4 **Lockbar General**

(a) Lockbars shall be kept straight and true both vertically and horizontally, driving pieces shall be examined to see if there is any lost motion.

(b) Lockbar clips, stops and guides shall be tightly attached to the rails. Arms and pins of clips shall be kept in good order so as to ensure that the Lockbars fit close up to the rail. Bearings of clips shall be kept well oiled. Lockbar clips shall not be bent to prevent leaning away. Care shall be taken to ensure that there is adequate clearance between clip hanger and the top studs when fully tightened so as to permit easy working.

(c) All Lockbars, clips, stops and guides shall be overhauled and thoroughly cleaned at least once a year. Renewals shall be made where necessary.

(d) If rail creep is affecting the working of Lockbars, Technician shall make a report in writing to the SSE/JE (P-Way), giving copy to the SSE/JE (Signal).

12.15.5 **Testing Lockbars:** Lockbars shall be tested to see that with the operating lever normal or reverse-

(a) Outside Lockbars lie practically level with the top of the rail;

(b) Inside Lockbars lie 38 mm below the top of the rail. They shall lie flush with the top of the rail when the lever is in the mid-stroke.

### **Section 16: Maintenance of Mechanical Detectors**

12.16.1 All detectors shall be examined regularly and the slides kept well lubricated.

12.16.2 **Detector notches:** Detector notches shall be kept square and not eased beyond the standard size. Notches in point slides shall be kept properly adjusted.

12.16.3 **Cleaning of detector shoes and angle slides:** Detector shoes and their angle slides should be regularly cleaned and graphited to permit free movement of the detector shoe.

12.16.4 **Testing of detectors:** Detectors shall be regularly tested by obstruction test with a test piece of 5 mm thickness placed between the switch and stock rail at 150 mm from the toe, with the obstruction in, the signal slide shall get obstructed.

12.16.5 **Replacement of cracked or broken parts:** Cracked or broken parts of detectors shall be repaired or renewed.

## **Section 17: Maintenance of Signal Wire Run (Single Wire)**

12.17.1 **Alignment:** All wire runs shall be maintained in proper level and alignment.

### **12.17.2 Wires Generally**

- (a) Damaged wire or wire rope showing signs of corrosion or rusting shall be renewed. Kinked wire shall be straightened and bad joints removed.
- (b) To prevent excessive wear over pulley wheels at one point, the wire shall be periodically moved and worn out portion shifted off the pulley wheel.

12.17.3 **Wires under track:** Wires running under the track shall neither drag on the ground nor rub against ballast, base of rails or side of sleepers.

## **Section 18: Maintenance of Pulley Stakes and Pulleys**

### **12.18.1 Pulleys and Pulley Stakes**

- (a) Brackets of pulley wheels shall be examined to see that they are securely fixed and that the wheels revolve freely.
- (b) All damaged, broken and missing pulley wheels or brackets shall be renewed promptly.
- (c) Bent pulley stakes shall be straightened and worn-out ones replaced.

## **Section 19: Maintenance of Electrical Repeaters and Signal Lamps/LEDs**

12.19.1 The SSE/JE (Signal) shall test the working of the signals fitted with electric repeaters when making their periodical inspection and see that they are in proper adjustment.

### **12.19.2 Examination and Replacement of Signal & Indicator Lamps**

- (a) All Signals (oil lit and electrically lit) and Point and Trap Indicator lamps shall be examined regularly and any lamps or founts found defective shall be replaced promptly. Cases of excessive damage to lamps or neglect in cleaning shall be reported to the Sr.DSTE or DSTE or ADSTE incharge of the section. Cleaning of signal lamps is the responsibility of the operating staff.
- (b) **Overhauling and Repairs:** All lamps shall be overhauled once a year and the date of overhaul marked on each lamp.
- (c) Only petty repairs to Signal lamps are to be carried out by SSE/JE (Signal). Lamps requiring heavy repairs shall be carefully packed and sent to the Signal Workshops.

## **Section 20: Maintenance of Double Wire Installations**

### **12.20.1 Transmissions Generally**

- (a) All transmissions shall work freely and loss of stroke at the end of transmission shall be avoided.

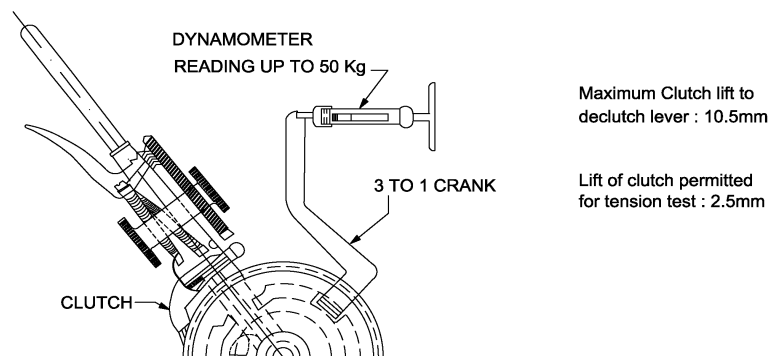


- (b) There shall be no binding in any part of transmissions and all wires and ropes shall lie properly in the grooves of pulleys and wheels respectively. All pulleys shall be parallel to the wire run.
- (c) All transmissions shall be kept taut; there shall be no appreciable sag between pulleys.
- (d) Care shall be taken to see that wires and ropes do not scrape against platform and other objects as rails, chairs, covers and lids.
- (e) All wheels and mechanisms shall be thoroughly lubricated with a grease gun and made to work easily. All cam paths shall be kept well lubricated with grease.

**12.20.2 Maintenance of Compensators:** Compensators shall be maintained as per the instructions for 'Installation and Maintenance of Double Wire Compensators'. Some of the salient features are-

- (a) All moving parts shall be lubricated every fortnight with axle oil medium to IS:1628 and where nipples are provided Grease to IS:507 shall be used with a grease gun. The compensator wheels grooves and the wire rope lengths working in them shall be lubricated with graphited grease grade I to IS:508.
- (b) It shall be checked that all bolts are properly tightened and all split pins and nuts are in proper positions.
- (c) All broken parts shall be replaced immediately.
- (d) It shall be checked that both the weight levers move independently. Weight levers shall not be bound together either by wire or by chain.
- (e) It shall be maintained that locking pawl is in a position normally free from the ratchet rod but during lever operation they shall be engaged properly with the ratchet rod teeth.
- (f) In case of hard working of Double Wire transmission during cold weather, it shall be checked by night that weight levers are not binding against stop pin at the bottom of the ratchet rod and adjustments made where required.

**12.20.3 Testing Point, Lock, Detector and Signal Levers:** The SSE (Signal)/incharge of Double Wire transmission shall test each point, lock, detector and signal lever by means of dynamometer as shown in Diagram once every 6 months. It shall be ascertained that-



DOUBLE WIRE INTERLOCKING FRAME -TESTING CLUTCH LEVER WITH DYNAMOMETER

- (a) The force required to operate a lever does not ordinarily exceed 35 kg. In the case of a signal lever without detectors, it shall not ordinarily exceed 27 kg.
  - (b) Point, lock or detector lever clutch does not trip after completion of lever movement. Should it do so, it indicates that the coupling spring adjustment is not correct or that somewhere in the transmission, usually at point or lock mechanism or detector, tight working or an obstruction exists. The cause shall always be carefully traced and rectified.
- 12.20.4 Broken wire locks:** Broken wire locks on Point and Lock mechanisms shall be inspected to see that they are properly adjusted and are working correctly.
- (a) Reconnection or repairs after wire breakage.
  - (b) After each test, or after wire breakage, compensator weights shall first be lifted by means of a pulley block to enable reconnection or repairs to be made.
  - (c) The drum of a trailable or clutch lever shall be reset by an auxiliary lever.
- 12.20.5 Responsibility and Periodicity of Broken Wire Tests:** Broken wire tests shall be carried out by each Senior Section Engineer (Signal)/incharge of maintenance of Double Wire installations atleast once a year and ensure that equipment failure is on safe side, unless otherwise specified.
- (a) Necessary steps shall be taken to shorten the wire wherever necessary in a newly laid Double Wire transmission for the wire stretch occurring in the course of time.

## Section 21: Maintenance of Signals and Fittings

### 12.21.1 Signal arms and its Fittings

- (a) Signal arms on a straight track shall be at right angles to the track concerned when sufficient approach is on the straight. On curves, signal arms shall be at right angles to an imaginary line drawn from the signal to the point where the best view is to be provided to the Loco Pilot.

- (b) Signal arms shall be kept securely fastened to the spectacles casting and maintained at the correct level when in the 'ON' position.
- (c) Signal arms shall be kept clean and properly painted.
- (d) It shall be ensured that spectacles are securely fixed on their spindles or studs, bearing brackets are firmly attached to the post and back light blinders are in their correct position.
- (e) Arm spindles or studs and counterweight lever connections shall be oiled regularly and kept working freely. It shall be ensured that counterweights are in their correct position and firmly secured and that the lock nuts on adjustable joints are tight.
- (f) Spectacle roundels or glasses found loose, cracked or broken shall be attended to and replaced promptly.

#### 12.21.2 **Slotting**

- (a) Where signals are slotted, any of the controlling agencies shall be independently capable of returning the signal to 'ON'.
- (b) When a Warner arm is placed below a Stop arm, the slot lever shall be installed so that the Warner cannot be taken 'OFF' unless the Stop Signal above is at 'OFF'. When the Stop Signal is returned to 'ON', the Warner shall return to 'ON'.

12.21.3 **Shunt Signals:** Where a Shunt Signal is placed on the same post as a main line signal, it shall be placed not less than 2.5 meters below the main arm.

12.21.4 **Balance Levers:** Where practicable, balance levers shall be placed out of reach from the ground and parallel to the line. Counterweights shall be securely fastened to the levers and safety bolts provided at the end of the levers.

#### 12.21.5 **Back Lights**

- (a) **Indications:** Except when the front light can be seen from the Cabin or interlocking frame location, back lights of mechanical signals shall show a white light when the arm is in the 'ON' position and no light in any other position.
- (b) **Warner Signal Fixed green light:** The fixed green light of a Warner Signal shall also show a back light.
- (c) **Distant Signals:** Distant Signals in multiple aspect area shall show two back lights in the 'ON' position and no light in any other position. However, where electric lighting of Distant Signals is provided, the Distant Signals in Multiple aspect area may show atleast one back light in the 'ON' position if the arrangement is such that the bottom light is lit only when the arm is displaying the 'attention' aspect.

**12.21.6 Trimming of Trees Obstructing Visibility:** Where trees interfere with the Loco Pilot's or cabin man's sighting of signals, the SSE/JE (Signal) shall arrange with the SSE/JE (Works) for Trimming of tree branches or cutting of trees within the Railway boundary. If the trees are in private land, the Sr.DSTE or DSTE or ADSTE incharge of the section shall be informed so that he may arrange through Sr.DEN or DEN or ADEN for the removal or cutting of the trees.

**12.21.7 Artificial backgrounds**

(a) Signals may be provided with an artificial background painted white, if found necessary to improve the sighting or when the background is a bridge or structure, such portion as necessary to form a background, may be painted white or be white washed.

(b) Arms provided with an artificial background shall project 150 mm beyond or be provided with a tell tale arm so that it can be seen by the Station Master.

**12.21.8 Posts:** Signal posts shall be kept plumb. Signal post guys, where provided shall be kept tight and in good repair.

**12.21.9 Deck Boards:** Deck boards on bracket posts and gantries shall be inspected to detect decayed or loose boards. Missing or defective boards shall be replaced.

**12.21.10 Provision of Signal Dubbers and Kerosene:** Whenever kerosene lit signals are provided, the signal dubbers and kerosene shall be provided by Traffic staff.

**12.21.11 Cleaning of Signal Glasses and Lamp Lenses:** The Traffic staff are responsible for wiping and cleaning of signal glasses, roundels, and lenses of kerosene lit signals. Roundels of electrically lit signals shall be cleaned by signal staff.

## **Section 22: Maintenance of Point, Trap and Shunting Permitted Indicators**

**12.22.1 Type, Provision, Placing and Indication**

(a) Point, Trap and Shunting Permitted Indicators shall be provided in accordance with the approved plans.

(b) Type, Provision, Placing and Indication of these indicators are covered in detail in [Chapter 7 of SEM](#).

## **Section 23: Maintenance Schedule**

**12.23.1** The maintenance schedule for various items of 'Mechanical signalling equipment shall be as in [Annexure: 12-MS1](#). At stations having dense traffic and high speeds, the Railways may prescribe more frequent inspections, if considered necessary.

## **Section 24: Overhauling and Testing of Interlocking Mechanical/Electromechanical**

### **12.24.1 Interlocking Frames**

- (a) All interlocking frames, interlocking key boxes and Station Master's Slide Control frames shall be overhauled once in three years and tested periodically once in a year. The records of the same shall be maintained.
- (b) The Electromechanical Frames shall be overhauled and tested periodically as per requirement contained in the above para.

### **12.24.2 System and Equipment Testing**

- (a) Relay interlocking and Electronic interlocking installations shall be tested as indicated in [SEM Chapter 21](#).
- (b) Periodical testing and overhauling of mechanical signalling equipment used in signalling installations shall be done as per requirements contained in [para 12.25.5 & 12.26.7](#).

## **Section 25: Overhauling of Interlocking Frames, Interlocking Key Boxes and Station Master's Slide Control Frames**

### **12.25.1 Periodicity**

- (a) All interlocking frames, interlocking key boxes and Station Master's Slide Control frames shall be overhauled once in every three years or earlier, if necessary.

### **12.25.2 Programme of Overhauling**

- (a) The Sr.DSTE/DSTE shall draw out a programme of overhauling of interlocking frames, interlocking key boxes and Station Master's slide control frames on the Division on a monthly basis spread preferably over the first 9 months of a calendar year. Any overhauling work that may fall into arrears due to unforeseen circumstances shall be completed during the remaining three months.

#### **(b) The programme shall indicate**

- (i) Particulars of Interlocking Frames, Interlocking Key Boxes and Station Master's slide control frames to be overhauled month by month;
- (ii) Dates of last overhauling.
- (c) A Copy of the programme shall be supplied to each SSE/JE (Signal) incharge who has to carry out the overhauling accordingly.

### **12.25.3 Requirement of Materials for Overhauling**

- (a) The Supervisory SSE/JE (Signal)/incharge shall check before undertaking the work that the material needed for overhauling of interlocking frames, interlocking key boxes and Station Master's slide control frames is available. If not, he shall requisition the same sufficiently in advance so that it is available for the work in time.

#### 12.25.4 Interlocking Frame

- (a) Instructions for working of Traffic during overhauling: When a lever frame, Station Master's control frame or interlocked key box or any other interlocking frame is being overhauled, the station shall be worked in accordance with special instructions issued by each Railway to ensure full compliance with G.R.3.38 and 3.39 and the Station Master shall be responsible for ensuring that all the facing points over which the train will pass, are correctly set, clamped and padlocked and that all trailing points over which the train will pass are correctly set before taking 'OFF' signals. The manner in which Station Master will ensure this shall be clearly laid down. Detailed temporary working instructions shall be prepared for every station by the DSO for each phase of the work in consultation with concerned DSTE and supplied to the station before overhauling is commenced.
- (b) A notification showing the date and time when the overhauling work would be taken in hand, its probable duration and instructions for the station Master to issue Caution Order to Loco pilots and for Loco Inspector to advise Loco pilots to observe the temporary speed restriction shall be issued jointly by the Sr.DSTE/DSTE and the DSO.
- (c) **For the portion of the yard, which is controlled by the Cabin to be overhauled**
  - (i) Before undertaking overhauling work wherever required, suitable communication facilities shall be provided.
  - (ii) The Loco pilots shall be issued a Caution order at the last stopping station instructing him/her of the speed restriction of 30 Km/h at the station where overhauling of interlocking frame is in progress.
  - (iii) Special instructions for reception/dispatch of trains and shunting operations, if any, should be drawn keeping in view GR & SR 15.09 (2) and annexed to the notification referred to in [para 12.25.4\(a\)](#).
  - (iv) Distant/warner signal and main home signal proceed aspect shall be made inoperative. Distant/warner signal shall be kept at 'ON' position and first auto signal in automatic block sections to be kept inoperative for 'Attention' and 'Proceed' aspects.
  - (v) Wherever work is required to be done during night hours, adequate lighting arrangements shall be provided.
  - (vi) Section of the track, on which caution order is to be imposed, must be specified.
- (d) Only after the Station Master on duty has assured himself that the line has been correctly set and facing points locked for the required movement, he may permit the signals to be taken 'OFF' for the reception or dispatch of a train.

- (e) Disconnection Memo on Form No. S&T/DN ([Annexure: 3-A10](#)) shall be given by the SSE/JE (Signal)/incharge, to the Station Master on duty and his signature shall be obtained before starting the work and reconnection memo shall be given after the work is completed.
- (f) The issue of caution orders and the imposition of speed restriction of 30 KMPH shall remain in force until interlocking frame has been tested by the authorised official and normal working is restored.

#### **12.25.5 Detailed Instructions for Overhauling**

- (a) All interlocking frames shall be overhauled under the personal supervision of the SSE/JE (Signal)/Incharge.
- (b) Before taking up the overhauling of a lever frame, the SSE/JE (Signal)/incharge shall examine the lever frame and collect the necessary materials to carry out repairs/rectify deficiencies noticed.
- (c) Quadrants, Quadrant supports, Levers, Lever shoes, Locking Boxes, Locking Box supports and Holding down bolts shall be examined to see that they are rigidly fixed and properly secured. The levers shall be aligned in straight line in case any misalignment exists. It shall be ensured that all the parts of the Lever Frame including the spare levers and their tappets are intact. It shall also be ensured that proper padlocking and sealing facility exists.
- (d) All notches in tappets, locks and the lock rivets shall be examined to ensure that they have not become unduly worn or slack. False (spare) notches in tappets shall be filled up or the tappets replaced.
- (e) All interlocking bars shall be examined to ensure that they are rigid, truly straight and not twisted or buckled. Spare holes in interlocking bars shall be filled up.
- (f) All tappets and connecting link pins shall be examined to see that they are not unduly worn out and do not permit excessive lost motion.
- (g) All worn out/cracked parts must be replaced wherever necessary.
- (h) The inside of the locking box as also the bars, the tappets and the locks shall be thoroughly cleaned with a stiff brush and kerosene. Afterwards, they shall be polished with graphite mixed with thin oil and finally dusted with graphite.
- (i) Each interlocking bar shall be tested before refitting to ensure that the locking provided through it is correct and the lost motion of the locked levers or their catch handles is within the permissible limit, i.e. the lever block cannot be moved more than 12 mm over the lever quadrant in the case of locking operated directly by the lever. In case of catch handle operated locking, it shall not be possible to raise the catch handle block more than 10 mm. Defects, if any, shall be rectified.

- (j) Locking shall be refitted carefully. Before replacing the covers, the locking shall be again powdered with graphite. Thin mineral oil shall be used for lubrication when graphite is found unsuitable owing to climatic conditions.
- (k) It shall be ensured that waste cotton pieces or any other foreign materials are not left inside the locking boxes.
- (l) Before replacing the covers, the locking shall be carefully checked with the approved locking diagram.

#### **12.25.6 Resumption of normal working**

- (a) It will be personal responsibility of the Supervisory SSE/JE (Signal) to test all interlocking frames up to 20 working levers after completion of overhauling and to introduce normal working. As regards interlocking frames with 21 to 30 working levers, normal working can be introduced after completion of overhauling and testing of interlocking by the Supervisory SSE/JE (Signal). The DSTE/ADSTE must, however test the locking as soon as possible after normal working has been resumed by the Supervisory SSE/JE (Signal).
- (b) When the lever frame to be overhauled is more than 20 working levers, as soon as the overhauling work has been completed, it will be the personal responsibility of the SSE/JE (Signal) incharge to intimate the Signal Officer concerned that the interlocking frame is ready for his test.
- (c) In regard to interlocking frames with more than 30 working levers, it will be the personal responsibility of the Signal Officer concerned to test all such interlocking frames after completion of overhauling and to introduce normal working.
- (d) The testing referred to in [para 12.26.7](#) shall be carried out as per approved locking table.
- (e) The Sr.DSTE/DSTE/ADSTE must keep in close touch with the progress of the overhauling work and see that the duration of the work is reduced to what is actually necessary to avoid undue continuance of the restrictions imposed on the traffic working.

#### **12.25.7 Overhauling of Interlocking Key Boxes**

- (a) Interlocking Key Boxes must be overhauled under the personal supervision of the SSE/JE (Signal) incharge.
- (b) Disconnection Memo on Form S&T/DN ([Annexure: 3-A10](#)) shall be issued by the SSE/JE (Signal) to the Station Master on duty and his signature obtained before starting and reconnection memo issued after completion of the overhauling work.
- (c) The responsibility for the safe custody of the interlocking keys released from the interlocking key box as long as the locking is disconnected shall rest with the SSE/JE (Signal)/incharge.



### 12.25.8 Overhauling of Station Master's Slide Control Frame

- (a) Station Master's Slide Control Frames shall be overhauled under the personal supervision of the SSE/JE (Signal)/incharge.
- (b) Instructions for working of Traffic during overhauling as laid down in [para 12.25.4](#) shall be applicable during overhauling of Station Master's Slide Control Frames.
- (c) The Supervisory SSE/JE (Signal)/incharge shall issue disconnection memo on Form S&T/DN [Annexure-3-A10](#) to the Station Master on duty and his signature obtained before starting and reconnection memo issued after completion of overhauling work. The following precautions should also be taken by SM on duty to ensure the safety of the train movements.
  - (i) The Cabin man on duty should be instructed to see that no signals are taken 'OFF' by him/her unless permitted by the Station Master on duty.
  - (ii) It should be ensured that no electric slot or key is transmitted in an unauthorised manner and that no conflicting slot or key is transmitted.

### 12.25.9 Certificate of Overhauling

- (a) Locking overhauling certificates on Form S&T/LO [Annexure-12-A3](#) for all interlocking frames, interlocking key boxes and Station Master's slide control frames shall be promptly submitted by the SSE/JE (Signal) to the Sr.DSTE/DSTE, in duplicate. The Sr.DSTE/DSTE shall, after necessary scrutiny forward a consolidated statement of the overhauling carried out every quarter along with one copy of the Certificate to the PCSTE for his record.

## Section 26: Testing of Interlocking Frames, Interlocking Key Boxes and Station Master's Slide Control Frames

### 12.26.1 Periodicity

- (a) Locking of interlocking frames, interlocking key boxes and Station Master's slide control frames shall be tested once in a year or earlier if required.
- (b) Locking shall also be tested before opening a new installation, after every addition and alteration and immediately after overhauling.

### 12.26.2 Programme of Testing

- (a) The testing of interlocking frames, interlocking key boxes and Station Master's slide control frames shall be done in a programmed basis on the same lines as laid down in Section '25' for overhauling. The testing programme shall be arranged as follows:
- (b) First at the time of overhauling, second a year later and third 2 years after overhauling. At the end of the third year, a test should be carried out separately only if overhauling is not proposed to be done within two months of the date on which periodical testing is due.

### 12.26.3 Essential Requirements of Locking to be Tested

- (a) It is essential that the interlocking of all signals with the points is so effected as to ensure the following conditions:-
  - (i) It shall not be possible to take 'OFF' a running signal until all points on the running line are correctly set and the facing points locked, all points giving access to the running lines from interlocked siding and goods lines are set against the running lines and interlocked level crossing gates on the routes including overlap are closed and locked across the road way. A signal lever when pulled shall lock or back lock as necessary the levers operating the points and gate locks referred to above.
  - (ii) It shall not be possible to take 'OFF' conflicting signals at the same time.
  - (iii) When signals are at 'ON', all points, which would be locked by the taking 'OFF' of such signals, shall be free.
  - (iv) It shall not be possible to take 'OFF' a Warner Signal until all the relative Stop Signals in advance have first been taken 'OFF' and when 'OFF' it must back lock such signals.
  - (v) It shall not be possible to take 'OFF' main home signal to proceed aspect unless all advance signals like advanced starter, intermediate starter and mainline starter are taken 'OFF'.
- (b) The locking in the frame shall correspond with that shown in the approved Interlocking Table.
- (c) The Locking shall be strong, durable and accurate and it should not be possible –
  - (i) for any mechanical lock to enter a notch other than that for which it is intended;
  - (ii) to force the locking.
- (d) The locking in the lever frame shall act on the commencement of the movement of the lever in the case of a direct type lever frame. In the case of a catch handle type of lever frame, the locking shall act on the commencement of the movement of the catch handle.
- (e) The release locking shall not be effected before the completion of the movement of lever and releasing the catch handle in the case of catch handle type lever frame.
- (f) Lever collars and slide collars shall be tested so that it is not possible to operate a lever or slide with a collar placed on it.

### 12.26.4 Methods of Testing

- (a) There are two methods of testing the locking:-
  - (i) against the Interlocking Table, and
  - (ii) against the signalling Plan.

#### **12.26.5 Testing by the SSE/JE (Signal)/incharge**

- (a) The SSE/JE (Signal)/incharge shall test locking against the interlocking table and do spot checks from the Signalling Plan.

#### **12.26.6 Testing by the DSTE/ADSTE**

- (a) DSTE/ADSTE shall test locking against the interlocking table as well as make spot checks from the Signalling Plan.

#### **12.26.7 Instructions for Testing**

- (a) All levers shall be placed in their normal position before testing is started. When testing against the interlocking table, levers shall ordinarily be tested consecutively beginning from lever number-1.
- (b) In each case where a lever is released by a combination of other levers, it is necessary to have all the levers of the group pulled over to test the back locks, then to put back each lever separately, leaving the other levers pulled over, to test each individual lock.
- (c) Some examples of testing locking are as follows

##### **(i) Warner Signal**

- Try the Warner lever. It should be locked.
- Pull over the relative Loop Homes and Outer Levers and also Loop starters if worked from the same cabin. Try the Warner lever again, it should be locked.
- Pull over the relative Main Home and Outer levers and try the Warner lever again. It should be locked.
- Pull over the Main line Starter lever and once more try the Warner lever. It should be free if there is no other running signal in advance of the Starter signal.
- After pulling the Warner lever, see if the Outer, the Home and the Starter signal levers are back locked. If Advanced starter exist then should be back locked.
- Replace the Warner, the Outer and the Home signal levers, but leave the starter lever pulled over. Try again to pull the Warner lever. The Warner lever should be locked.

##### **(ii) Stop Signal**

- Set up each route separately, and if the stop signal is released by another signal (e.g., the Outer by the Home), prove that the releasing and back locking is correct as in the case of Warner signal levers.
- See that all conflicting point and signal levers, both in advance and in rear of the signal under test, are locked.

- Replace the signal lever under test and pull over each conflicting point lever or combination of conflicting point levers in the route separately and see if the signal lever is locked.
- Try each conflicting signal with the signal lever under test in the normal position, pulling such levers as required releasing each conflicting signal.
- Points in rear of the signal under test should be tried both in the normal and reverse positions with the signal lever reversed to see if the both ways locking is correct.
- The extent of this both ways locking in rear of each signal varies according to local condition.

### (iii) Junction Signal Test

(iv) In Figure 1, when lever No.2 is tested, it is not sufficient to pull 3 and try if 4 is locked normal because 3 locks 4 both ways. The methods of testing where the facing points stand normally unlocked, should be as follows :-

- Try 1 and 2. Both should be locked.
- Pull 3 and try 1, 2 and 4, 2 and 4 should be locked and 1 free.
- Pull 1 and see that 3 is back locked.
- Replace all levers and pull 4 and 3, 1 should be locked, 4 locked in reverse and 2 free.
- Pull 2 and see that 3 is back locked.

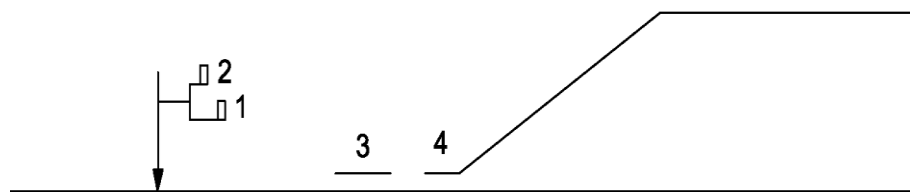


Fig : 1

### (v) Point Locking

(i) The locking between point levers is tested on the same principles as the locking between signal levers, care being taken that each point lever is free to be tested by pulling the releasing levers, if any, and also that points are not being held by facing point locks.

## (vi) Special/Conditional Locking

(vii) Figure 2 is an example of special locking, where 1 is released by 3 when 2 is normal. The method should be as follows:-

- Try 1, 1 should be locked,
- Pull 2 and try 1, 1 should be free,
- Pull 1, 3 should be locked and 2 backlocked.
- Replace all levers. Pull 3 and try 1, 1 should be free,
- Pull 1, 2 should be locked and 3 backlocked.

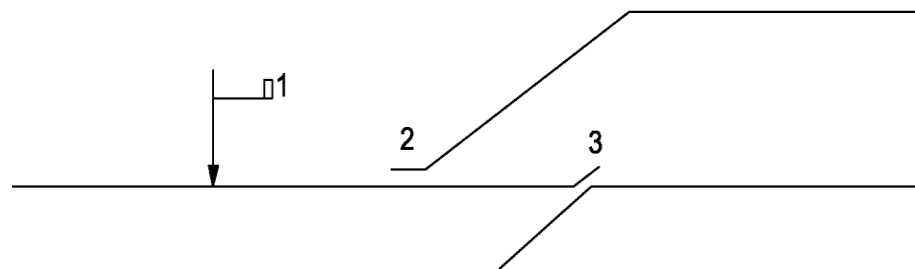


Fig : 2

- In each case, where a lever is released by a special combination, as in Fig.3, where 1 is released by 4 with 2 and 3 normal, each part of the combination must be tested on the same principle as before. Either 2 reverse or 3 reverse must "break-down" the release on 1 by 4.

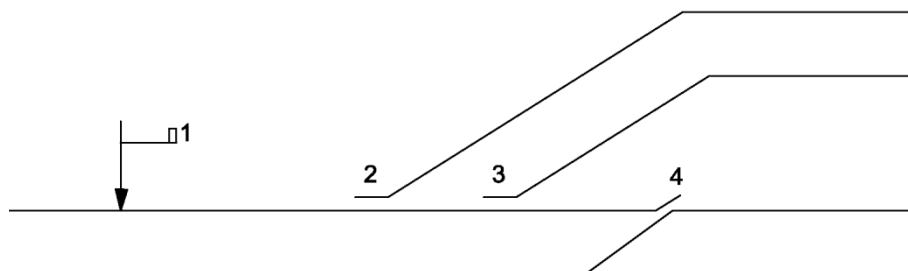


Fig : 3

## ➤ Reciprocal Locks and Checking

- As each lock is tested, its reciprocal should, whenever possible, be tested at the same time. As and when they are dealt with, the figures must be ticked off on the interlocking table so that no lock is missed.

## ➤ Locked Levers

- While testing a locked lever, a steady pressure should be applied so as to ensure that it is not free before the releasing lever has completed its travel. This will prove that there are no conflicting notches.

### 12.26.8 Test Charts

- (a) Test Charts showing the manipulation of various levers to check each locking as detailed in [para 12.26.7](#) should preferably be prepared to facilitate testing of large interlocking frames.

### 12.26.9 Lost Motion Test

- (a) When a lever or catch handle which should be locked can be moved more than the allowance stipulated in [para 12.1.3\(i\)](#), it should be considered as having too much lost motion, which must be removed.

### 12.26.10 Certificate of testing locking

- (a) Certificate of Testing locking on Form S&T/LT ([Annexure-12-A4](#)) for all interlocking frames, interlocking Key Boxes and Station Master's slide control frames shall be promptly submitted by the SSE/JE(Signal) to the Sr.DSTE/DSTE in duplicate. The Sr.DSTE/DSTE shall, after necessary scrutiny, forward a consolidated statement along with a copy of the certificate to the PCSTE for his/her record.

## Section 27: Records of Testing and Overhauling

### 12.27.1 Records of Testing and Overhauling

- (a) Record of testing and overhauling of interlocking frames, interlocking key boxes and Station Master's slide control frames shall be maintained as follows:-
  - (i) **At individual stations:** In the Signal incidences and Inspection register.
  - (ii) **With the SSE/JE (Signal):** In a separate Register, a separate page shall be used for each interlocking frame, interlocking key box and Station Master's slide control frame.
  - (iii) With the Sr.DSTE/DSTE and the PCSTE on cards. One card shall be used for each interlocking frame, interlocking key box and Station Master's slide control frame. These cards shall be suitably filled to indicate -
    - Testing or overhauling due "current period".
    - Testing or overhauling "over-due".
    - Testing or overhauling "done during the period".
    - Testing or overhauling "done during previous period and not requiring immediate attention".
  - (iv) A site verified copy of approved locking table and locking diagram, which was basis for testing on completion of overhauling shall each be maintained with the SSE/JE (signal) and the Divisional Office.

### 12.27.2 Date of last Overhauling and Testing

- (a) Date of last overhauling and testing shall be painted on the lever frames, interlocking key boxes and Station Master's slide control frames.

## Section 28: Testing and Overhauling of Electromechanical Installations

### 12.28.1 Mechanical Locking

- (a) Instructions contained in the preceding paragraphs for the installation, maintenance, overhauling and testing of locking of mechanical interlocking frames shall also apply to electromechanical installations with mechanical locking frames wherever relevant.
- (b) The mechanical locking of interlocking frames shall be tested for lost motion, as per [para 12.1.3\(i\)](#) and lost motion, when in excess of the prescribed limits, shall be removed.

### 12.28.2 Electrical Locking

- (a) In electromechanical installations electric lever locks, key transmitters, circuit controllers, Detectors etc. shall be provided as per approved plan.
- (b) Diagram of electrical circuits for each such gears shall be prepared and shall show all the necessary controls which shall be required to release a particular lever.
- (c) Where lever locks have been provided in the mechanical lever frames for controlling operation of Electric Point Machine, Electric Signal Machine or for route holding etc the functioning of the same shall be tested.
  - (i) **Points Lever:** In points lever ABDE locks are provided for Track & Indication locking. Lever shall be tested to ensure that the lever lock is energised and the lever is free to be operated in A/E position only when the controlling tracks are clear. The lever shall again be locked in D position when the point is being operated from normal to reverse and lever shall be free only when the points has operated fully and locked and detected in reverse position. Similarly, while operating the lever from reverse to normal the lever shall be first locked in E position to ensure track locking and subsequently will be held at B position for point operation. The lever lock shall not energise at B position unless the points have operated, set, locked and detected in normal position.
  - (ii) **Signal Lever:** While pulling the signal lever from normal to reverse the lever shall be locked in A position and will be free only when route for the reception of the train has been correctly set, all facing points locked and all the controlling tracks are clear i.e. all conditions are fulfilled for taking 'OFF' the signal. While putting back the lever from reverse to normal position the lever shall be locked at B position and will be free only when the intended movement is completed and it is free from back locking as well as approach locking where provided. Normal indication locking must also be effective in B position in case of semaphore signal.

### 12.28.3 Testing and overhauling of Electrical Locking

- (a) Mechanical interlocking frames provided with electrical signalling equipment shall be tested and overhauled as per requirements contained in [paras.12.25.5 & 12.26.7](#).
- (b) The testing of electrical locking shall be carried out in accordance with the approved release circuit of each lever as shown on the approved diagram of electrical circuits.
- (c) For testing the electrical locking provided on a lever, the other levers required to release that lever shall be pulled and it must be ensured that the lever is free to be pulled mechanically.
- (d) All the conditions for the release of the electrical lock of the lever under test shall be set up. The lever shall now be pulled from normal to reverse for testing of A&D locks and reverse to normal for E&B locks and proper functioning of the lever locks checked.
- (e) A test lamp/voltmeter shall now be connected on the electrical lock of the lever under test. The lever shall now be pulled from normal to reverse and vice versa. The test lamp should lit up at lock positions. The lever shall be held at these positions one after the other and all the lock release conditions shall be broken one by one. It shall be ensured that feed to the lever lock is disconnected each time. While doing this test, care shall be taken to test each circuit individually one after the other duly isolating other parallel circuits.

### 12.28.4 Testing of other electrical equipment

- (a) Instructions contained in [Chapter 19 of SEM](#) for testing of electrical signalling installations shall also apply to electromechanical installations wherever relevant.
- (b) All electrical equipments such as electric lever locks, circuit controllers etc., as well as wiring shall be examined and tested for insulation. The insulation must not be less than 10 Mega Ohm. Defective equipments shall be replaced.
- (c) Moving parts of circuit controllers, their mechanical connections and contact makers shall be checked. Repairs and replacements should be carried out wherever necessary.

### 12.28.5 Date of last overhauling and testing

- (a) Date of last overhauling and testing should be painted on the interlocking frame.

### 12.28.6 Certificate of overhauling

- (a) Locking overhauling certificate on Form S&T/LO ([Annexure:12-A3](#)) for all mechanical interlocking frames shall be promptly submitted by the SSE/JE (Signal) to the Sr.DSTE/DSTE, who shall after necessary scrutiny forward a consolidated certificate to the PCSTE.





Note:- This Chapter has under mentioned Annexures

<b>S.No</b>	<b>Annexure No</b>	<b>Description</b>
1	<a href="#">12-A1</a>	Essential Requirements before Interlocking of a Point
2	<a href="#">12-A2</a>	Certificate of Overhauling Interlocking Frames
3	<a href="#">12-A3</a>	Certificate of Testing of locking



Note: This Chapter has under mentioned Annexures in [Appendix I](#)

<b>S.No</b>	<b>Annexure No</b>	<b>Description</b>
1	<a href="#">12-MS1</a>	Maintenance Schedules for Mechanical Signalling



Note: This Chapter has under mentioned Drawings in [Appendix II](#)

<b>S. No</b>	<b>Drawing No</b>	<b>Description</b>
1	<a href="#">12-D1</a>	Mechanical Signalling Gears – Colouring Scheme ( 6 Sheets)

### Essential Requirements before Interlocking of a Point

Before the interlocking work at points is undertaken, it must be ensured that the JE/SSE( P-Way) has:

- (a) brought the track to correct level and alignment.
- (b) eased off rail joints on either side of points to be interlocked and closed the stock rail joints associated with lock bars.
- (c) fully ballasted and packed all points which are to be interlocked and taken adequate measures to prevent lateral and longitudinal movement of points.
- (d) provided creep and level pillars.
- (e) arranged the sleepers on adjacent tracks in alignment, where rods and wires have to cross.
- (f) seen that the gauge is correct.
- (g) provided and fixed special timbers as required.
- (h) provided means to prevent creep in the vicinity of points.
- (i) fitted gauge tie plates correctly.
- (j) made the stretchers of such a length so that the throw of switches is as per approved drawings.
- (k) adjusted loose heel switches so that:
  - (i) they can be thrown both ways with ease and can be housed against the stock rail by hand and remain there when the pressure is removed.
  - (ii) the planed surface of the switch rail fully houses against the stock rail as per approved drawings.
- (l) adjusted fixed heel switches so that :
  - (i) they normally lie in the mid-position and flex equally in the normal and reverse positions.
  - (ii) the planed surface of the switch rails fully houses against the stock rails as per approved drawings.
- (m) fitted flexible stretchers so that they flex equally in the normal and reverse positions,
- (n) provided a stop for the open position of a single switch layout.

**Certificate of Overhauling of Interlocking Frames**

.....RAILWAY

**SIGNAL AND TELECOMMUNICATION DEPARTMENT**

No.....

To

The Divisional Signal and Telecommunication Engineer,  
 .....Division

This is to certify that I have personally supervised the overhauling of the interlocking frames/ Interlocking key boxes/Station Master's slide control frames at the station/cabins on my section shown below, and that they have been thoroughly examined and cleaned, also repaired or refitted where necessary and all parts are in good working order. The mechanical locking is in accordance with the approved interlocking charts and interlocking tables.

Station /Cabin name	Apparatus overhauled	Date of last overhaul	Date overhauled	Reference to plans		Remarks
				Locking table, locking diagram	Signalling plan	

Dated:

Signature.....

Name .....

Designation.....

Station.....

**Certificate of Testing of Locking**

.....RAILWAY

**SIGNAL AND TELECOMMUNICATION DEPARTMENT****for the month ending.....20..**

No.....

To,

The Divisional Signal &amp; Telecommunication Engineer,

.....Division

This is to certify that I have personally tested the interlocking frames, interlocking key boxes and Station Master's slide control frames at the stations on my section shown below and that they are in good working order and that the mechanical locking/electrical locking is in accordance with the approved interlocking tables.

Name of Station /Cabin	Apparatus tested	Date of last test	Date tested	Tested against		Remarks
				Signalling plan	Locking table/ selection table	

Dated:

Signature.....

Name .....

Designation.....

Station.....

## Chapter 13: ATP, ETCS, IRATP (TCAS) & TMS

### Section 1: General Requirements

- 13.1.1 **Definitions:** Please refer to [Glossary](#) for definitions of Technical terms used in this chapter.
- 13.1.2 There are two types of ATP Systems.
- (a) European Train Control System (ETCS) having four levels.
  - (b) Train Collision Avoidance System (TCAS) is Indian Railways ATP System.
- 13.1.3 **ATP requirements**
- (a) ATP systems shall confirm to latest specification and shall be of approved type.
  - (b) ATP systems shall be suitable for working on Electrified and Non-Electrified sections.
  - (c) Functions in ATP systems shall comply with the Safety Integrity Level as stipulated.
- ATP systems shall have two sub-systems viz. Trackside and On-board.
- 13.1.4 **Trackside:**
- (a) Movement authorities (MA) shall be generated by trackside equipment based on input received from signal interlocking.
  - (b) The track description data such as Permanent Speed Restrictions, Gradients, Level Crossing Gates, etc. are to be pre-fed in the track side equipment.
  - (c) The trackside equipment shall Communicate MA to on board equipment along with track description data.
- 13.1.5 **On-board:**
- (a) The On-board equipment of the ATP shall be correctly and effectively interfaced to existing Air/Vacuum/Dual/Electropneumatic brake system of Diesel and Electric Locomotives as well as other self-propelled vehicles treated as train.
  - (b) The On-board Vital Computer (OBC) shall calculate the maximum permitted speed for the track section ahead based on a dynamic speed profile taking into account the train running/braking characteristics which are known on-board and the MA (movement authority) and track description data received from trackside.
  - (c) It shall continuously supervise the train speed and apply brakes if the train speed exceeds the most restrictive speed by a pre-defined speed margin.

- (d) It shall give a warning to the Loco Pilot to enable him to react and to avoid intervention from on-board equipment for application of service brake.
- (e) It shall not be possible to mute the warning and to stop automatic brake applications by prior operation on Driver Machine Interface (DMI).
- (f) It shall not be possible to cancel the Emergency brake application initiated by interrupting the power supply to the system.
- (g) The speed sensors shall be provided on the locomotive itself or on the coach housing the on board equipment for EMU/MEMU.

#### 13.1.6 **Conformity to Schedule of Dimensions:**

The track side and on-board equipment shall not in any way infringe the schedule of dimensions being followed by the Indian Railways.

#### 13.1.7 **Power Supply Arrangement:**

- (a) **Track Side:** The track side system of the ATP shall work on AC or DC power supply & shall have power backup. The power supply shall run from power supply room to line side equipment on line wise separate cable with redundancy in diversified path preferably.
- (b) **Onboard:** The On board equipment of the ATP shall work on the DC power supply available in the locomotive.

#### 13.1.8 **Operating Modes & its Transitions:**

- (a) The current mode of On-board equipment shall be indicated to the Loco Pilot by means of suitable indications on the DMI.
- (b) In case of mode transition, when the responsibility of the loco pilot increases due to the result of such automatic transition, the OBC shall seek an acknowledgement from the loco pilot, irrespective of whether the train is stationary or moving. In case the transition has to be acknowledged and the loco pilot fails to acknowledge as required, the OBC shall initiate a brake application.

#### 13.1.9 **Application/Executive Logic Handling:**

- (a) The programming/feeding of data to Track side or On-board equipment shall be suitably protected against unauthorized use.
- (b) The executive logic uploaded in Track side or On-board shall be of approved type.
- (c) Factory Acceptance Testing shall be carried out on the application logic before uploading it in track side or On-board.
- (d) Version Control and checksum shall be effectively implemented for both Application and executive logic.
- (e) Zonal Railways shall set up a system to implement the changes in signal interlocking and track description data for effective functioning of ATP system.

#### 13.1.10 Automatic Self-Test at Boot up:

- (a) The on-board equipment shall perform an automatic self-test when the equipment is switched ON.
- (b) This self-test shall not require any action on the part of the Loco Pilot/operator.
- (c) This self-test shall test proper working of Brake Interfaces on boot-up.
- (d) The result of self-tests shall be indicated on DMI.

#### 13.1.11 Isolation of On-board Equipment:

- (a) On-board system shall have provision for isolation to cater for failure situations which shall result in disconnection of the system from the locomotive braking system. This shall be indicated to the Loco Pilot by means of a visual indication which shall be available even if DMI has failed.
- (b) To avoid accidental/unwarranted use, the isolation arrangement of the equipment must be protected and sealed.
- (c) Isolation of system must be recorded by the system as well as recorded in a non-resettable type 6-digit counter.

#### 13.1.12 Data Logging & Diagnostics:

On board as well as Track side system shall be provided with Data logging for diagnostic functions.

### **Section 2: European Train Control Systems (ETCS) & Train Protection and Warning Systems (TPWS)**

#### 13.2.1 Levels of ETCS: ETCS has Four Levels:

- (a) **Level 0:** A level of ATP defined to cover instances when the ATP on-board equipment is operating in an area where the trackside is not fitted with operational ATP equipment.
- (b) **Level 1:** A level of ATP overlaid onto conventional track side signalling that uses balises/loop/Radio Infill to pass movement authorities to the train whilst relying on conventional means to determine train position and integrity.
- (c) **Level 2:** A level of ATP that uses radio to pass movement authorities to the train whilst relying on trackside conventional means to determine train position and integrity.
- (d) **Level 3:** A level of ATP that uses radio to pass movement authorities to the train. Level 3 uses train reported position and integrity to determine if it is safe to issue the movement authority.

### 13.2.2 ETCS Level 0

- (a) Level 0 applies when an ATP-fitted vehicle is used on a non-ATP route. The train borne equipment only supervises the maximum speed of that type of train in unfitted areas.
- (b) In Level 0 it is authorized to operate trains without any train control system and therefore line side fixed signals are to be followed by Loco Pilot.
- (c) Train detection and train integrity supervision are performed by the trackside equipment of the underlying signalling system (interlocking, track circuits etc.).
- (d) Level 0 uses no track-train transmission except balises to command level transitions. Balises therefore still have to be read.
- (e) No supervisory information is indicated on the DMI except the train speed. Train data has to be entered in order not to have to stop a train at a level transition to ATP equipped area and to supervise maximum train speed in unfitted areas.

### 13.2.3 ETCS Level 1

- (a) Level 1 is a spot transmission system to be used as an overlay on an underlying signalling system. Trackside signals are required in Level 1 application. Train Protection Warning System (TPWS) is equivalent to Level 1.
- (b) Track side equipment of Level 1 comprises of
  - (i) Balises
  - (ii) Line side electronic unit (LEU)
  - (iii) Communication link (data cable) between the LEU & the balise
  - (iv) On-board equipment of Level 1 comprises of:
    - On-board Vital Computer (OBC)
    - Data logger for diagnostics (either part of OBC or separate)
    - Driver Machine Interface (DMI), indications & and non-resettable counters
    - Balise Transmission Module (BTM)
    - Balise antenna fixed to the under frame
    - Speed Sensors such as Pulse Generators, Accelerometers, Radar etc.
    - Train Interface Unit (TIU)
    - Interface to existing brake control system which in turn controls application of service/emergency brakes or interface to existing brake system directly
    - Power supply arrangement
    - Suitable isolation arrangement for isolating the system



- (c) The Trackside equipment does not know the train to which it is sending information. Movement authorities are generated by Trackside equipment and are transmitted to the train via balises. Balises pick up signal aspects from the trackside signals via Line side Electronics Unit (LEU) and transmit them to the vehicle as a movement authority along with track description data.
- (d) The Trackside system shall interface with the signalling system through LEU without affecting normal working & safety of signalling system. LEU shall take input regarding signal aspect through potential free contacts of the Lamp Checking Relays (ECRs).
- (e) Because of the spot transmission of data, the train must travel over the balise to obtain the next movement authority.
- (f) The fixing arrangement of the balise on the sleeper shall be such that it does not require any drilling to the sleeper.
- (g) If in level 1, a Trackside signal clears an approaching train cannot receive this information until it passes the balise group at that signal. The Loco pilot therefore has to observe the Trackside signal to know when to proceed. The train has then to be permitted to approach the stopping location below a maximum permitted release speed. Additional balises ("infill balises") can be placed in rear of signal to transmit infill information, so that the train will receive new information before reaching the signal.
- (h) Train Detection and Train Integrity supervision are performed by the Trackside equipment of the underlying signalling system (interlocking, track circuits etc.) and are outside the scope of level 1 ATP system.
- (i) Level 1 shall have two levels of brake commands.
  - (i) Service brake command
  - (ii) Emergency brake command
- (j) **Release Speed:**
  - (i) A release speed shall be calculated onboard to allow the train to approach the target (i.e. stop signal at ON) with such speed so as to ensure that the train stops before reaching the danger point up-to which train movement is considered safe (i.e., overlap distance beyond the stop signal at ON), based on data received. The release speed shall be calculated onboard based on safety distance including signal overlap, deceleration performance of the train & any other relevant considerations.
  - (ii) The release speed shall be programmed as a pre-defined value & transmitted to onboard equipment via the Track side equipment.
- (k) If the current train speed exceeds the Release Speed, emergency brake shall be applied by Level 1.

### 13.2.4 ETCS level-1: Train Protection & Warning System (TPWS)

(a) Train Protection and Warning System assures higher level of safety during train operation. It allows safe movement of trains under its supervision. It enables automatic train protection and prevents collision, like situation. It facilitates to run the train at maximum permitted speed by providing the indication to the driver 500 meters in advance of signal and higher average speed of train. The Entire system provides assistance to the Driver and can be called as an aid to the Driver.

(b) TPWS basically consists of:

- (i) Cab Equipment
- (ii) Trackside Equipment

(c) **Cab Equipment/On-Board Equipment**

It consists of the following units:

- (i) On-Board Computer (OBC)
- (ii) Balise Transmission Module (BTM)
- (iii) BTM Antenna
- (iv) Simplified Driver Machine Interface (SDMI)
- (v) Wheel Sensors
- (vi) Brake Interface
- (vii) Health indication Panel cum Emergency Brake (EB) counter
- (viii) Audio Buzzer unit
- (ix) Isolation switch

(d) **Trackside Equipment**

It consists of the following:

- (i) Line Side Electronic unit (LEU)
- (ii) Euro Balise consists of
  - Fixed Balise
  - Controlled Balise

(e) **Sequence of Operation**

- (i) LEU picks up the Signal Aspect with its ECR input.
- (ii) Aspect information passed on to the Balise.
- (iii) BTM Antenna picks up telegram from Balise.
- (iv) BTM decodes the data and sends to OBC.

- (f) OBC processes this information and generates the required commands (such as Movement Authority or Braking, Warning). These actions take place depending up on the current signal aspect and actual speed of the train.
  - (i) Adopted to Act on data received from Balise in TPWS territory.
  - (ii) Calculation of speed profile for track section ahead based on data received.
  - (iii) Audio visual warnings about possible intervention from TPWS before SB & EB.
  - (iv) Continuous monitoring of current speed with maximum permitted speed of train & bringing the brake intervention (SB) when it exceeds 5 KMPH.
  - (v) Train Trip by emergency brake application if speed exceeds 10 KMPH.
  - (vi) Emergency brake application if train passes the stop signal at ON.
  - (vii) Manual release of Emergency brake by Isolating the system.
  - (viii) Passing manual stop signal at ON by using a bye-pass button.
  - (ix) Speed monitoring while passing on Automatic signal at ON.
  - (x) Provision of Roll back protection.
  - (xi) Provision for Isolation of TPWS system in case of malfunctioning.

### 13.2.5 ETCS Level 2

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(c) On-board equipment of Level-2 comprises of:

- (i) On-board Vital Computer (OBC)
- (ii) Data logger for diagnostics (either part of OBC or separate)
- (iii) Driver Machine Interface (DMI), indications & and non-resettable counters
- (iv) Balise Transmission Module (BTM)
- (v) Balise antenna fixed to the under frame
- (vi) GSM-R/LTE Radio
- (vii) Speed Sensors Such as Pulse Generators, Accelerometers, Radar etc.
- (viii) Train Interface Unit (TIU)
- (ix) Interface to existing brake control system which in turn controls application of service/emergency brakes or interface to existing brake system directly
- (x) Power supply arrangement
- (xi) Suitable isolation arrangement for isolating the system.

(d) Level 2 provides a continuous speed supervision system, which also protects against overrun of the authority by applying brakes.

(e) Based on inputs received from Signalling interlocking, Radio Block Centre generates Movement Authorities which are transmitted to the train via radio.

(f) Train detection and train integrity supervision are performed by the trackside equipment of the underlying signalling system (interlocking, track circuits etc.) and are outside the scope of Level 2.

(g) Level 2 provides bi-directional track-train communication.

(h) Train movements shall be supervised continually by the radio block centre in its territory.

(i) The radio block centre which provides the information to the trains shall know each ATP controlled train individually by the unique identity of its leading ATP on-board equipment.

(j) The movement authority is transmitted to the vehicle continuously via GSM-R/LTE radio along with track description data.

(k) The balises act as reference points and are used only to correct the accumulated odometry error. Between two balises, the train determines its position via speed sensors (Pulse Generators, accelerometer, radar).

(l) The on-board computer continuously compares the train speed with the Permitted speed and commands the brake application, if necessary. Line side signals can be suppressed in Level 2.

(m) Level-2 shall accommodate regenerative braking (optional). It shall have two levels of brake commands:

- (i) Service brake command.
- (ii) Emergency brake command.

### 13.2.6 Level 3 (Reserved for future)

### 13.2.7 Driver Machine Interface for ETCS

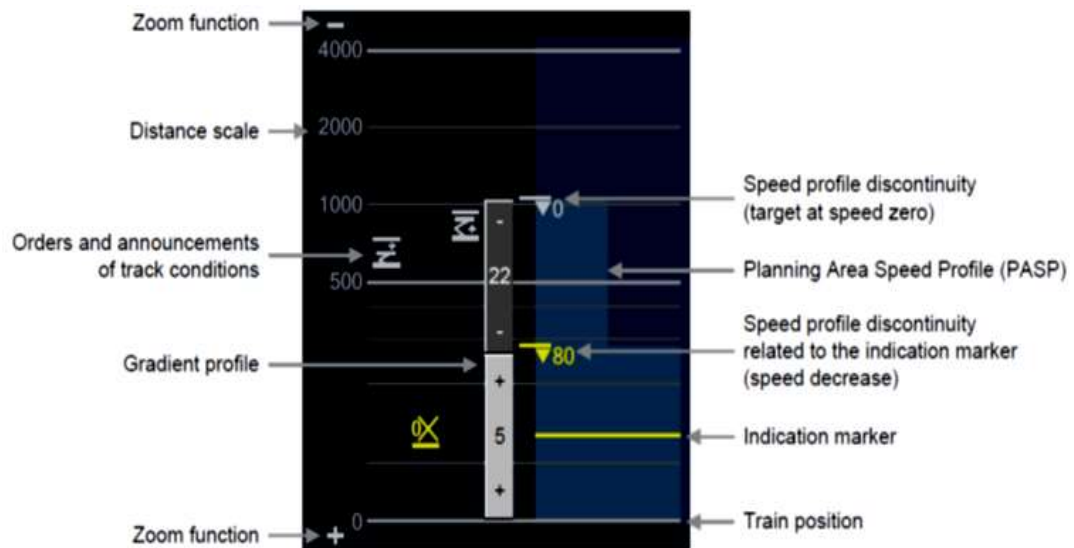
(a) The Driver Machine Interface shall be applicable for all the levels. A typical overall view of the main window of the DMI during the start of the mission (i.e., start of travel) is shown below:



(b) A typical overview of the objects in speed and supervision areas during running of the train is shown below. This is on the left side of the Driver Machine interface.



- (c) A typical overview of the objects in the planning area during running of the train is shown below. This is on the right side of the Driver Machine interface.



### Section 3: IRATP - Train Collision Avoidance System (TCAS)

- 13.3.1 Indian Railways Automatic Train Protection (IRATP) indigenously developed, is named as Train Collision Avoidance System (TCAS). TCAS is an Automatic Train Protection System with Cab Signalling features. Both the terms are used synonymously.

(a) Two Major areas of Safety Concern are

- (i) LC gate Accidents
- (ii) Signal Passing at Danger (SPAD)

TCAS is intended to provide train protection by addressing:

- Prevention of collisions
- Control of speed at tracks having speed restrictions

(b) Automatic Train Protection (ATP) features of IRATP are:

- (i) Detection and Prevention of SPAD
- (ii) Cab signalling with Display of movement authority, target distance, speed and signal aspect
- (iii) Continuous train control
- (iv) Protection for speed restriction
- (v) Detection of roll back
- (vi) Blowing horn while approaching Level Crossing Gate

(c) Train Collision Avoidance Features are

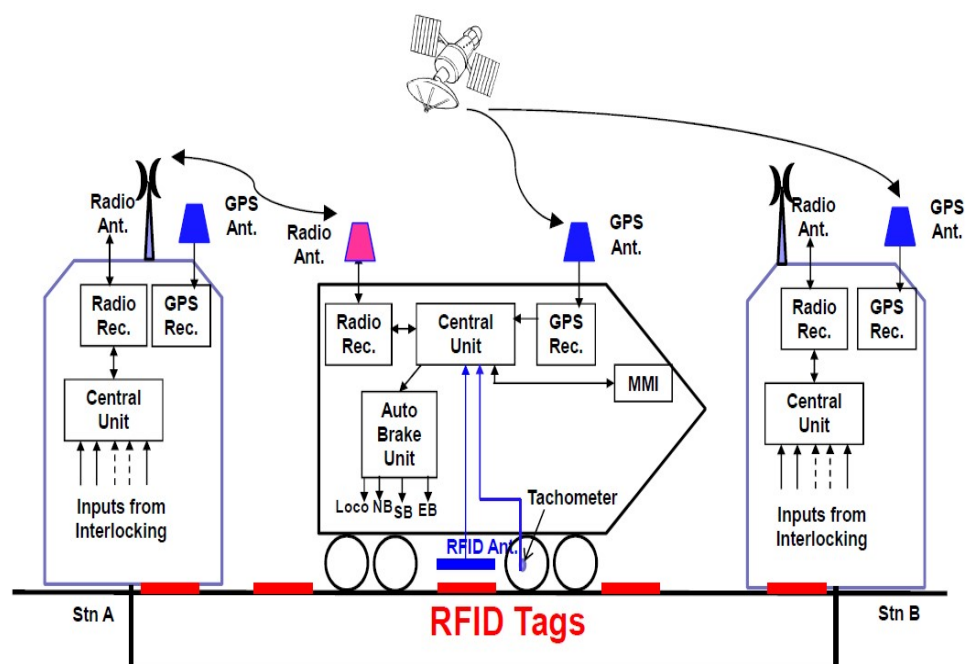
- (i) Head On Collision prevention
- (ii) Rear End Collision prevention
- (iii) Side Collision prevention

13.3.2 Track side equipment of IRATP comprises of

- (a) RFID Tag
- (b) Stationary unit
- (c) Radio

13.3.3 On-board equipment of IRATP comprises of

- (a) On Board Computer (OBC)
- (b) RFID readers consisting of two RFID Reader in hot standby
- (c) \*Driver Machine Interface (DMI), indications and non-resettable counters
- (d) Loco Radio Unit consisting of two Radio Modems in hot standby with separate cables and antennae for each radio
- (e) Pulse Generators (Speed Sensors)
- (f) Train Interface Unit (TIU)
- (g) Interface to existing brake control system which in turn controls application of normal/service/emergency brakes or interface to existing brake system directly
- (h) Power supply arrangement
- (i) Suitable isolation arrangement for isolating the system.



\*Note: MMI stands for Man Machine Interface = DMI



- 13.3.4 (a) Based on inputs received from Signalling interlocking, the Stationary unit of TCAS generates Movement Authority which is transmitted to the train via radio.
- (b) Stationary unit of TCAS shall have feasibility to interface with relay based Interlocking and Electronic Interlocking.
- (c) Train detection and train integrity supervision are performed by the trackside equipment of the underlying signalling system (interlocking, track circuits etc.).
- (d) DMI of the onboard unit of TCAS shall provide assistance to Loco Pilots by means of real-time display of the aspect of approaching signal.
- (e) TCAS shall provide bi-directional track train communication.
- (f) Train movements shall be supervised continually by the Stationary unit in its territory.
- (g) The Stationary unit which provides the information to the trains shall know each TCAS controlled train individually by the identity of its leading TCAS on-board equipment.
- (h) The movement authority is transmitted to the vehicle continuously via UHF/ GSMR/LTE radio together with speed information and track description data.
- (i) The RFID Tags act as reference points and shall be used to correct the accumulated odometry error. Between two RFID Tags, the train shall determine its position via Pulse Generators.
- (j) The fixing arrangement of the RFID Tag on the sleeper shall be such that it does not require any drilling to the sleeper.
- (k) The on-board computer shall continuously compare the train speed with the permitted speed and commands the brake application, if necessary.
- (L) Multi-vendor interoperability shall be provided.

13.3.5 Three levels of brake commands in TCAS are:

- (a) Normal brake command
- (b) Service brake command
- (c) Emergency brake command

Simulated Braking Distance Calculations for service and emergency brakes are given at [Annexure:13-A1](#).

### 13.3.6 Driver Machine Interface of TCAS

A typical overall view of DMI is shown below:



Note: For Maintenance schedule of TCAS please refer to [Annexure 13-MS2](#).

## Section 4: Traffic Management System (TMS)

### 13.4.1 Traffic Management System (TMS)

Traffic Management System broadly carries out following functions:

- (a) Centralized Operation of Signalling Systems for a large section encompassing multiple interlocked stations and LC gates.
- (b) Centralized Real time Monitoring of Train Traffic for enabling efficient decision making for traffic control of large section.
- (c) Interfacing & real time data sharing with COA (Control Office Application), Crew management system, PA system at station, ATP, etc. as required.
- (d) TMS should have facility of Automatic route setting (ARS), Long route setting, Route stacking command for avoiding repetitive operation by controller.
- (e) The system shall be able to generate various MIS report, train graph and detect and manage alarms and logs generated in the system.

*Note: CTC (Centralised Traffic Control) system caters for centralised control & supervision of train operation whereas TMS system comprises of CTC system as well as other management tools like MIS report, time tabling, asset monitoring, interfaces with COA, ATP system, crew management & passenger information system etc. CTC is a sub set of TMS.*

**13.4.2 Functionalities of TMS:** The system broadly envisages the functionality as described below:

**(a) Live Indications: Visual display wall:** This displays track layouts of stations, auto sections, IBS and interlocked LC Gates of section monitored by TMS indicating real-time status of track circuited lines, signal aspects, points, LC Gate etc. The panel will also provide alarm indications of failure of points, signals, track circuits etc. as the case may be.

**(b) Live Indication to Train controller terminals:**

- (i) These consist of LCD/LED monitors operated by one computer with GPU (Graphic Processing Unit).
- (ii) All terminals shall be able to display complete information of yards covered by TMS with details of track circuits, signals, Points, LC gates etc. Any failure of signalling system on any of yard will be available in audio & visual form to draw attention of controller.
- (iii) The train controller terminal is capable of running the Decision Support System (DSS) feature. Decision support system identifies operational conflicts (like precedence, crossing etc.) in advance and suggests optimized control options to the controller.
- (iv) Live Indications on terminals provided with staff at Important Junction stations/Car shed/lobbies may be provided, as required.

**(c) Train Describer System (TDS):**

- (i) It associates a train with an alpha-numeric mark called a train describer tag.
- (ii) The train description tag tracks the train in sections controlled by TDS.
- (iii) The train describer system automatically assigns train describer tags from a train number queue to trains originating/terminating at the stations covered by TDS based on time table.
- (iv) The train describer system registers & displays abnormal conditions such as following:
  - Single track circuit failure.
  - Faulty position of points.
  - Change in direction of a train.
  - Division and joining of trains (not time tabled ones).
  - Unidentified trains.
  - Trains passing a signal showing a stop aspect.
  - More trains on the same track circuit.
  - Wrong marking of object/functions. (For example-A train with electric loco being marked onto non-electrified line, A passenger train marked to a goods line, A train being routed to wrong destination etc.).

- (v) Abnormal disappearing of train describer tag shall generate an alarm and display in different colour.

**(d) Control Function:**

After taking control of an area, the central controller will be able to send commands to the corresponding interlocking. The possible commands are:

- (i) Setting/cancellation of route.
- (ii) Moving point to Normal or Reverse.
- (iii) Controlling signal (ON/OFF) as permitted by interlocking.
- (iv) Setting/cancellation of traffic & power block.
- (v) Turning the ARS mode ON/OFF, long route setting & route stacking.
- (vi) Loading of Timetable/Train Chart.

**(e) Automatic Route Setting (ARS):**

- (i) The automatic route setting feature will be possible to be provided for identified stations/routes/sections.
- (ii) The ARS system relieves the operator from repetitive route setting tasks for the trains at these stations and the operator can monitor the train operation from OCC (Operation Control Centre). The system shall execute the commands according to timetable.

**(f) Long Route Setting & Route Stacking:** The chief controller/section controller in OCC can set long route for one station to another station. Provision of Route stacking shall be made to set routes of multiple trains in advance.

**(g) Block Working Operation:**

- (i) Block Operation for EI station will be done through CTC controller from OCC. Suitable failsafe provision of inbuilt block operation system in EI is needed for this and Conventional block instrument/panel may not be used for block operation. In case inbuilt block working in EI is not available, local operation of block instrument will be done by SM at station.
- (ii) For PI/RRI stations operation of block instruments/block panel may be required to be done by SM at station.

### 13.4.3 Management Information System (MIS):

**(a) MIS Reports:** The system will generate report for trains run delayed by time table. Based on the events logged and the operator input, the system will generate various traffic management reports such as:

- (i) Various Train control charts.
- (ii) Various Punctuality reports.
- (iii) Actual Rake Link Report.
- (iv) Rake Composition report.
- (v) Rake Maintenance/overhauling reports.
- (vi) Analytical report of various unusual occurrences, i.e. signal failures, OHE break down, rake failure etc. (This may be generated on daily, weekly or monthly basis on prescribed format.)
- (vii) Analytical report of crew link/utilization.
- (viii) Analytical report on rake link utilization.
- (ix) Total traffic/power blocks granted/refused along with locations, time blocked, time cleared.
- (x) Any other analytical report as required.

**(b) Train Graph:** The train graph will be made available on the specified terminals.

This broadly has following features:

- (i) The system will plot historical train graph for analysis.
- (ii) It will plot time on X axis and stations on Y axis.
- (iii) The train graph will have facility to show different train types in different color. It shall be possible to show schedule time and the actual time in the same graph but with different colour.
- (iv) It will be possible to show mainline trains/Suburban/Goods/Special trains in different colour.
- (v) On clicking/selecting a particular Train Graph it will give complete information about the train details viz. train no, crew information, rake details etc.
- (vi) Advance charting: In case controller defines the traffic block on particular line for particular time, system will be able to prepare train graph showing advance/predictive movements of available trains in particular section in different colours.

- (vii) It will be possible to edit the timetable graphically from the Train Graph display by drag and drop operations.
- (viii) The Timetable software will automatically perform the reforecasting of the future train trips when modifications are being performed either by the operator or due to traffic perturbations.
- (ix) The Train Distance Graph will highlight traffic conflicts and will assist the regulator in identifying and implementing solutions to resolve conflict situation like - Same platform use.

**13.4.4 Simulation Studies on Simulation terminal:** Separate terminal may be provided for simulation studies & training purpose. The replay of log, time table editing, editing of train graph etc. will be provided on this terminal.

**13.4.5 Time Table Builder and Editing:**

Based on data base of infrastructure like signal distances, permitted speed of trains, Signal interlocking, track circuit lengths etc. required for generation of time table, time table builder, an off-line software, will prepare a time table. Time table so generated can be modified/edited offline and after testing of same on simulator terminal, can be loaded on the TDS system.

**13.4.6 Event Log and Alarm Management System:**

- (a) **Event Log:** All important events (command, indications, errors, system information etc.) will be logged in a database for later printing and analysis.
- (b) **Replay of Event log:** The replay function will show an history of events that has happened earlier in the TDS system. The replay function will display, among other details, the dynamic status for infrastructure, train number and alarm list.
- (c) **Traffic Related Alarms:** Vital traffic operation related alarms can be
  - (i) Train not described.
  - (ii) Any unscheduled Train stoppage.
  - (iii) Routes not released after passage of train.
  - (iv) Failure of Signalling gear.
- (d) **Network Related Alarms:** All alarms not directly related to traffic operations are considered to be Network related alarms. Failure of Network Communication/inability to access any of the nodes, defective terminals, and hardware & software failures will be flashed.

#### 13.4.7 Decision Support System (DSS):

- (a) Based on the constraints & logic given by Railways, system will give optimized decision to admit or dispatch particular train at entry/exit points of a particular section.
- (b) Train running at the time of disruption: System will suggest effect of disruption on train service. Based on constraints, facilities & logic provided by railways, system will give solution for running of trains, diversion, cancellation or regulation of train services.
- (c) System will be able to detect conflicts like:
  - (i) Usage of the same platform;
  - (ii) Usage of the same routes;
  - (iii) Usage of incompatible routes;
  - (iv) Usage of the same section and same directions;
  - (v) Usage of the same section and opposite directions.
- (d) In case of conflicts, TMS display a specific icon on the train graph and generates a solution which consists in the rescheduling of the involved activities.

#### 13.4.8 Various TMS Terminals may be provided, as required, as under:

- (a) **TMS Terminal for Signal Fault Controller at OCC:** Remote monitoring of status of Signalling equipment at stations and in Block Sections will be provided on these terminals. This will include logging in of events in central system, generating alarms, alerts etc. Signalling equipment failure alarms as decided by the Engineer along with category will be available on the terminal. It will be possible to acknowledge the alarms by the user.
- (b) **TMS Terminals for Track Controller and Traction Power Controller at OCC:** Equipment failure alarms specific to Track or Traction Power, as decided by the Engineer along with category will be available on the respective terminals. It will be possible to input remarks/Information pertaining to various unusual occurrences e.g. failures & delays to operation etc.
- (c) **TMS Maintenance Terminal at OCC:** The Maintenance Terminal will be used for supervisory functions of the network and for observing any required nodes and their configuration at any time. Displays of equipment faults, communication failure occurring anywhere in the OCC or field network will be available. Failure alarms will also be given.

It will be possible to bypass any node if so required and configure other terminals from this terminal.
- (d) **TMS Terminal for Station Master at Station:** One TMS Terminal for Station Master at every Station will be provided. This will facilitate functions of Train Describer System.

- (e) **TMS Terminal with Signal Maintainer at Station:** The alarms for failure of vital Signalling and Power Supply Equipment in the jurisdiction of Station will be available on the terminal.
- (f) **Miscellaneous User Terminal:** Required Nos. of Miscellaneous User TMS Terminals to important offices/locations will be provided. The locations may be station, Divisional and Zonal office as decided by the Railway. These terminals will provide first-hand information about running of trains in visual form and in the required format.

#### 13.4.9 Various Interface/Integration Requirements:

Various interface/integration Requirements may be as given below:

- (a) Interface between TMS and SCADA system.
- (b) Integration with Crew Management system (CMS).
- (c) Interface with Master Clock System.
- (d) Interface with COA.
- (e) Interface with adjacent TMS, if any.
- (f) Interfaces with Passenger Information System.
- (g) Interface with ATP system.

#### 13.4.10 Data Communication Network:

- (a) Dedicated OFC network in ring network shall be used for interconnecting field interlocking system with TMS/CTC. Backup network from other sources may also be planned for optimal availability.
- (b) Multi-Protocol Layering Switch (MPLS) data transport protocols may be Preferred for better resource sharing.
- (c) WAN network shall be used for networking of field functions like Freight Operations Information System (FOIS), Crew Management System (CMS), Wagon Management System (WMS).
- (d) Design and bandwidth planning shall be such that data between various stations or OCC to Stations or stations to OCC can be transported simultaneously without any delay or jitter or drop in packets.
- (e) Integrated digital voice communication with voice logging facility, as required, shall be provided covering all field nodes (Station, Hut, LC gate etc.).

*Note: Auxiliary Warning System (AWS) is an old generation system which is not in confirmation with any level of ATP. Those working on them in suburban sections of Central and Western Railways may refer to RDSO specification for Advanced Auxiliary Warning system (AAWS).*





*Note: This Chapter has under mentioned Annexures*

<i>S.No.</i>	<i>Annexure No.</i>	<i>Description</i>
1	<a href="#">13-A1</a>	<i>Braking Distance Calculations for TCAS</i>




*Note: This Chapter has under mentioned Maintenance Schedules in [Appendix I](#)*

<i>S.No.</i>	<i>Annexure No.</i>	<i>Description</i>
1	<a href="#">13-MS1</a>	<i>Maintenance Schedule of Train Protection &amp; Warning System (TPWS)</i>
2	<a href="#">13-MS2</a>	<i>Maintenance Schedule of Train Collision Avoidance System (TCAS)</i>
3	<a href="#">13-MS3</a>	<i>Maintenance Schedule of Centralized Traffic Control (CTC)</i>

## Braking Distance Calculation for TCAS

### RDSO Motive Power Dte. Data

Type of braking : Service brake										
Formation: WAG7+59 BOX wagon Loaded										
Speed Reduction Range 										
Current Speed of Train in kmph	90 Kmph	80 Kmph	70 Kmph	60 Kmph	50 Kmph	40 Kmph	30 Kmph	20 Kmph	10 Kmph	0 Kmph i.e. SBD
100	590 m (*91.6)	826 m (81.4)	988 m (70.4)	1093 m (61.2)	1209 m (49.9)	1277 m (40.9)	1332 m (30.9)	1381 m (21.9)	1400 m (10.4)	1404 m (4.0)
90		574 m (80.4)	776 m (69.2)	879 m (60.7)	994 m (48.6)	1062 m (39.5)	1116 m (30.4)	1163 m (18.4)	1182 m (9.5)	1195 m (0.5)
80			508 m (70.3)	683 m (59.5)	770 m (51.0)	863 m (38.9)	916 m (29.9)	953 m (20.9)	975 m (11.9)	982 m (0.0)
70				442 m (60.5)	590 m (49.7)	661 m (41.3)	733 m (29.3)	769 m (20.3)	794 m (8.3)	797 m (2.4)
60					376 m (50.7)	496 m (40.0)	566 m (28.6)	602 m (19.6)	622 m (10.6)	627 m (1.7)
50						310 m (40.8)	403 m (30.2)	442 m (21.9)	466 m (12.9)	475 m (1.0)
40							244 m (31.0)	310 m (20.0)	366 m (9.1)	339 m (0.2)
30								188 m (19.3)	216 m (10.6)	222 m (2.3)
20									111 m (11.2)	123 m (0.7)
10										45 m (1.3)

\* Explanatory note on understanding above table : During speed trials, on application of Service brake on a Train running at 100 kmph, after travelling a distance of 590 meters, Train's speed got reduced to 91.6 kmph.

## TCAS Field Trials Data

### Loco Type - WAG7

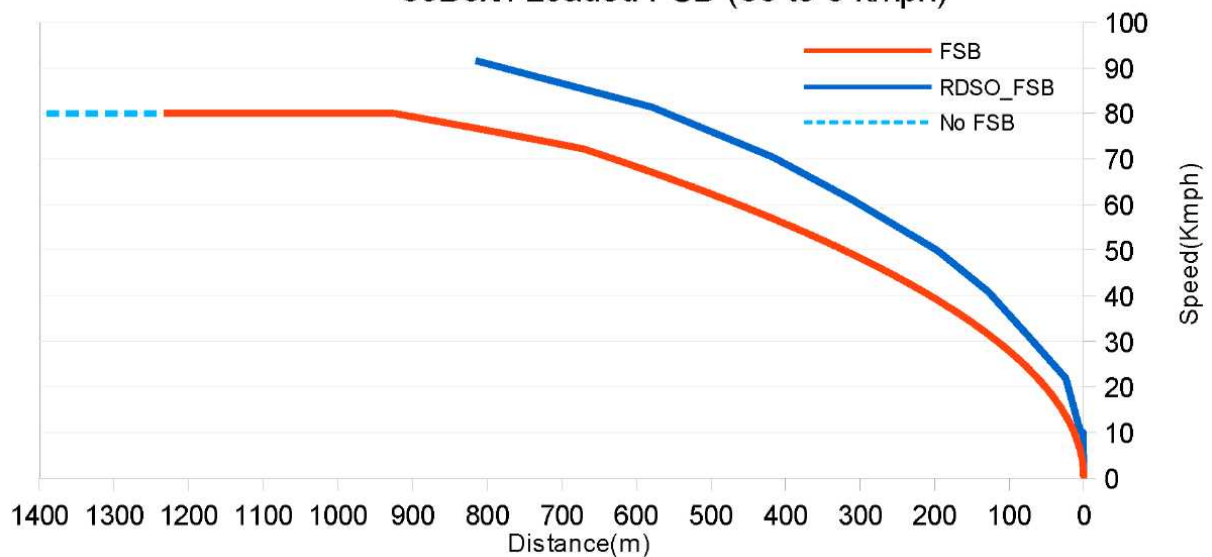
#### 59 Boxn Loaded Goods Train Formation

Distance covered since brake command to achieve speed reduction to speed indicated

Brake Type = FSB, Brake Propagation Time = 14s, Brake Build time = 12s, DC =  $0.28 \text{ m/s}^2 < 30$ ;  $0.3 \text{ m/s}^2 > 30$ ;

Initial Speed	70	60	50	40	30	20	10	0
80	606	773	915	1030	1120	1185	1223	1236
70		528	670	785	875	940	978	991
60			450	566	656	720	759	772
50				372	462	526	565	578
40					294	359	397	410
30						221	263	276
20							141	155
10								62

59Boxn Loaded FSB (80 to 0 kmph)



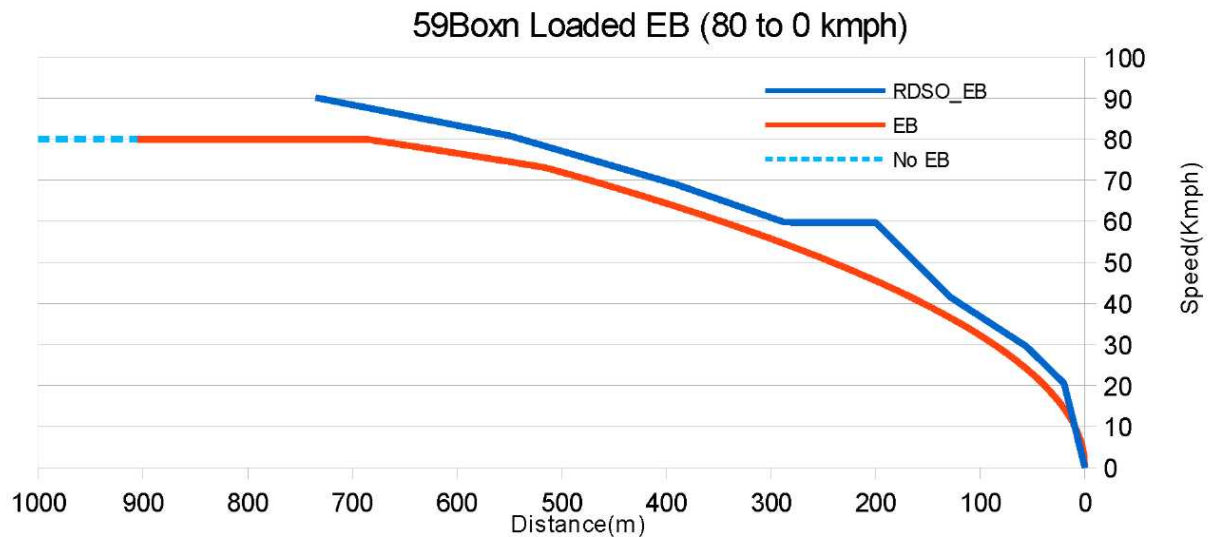
### RDSO Motive Power Dte. Data

Type of braking : Emergency brake										
Formation: WAG7 + 59 BOX wagon Loaded										
Speed Reduction Range $\longrightarrow$										
Current Speed of Train in kmph	90 Kmph	80 Kmph	70 Kmph	60 Kmph	50 Kmph	40 Kmph	30 Kmph	20 Kmph	10 Kmph	0 Kmph i.e. SBD
100	587 m (*90.2)	772 m (80.9)	932 m (69.0)	1035 m (59.8)	1122 m (59.7)	1193 m (41.6)	1266 m (29.5)	1302 m (20.5)	1324 m (11.6)	1321 m (2.6)
90		527 m (80.4)	690 m (71.1)	829 m (59.3)	915 m (50.2)	986 m (41.1)	1057 m (29.0)	1093 m (20.0)	1114 m (11.1)	1120 m (2.1)
80			466 m (70.6)	608 m (61.4)	725 m (49.6)	795 m (40.5)	865 m (28.5)	900 m (19.5)	920 m (10.5)	925 m (1.5)
70				406 m (60.8)	526 m (51.6)	621 m (39.9)	675 m (30.8)	714 m (21.8)	742 m (9.9)	746 m (0.9)
60					345 m (50.9)	464 m (39.1)	517 m (30.1)	564 m (18.1)	582 m (9.2)	584 m (0.2)
50						284 m (41.1)	376 m (29.3)	413 m (20.4)	434 m (11.4)	441 m (2.5)
40							269 m (29.2)	288 m (19.5)	308 m (10.6)	314 m (1.6)
30								188 m (19.4)	200 m (9.7)	204 m (2.3)
20									107 m (9.5)	113 m (2.5)
10										41 m (1.5)

*\* Explanatory note on understanding above table : During speed trials, on application of Emergency brake on a Train running at 100 kmph, after travelling a distance of 587 meters, Train's speed got reduced to 90.2 kmph.*

## TCAS Field Trials Data

Loco Type - WAG7								
59 Boxn Loaded Goods Train Formation								
Distance covered since brake command to achieve speed reduction to speed indicated								
Brake Type = EB, Brake Propagation Time = 10s, Brake Build time = 8s, DC = $0.38 \text{ m/s}^2 < 30$ ; $0.4 \text{ m/s}^2 > 30$ ;								
Initial speed	70	60	50	40	30	20	10	0
80	435	561	667	754	821	869	898	908
70		379	486	572	640	688	717	727
60			324	410	478	526	555	565
50				268	335	383	412	422
40					212	260	289	298
30						158	189	199
20							101	112
10								44



## Chapter 14: LC Gates

### Section 1: LC General

14.1.1 **Codes:** This chapter shall be read in conjunction with chapter III and Chapter XVI of General Rules, [Chapter 7](#) and [Chapter 20 of SEM](#).

14.1.2 **Classification of Level Crossings** (*Ref: Para 902, Chapter 9 of IRPWM*)

The classification of road-rail surface level crossings shall be decided by the Engineering Department as per para 902 (refer to IRPWM) of Indian Railways Permanent Way Manual (IRPWM).

Level crossings are classified as under:

- (a) Special class: For roads having TVU greater than 50,000.
- (b) A Class: For roads having TVU between 50,000 and 30,000 or Line capacity utilisation 80% (on single line section) and number of road vehicle more than 1000.
- (c) B Class – TVUs less than 30,000 and up to 20,000 and number of road vehicles greater than 750.

‘B’ Class is further subdivided as following:

B1 class... TVUs less than 30,000 and up to 25,000

B2 class... TVUs less than 25,000 and up to 20,000

- (d) C Class: All other Level crossings for road not covered in above classes.

*Note: Please refer to chapter-9 of IRPWM, Para 902 & other Engg. Dept`s notifications on latest norms*

14.1.3 **Categories of Level Crossing Gates**

Gates can be broadly divided into the following categories:

(a) **Non-Interlocked Gates, Interlocked Gates:**

- (i) **Non-Interlocked Gates:** These gates may be in the form of lifting barriers or swing/ movable gates of approved design. These gates are installed and maintained by engineering department. Communication equipments of approved type are provided and maintained at such manned gates by S&T department.
- (ii) **Interlocked Gates:** At interlocked gates, interlocking and communication equipment are provided and maintained by S&T department. These gates are interlocked and protected with signals.

**(b) Engineering Gates, Traffic Gates:**

- (i) Engineering Gates:** Gates beyond the outermost stop signals are called Engineering gates and are manned and operated by Engineering staff. These gates may be non-interlocked or interlocked with signals.
- (ii) Traffic Gates:** Gates located between the outermost stop signals are called Traffic Gates and are manned and operated by Traffic staff. These gates shall be interlocked with station signals.

**14.1.4 Normal Position of Gates:** Normal position of Interlocked gates shall be as per para 904 and 907 of IRPWM.

**14.1.5 Equipment at Level Crossing**

- (a) The Level Crossings shall be provided with equipment as per para 910 of IRPWM. These equipments are provided and maintained by Engineering or Traffic department.
- (b) The Working instruction including the gate working diagram of level crossing equipped with gate signals and situated outside the station limits, shall be provided at the gate lodge. A copy of the working instruction shall also be kept at the controlling station. These instructions shall be provided in vernacular language.
- (c) Safety measures for different classes of level crossings such as interlocking with signals, provision of telephone communication and approach warning arrangement shall be as per [Annexure: 14-A1](#).
- (d) Communication of approved type shall be provided between the Gate-lodge and the Station Master's office/cabin man in accordance with para 2 of [Annexure: 14-A1](#). Such communication may be provided to the authorized operating official instead of Station Master's Office/cabin man to suit the local operating condition. One to one communication shall be ensured. The communication of Gateman shall also be with CTC (where provided).
- (e) Audible warning by a bell/buzzer of approved type operated by the approach of a train shall be provided at interlocked gates in accordance with para 3 of [Annexure: 14-A1](#).

**14.1.6 Interlocking of LC Gates**

- (a) Norms as notified from time to time by Railway Board shall be followed for Interlocking of Gates.
- (b) Gate Signaling shall match sectional Signaling.

#### 14.1.7 Interlocked Level Crossing Gates – Outside Station Limits

- (a) On sections provided with two aspect Signaling,
  - (i) A Stop Signal at 400 meters from the gate shall be provided.
  - (ii) Where the section is provided with separate Warner signal, such a Warner signal shall be provided at a distance of not less than 1.2 km from the Gate Stop Signal.
- (b) On Sections provided with multiple aspect signalling,
  - (i) The Gate Stop Signal shall be located at not less than 180 meters in rear of the gate.

*Note: Existing LC gates at 120 meters in automatic signalling/Suburban sections may continue*

- (ii) In Single Distant territory, the Distant Signal shall be located, at not less than one kilometer in rear of the Gate Signal.
  - (iii) In Double Distant territory, Gate Distant signal shall be located, at not less than 2 kilometers in rear of the Gate signal and Gate Inner Distant Signal shall be located, at not less than one kilometer in rear of the Gate Signal.
- (c) The Gate Stop Signal shall be provided with 'G' marker except where prohibited under special instructions.

The 'G' marker shall consist of letter 'G' in black on yellow circular disc. The instructions in [Chapter 20, Section 1](#) shall apply to signals protecting Level Crossing Gates in Automatic Signalling Block territory.

- (d) Approach locking shall be provided, which shall be effective from a distance not less than the Emergency braking distance of the trains running on the section at the maximum permissible speed.

Where there are no track circuits in the rear of the Gate stop signal or the total length of such track circuits in rear of the Gate stop signal is less than the Emergency braking distance, Dead approach locking with delay as per [para No. 21.1.21 \(Table-1\)](#) shall be provided.

#### 14.1.8 Interlocked Level Crossing Gates within Station Limits

- (a) Where interlocked level crossings within station limits are operated from a place other than the place of operation of the signal protecting the gate, arrangements of interlocking should be such that the last operation before taking off the signal should be, the closing of the gate and the first operation after the train has cleared the level crossing and the signal has been put back to 'ON' position, should be the opening of the gate by the Gateman.



(b) On sections provided with two aspect Signalling:

- (i) The Outer Signal shall be located at a minimum distance of 400 meters from the gate.
- (ii) Where the Outer Signal cannot be so located and the Outer Signal falls in between Home Signal and Gate, a separate Gate signal may be located at a distance of 400 meters in rear of the gate.
- (iii) Where there is adequate visibility of the Outer Signal (1.2 km if sectional speed is 100 kmph above and 0.8 km if sectional speed is less than 100 kmph) the Gate Signal shall work independent of the Outer Signal.
- (iv) Where the visibility of Outer Signal is not adequate, the Outer Signal shall be shifted and combined with the Gate Signal where feasible or inter-slotting arrangement shall be provided between the Outer Signal and the Gate Signal.

(c) On sections provided with Multiple Aspect Signaling: when the interlocked gates are situated between Distant and Home Signal:

- (i) The Gate Stop Signal shall be located, at not less than 180 meters in rear of the gate.
- (ii) In Single Distant territory, the Distant Signal (which shall function as Gate Distant as well) shall be located, at not less than one kilometer in rear of the Gate Signal.
- (iii) In Double distant territory, Gate Distant signal shall be located, at not less than 2 kilometers in rear of the Gate signal and Gate Inner Distant Signal shall be located, at not less than one kilometer in rear of the Gate Signal.

#### **14.1.9 LC Gates in Automatic Block Signalling/Suburban Sections**

##### **(a) Operation & Audible Warning**

- (i) Level Crossing gates in automatic sections shall be worked by lifting barrier gates operated mechanically or electrically and shall be interlocked with signals.
- (ii) They shall also be provided with audible warning on both sides of the road, actuated by approaching trains. In addition, road user signal shall be provided on both sides of the road, which shall exhibit 'stop' aspect, if there is any train on the approach or whenever the gate is in closed condition and it shall display 'Caution' aspect when gate is in open condition.
- (iii) The audible and visual train approach annunciation shall be such that the Gateman gets adequate warning time, which shall be a minimum of 60 seconds for the train with maximum permissible speed, for closing the level crossing gates before the train approaches within the sighting distance of the relevant gate signals.

### **(b) Approach Locking in Automatic Block Signalling/Suburban Sections**

- (i) Both Approach locking and back-locking shall be provided by track circuits/Axle Counters on the interlocked level crossings situated on sections provided with automatic signalling.
- (ii) The approach locking shall be effective from the moment the train occupies the track circuit in rear of the signal, which has assumed, 'OFF' position when the Gate Signal is taken 'OFF' and the back locking shall be effective until the train clears the level crossing. The audible warning (for Road Users) shall stop as soon as gate is closed and locked but 'stop' aspect (for road users, where provided) shall continue to be displayed till the gates are re-opened for traffic.
- (iii) Approach locking should be effective from a distance not less than emergency braking distance required for maximum permissible speed on that section.

#### **14.1.10 Emergency Provisions Due to Failures**

##### **(a) Level Crossing Gate Unable to Close**

- (i) Emergency Sliding Booms shall be provided at all interlocked gates to work trains on signals in case of failure of lifting barrier.
- (ii) Fixing of Emergency Sliding Boom shall be outside lifting barrier to ensure safety of road users & trains. Painting scheme of sliding boom shall be same as lifting barrier.
- (iii) Stop indicator Board (Retro reflective type) shall be provided on Emergency Sliding Booms. Also road signal, if provided shall display ON aspect to avoid confusion to road traffic.
- (iv) Normal aspects of signals as per interlocking may be provided during use of Sliding Boom Barrier with following arrangements:
  - Sliding Boom should be directly locked by 'E' type lock or by any suitable means.
  - E-type locks of same ward (matching with working lifting barrier) should not be used in sliding boom type.

##### **(b) Level Crossing Gate Unable to Open**

- (i) An Emergency key shall be provided at the gate lodge at all interlocked gates and shall be kept in "EKT sealed box with pad lock", to enable Gate man to open the gate and allow road traffic in case of failure of lifting barrier to open.
- (ii) Counter should be provided for logging gate man's extraction of emergency key to open LC gate.
- (iii) Record of use of emergency key shall be maintained in a register with reason.

- (iv) Emergency key IN and OUT contact must be proved in relevant interlocking circuit so that; Signal shall be taken off only when Emergency key is proved IN and signal Taken OFF must be put to Most Restrictive aspect, if emergency key is taken OUT from EKT.
- (v) There shall be a facility provided for Gateman to put back Gate Signal to danger in case of emergency.

## **Section 2: Installation of LC Gates**

### **14.2.1 Instructions for Mechanical/Electrical Lifting Barriers**

- (a) At stations, it is desirable that level crossings should not be located at fouling reception, stabling lines, berthing track and signal overlaps. As far as possible, level crossings should be provided at a place, which gives an uninterrupted view not only to drivers of approaching trains but also to the road users.
- (b) Lifting barrier of approved type shall be installed.
- (c) Interlocking arrangement at the interlocked gate shall be as per approved plan and wiring diagram.
- (d) The minimum distance of lifting barrier from the centre line of nearest track shall be minimum 3.5 meters.
- (e) Foundation for pedestal shall be of adequate strength.
- (f) Lifting barrier shall have two booms, one each on either side of the track. The boom of the barrier shall extend across the full width of the road. It shall be installed perpendicular to the road. In case of wider roads provided with road divider, provision of two half barriers, each set operated diagonally by a separate winch in mechanical lifting barrier or operating panel in electric lifting barrier may be provided. Pedestals should be outside the road.
- (g) For Mechanical Lifting Barrier, the boom rest (stop post) shall be in alignment with the boom. The open position of the lifting barrier shall be within 80° to 90° from the horizontal and the closed position shall be within 0° to 10° from the horizontal. Colour Light road user signal shall be provided to indicate whether the gate is closed or open.
- (h) When the gate is closed to road traffic, clearance between the road surface level and the boom shall be 0.8 to 1 meter. The road surface level shall be maintained as per concerned para of IRPWM.
- (i) The open position for Electric Lifting Barrier, shall be as specified in the relevant specification.
- (j) Lifting barrier shall be so installed that it shall be possible to stop or reverse its movement at any point during operation without damage.
- (k) At the centre of the boom, the lifting barrier shall be provided with a 600 mm dia red disc having red reflector/luminous strip facing the road traffic.

- (l) The boom shall be either painted with 300 mm bands of alternate black and yellow colour or provided with approved type of retro-reflective strips. Fluorescent or any other approved type of yellow color paint shall be used.
- (m) Warning boards shall be provided as mentioned in [Para No. 7.2.1 to 7.2.5](#).
- (n) Markers on signals in automatic Signaling territory shall be provided as mentioned in [Para No.20.1.6](#).
- (o) Rumble strip, speed breakers and warning signs to road user shall be provided by Engineering department as per extant instruction.
- (p) In semaphore Signaling territory, where distant/separate warning signal is worked with electric signal machine, indication locking shall be provided on gate signal lever.
- (q) Wherever required in accordance with Para-3 of [Annexure: 14-A1](#) approved type of train detection device shall be provided for initiating approach warning to Gateman. The device shall be so located as to provide the approach warning at least 60 seconds before arrival of the trains running in the section at the maximum permissible speed. The warning shall continue till the train reaches the level crossing.
- (r) A gate working diagram shall be provided at the place of operation for all interlocked engineering Level Crossing Gates. At all interlocked LC gates having independent operations of signals, indication panel shall be provided.
- (s) All relays, batteries, etc. for operation of gate and gate signals shall be housed in signalling grommet/masonry structure.
- (t) Equipment for communication of approved type shall be fixed inside gate lodge on a wooden or on any other approved type shelf/box at an appropriate height from ground level as per space available. The wiring for communication equipment shall be properly secured by adopting best practices.

#### **14.2.2 Installation of LC Gates in RE Area**

- (a) Power supply for Level Crossing shall be made available from both UP and DN AT supply in accordance with para 20713.2 (iii) of ACTM Vol. II (Part I) in addition to local supply.
- (b) For interlocking a Level Crossing in RE area, neutral section shall be relocated wherever minimum distance between gate signals and neutral section is not available as per para 16.4 and 16.5 of AC Traction Manual. (Volume II, Part II)
- (c) Proper precautions as stipulated in [Chapter 22 of SEM](#) shall be taken.

#### **14.2.3 Installation of Mechanical Lifting Barriers (MLB)**

- (a) A separate fracture segment shall connect the boom with the mechanism near the pivot. Fracture segment mounting shall be of such a design that it can be transported, replaced easily and quickly and in case of a mighty hit shall allow for the break of the segment without endangering the mechanism itself.
- (b) Winch for the operation of the lifting barrier shall be located at a place (including cabin) not exceeding 150 meters from the gate and having clear visibility of the road.
- (c) It shall be ensured that while closing the gate, warning bell rings and lamp bracket also gets turned to give required indication to road users. Alternatively standard audio and visual signals for road users as required for electric lifting barriers shall be provided.
- (d) It shall be ensured that the roller fitted to the rope drum enters the trunnion bracket and activates the boom for closure/opening.
- (e) It shall be ensured that Boom locking is effective and it is not possible to lift the boom by more than 10° from closed position.
- (f) The wire rope shall not overlap at the winch and rope drums.
- (g) The guy rod shall be given sufficient tension for smooth operation of the boom.
- (h) Oil holes, grease nipples, etc. shall be provided with spring loaded covers.
- (i) It shall be possible to extract the key from the winch only when the gate is fully closed.
- (j) At mechanical interlocked gates, interlocking shall be achieved through 'E' type locks or by approved means.

#### **14.2.4 Installation of Electric Lifting Barrier (ELB)**

- (a) Where reliable power supply is available at any interlocked Level Crossing Gates (of special class, A, B1, B2 class & C class) in any section, electrically operated lifting barrier of approved design shall be provided.
- (b) The boom shall be of approved type. The metallic type boom shall be segmented for easy transport, installation and replacement.
- (c) Operation of the lifting barrier may be provided from a gate control panel or by any other approved equipment.
- (d) At the centre of the boom, a red reflector shall be provided.
- (e) Emergency operation by hand crank shall be provided.
- (f) The boom must be so balanced that in case of failure of power supply, the barrier shall remain in the position last assumed.

- (g) Power supply equipment shall be installed in a Gate goomty. In RE areas, Up AT, Dn AT in Double line or single AT in Single line shall be provided along with local power supply. In Non-RE areas, Local power supply, Generator supply, Solar power supply shall be provided.
- (h) Road user signal shall be provided to indicate whether the gate is closed or open. While closing/opening the Electric lifting barrier, a hooter shall sound and road user signal shall exhibit red. In closed condition of ELB, the hooter shall stop and road user signal shall display steady red. In open condition of ELB, the road user signal shall display steady yellow.
- (i) At least two types of operations should be provided i.e. Power operation and Manual Cranking operation. Hand Generator operation type may also be provided where feasible.

### **Section 3: Maintenance of LC Gates**

#### **14.3.1 Maintenance of Mechanical Lifting Barrier (MLB)**


- (a) All moving parts shall be properly lubricated.
- (b) Gears, rope drums and wire rope shall be doused with soft grease.
- (c) Cleaning of rodding and wire transmission should be done properly. Cleaning of all pipes and ducts to prevent obstruction by accumulation of dirt shall be ensured.
- (d) All bolts and nuts shall be tightened and split pins shall be split properly.
- (e) Worn out pins, if any, in the crank shall be replaced.
- (f) It shall be ensured that both the booms are parallel in open condition.
- (g) Proper adjustment of wire sag and tension shall be made.
- (h) Integrity of interlocking and boom locking shall be checked.
- (i) Rusty wires and rodding shall be replaced.
- (j) It shall be ensured that 'E' type lock which locks the winch should also lock winch handle in closed position of barrier.
- (k) All gate locking apparatus must be examined regularly and working parts kept oiled. Gate locks must be kept in good working order.
- (l) Proper working of audio/visual warning shall be ensured.


#### 14.3.2 Maintenance of Electric Lifting Barrier (ELB)

- (a) Machines must be kept in good condition, free from rust, dust and dirt.
- (b) The bearing surface and moving parts of the electric lifting barrier shall be lubricated properly.
- (c) Contacts must be kept clean and in proper adjustment. If contact surfaces are pitted, they must be replaced.
- (d) **Commutator and Brushes**
  - (i) Commutator must be clean, smooth and have a bright appearance.
  - (ii) Brushes must be kept clean and properly bedded on the commutator. Brushes should have proper pressure and should be free in brush holders.
- (e) Friction clutch must be so adjusted that the same should get de-clutched when the boom is raised or lowered fully and the power supply is not cut off.
- (f) The shock absorber at the boom rest (stop post) must be kept properly adjusted.
- (g) The time of operation of electric lifting barrier shall not exceed stipulated time. Measured value of current should not exceed rated values.
- (h) The satisfactory functioning of the lifting barrier by a hand crank shall be checked.
- (i) All gate locking apparatus must be examined regularly and working parts kept oiled. Gate locks must be kept in good working order.
- (j) Proper working of audio/visual warning shall be ensured.
- (k) Approach warning arrangement where provided, is working satisfactorily and effectiveness of Approach and Back locking provided shall be ensured.
- (l) Track circuits/Axle counters, if provided, shall be maintained in accordance with instructions laid down in [Chapter 17 of SEM](#).
- (m) Communication of approved type, provided between Level Crossing gates and the adjoining stations shall be checked in regard to their satisfactory functioning.
- (n) Heavy repairs, renewals or alterations to gate interlocking must not be carried out until Jr. Engineer/Sr. Section Engineer (Signal) concerned has arranged for the protection of the road traffic by the concerned department and the work shall be carried out under proper disconnection.

- (o) SSE(Signal)/Incharge shall maintain a register indicating details of each class of Level Crossing Gate in regard to its location, number, type of gate provided, provision of communication, interlocking arrangement, provision of approach warning and flash lights etc. pertaining to his section. A statement in regard to the above should be submitted on first January and first July every year, to the Sr. Divisional Signal and Telecommunication Engineer/Divisional Signal and Telecommunication Engineer.
- (p) Maintenance Schedules as given in Annexures shall be followed. These may be modified/supplemented by PCSTE of the Railway to suit local needs.

*Note: Where ever 'Track Circuit' is mentioned in this chapter, it also applies to Axle Counters.*

 <i>Note: This Chapter has under mentioned Annexures</i>		
<i>S.No.</i>	<i>Annexure No.</i>	<i>Description</i>
1	<a href="#">14-A1</a>	<i>Safety Measures to be Provided at Level Crossings</i>

 <i>Note: This Chapter has under mentioned Maintenance Schedule in <a href="#">Appendix I</a></i>		
<i>S.No.</i>	<i>Annexure No.</i>	<i>Description</i>
1	<a href="#">14-MS1</a>	<i>Maintenance Schedule of Mechanical Lifting Barrier</i>
2	<a href="#">14-MS2</a>	<i>Maintenance Schedule of Power Operated Lifting Barrier</i>
3	<a href="#">14-MS3</a>	<i>Maintenance Schedule of Sliding Boom</i>



### Safety Measures to be Provided at Level Crossings

	Spl. Class	A Class	B1 Class	B2 Class	C Class (Manned)	Other Stipulations
TVU->	>50000	>30000 and <50000	>25000 and <30000	>20000 and <25000	>3000 Cat I and >2500 Cat II	
1. Interlocking of Gates with Signals						
a) Within Station Limits	Should be Interlocked with Station Signals	Should be Interlocked with Station Signals	Should be Interlocked with Station Signals	Should be Interlocked with Station Signals	Should be Interlocked with Station Signals in Suburban section, in Automatic Block signalling. In Non-Suburban section, all traffic gates should be interlocked with station signal or if it has to be interlocked for any other reason.	To minimize the Mean Waiting Time for road users, the arrangement of Interlocking should be such that the last operation before taking 'OFF' of Signal should be the closing of the Gate and the first operation after the train has cleared the Level Crossing and the Signal is put back to 'ON' position, should be opening of the Gate by the Gateman.
b) Outside Station Limits	Should be Interlocked with Gate Signals	Should be Interlocked with Gate Signals	Should be Interlocked with Gate Signals	Should be Interlocked with Gate Signals	Should be Interlocked with Gate Signals, in Automatic Block Signalling sections.	i) In case of Level Crossing protected by signal, where the sighting of the signal by an engine driver is inadequate and the Gate signal is not pre - warned through other means (Distant Signal/Independent Warner Signal/Repeater Signal etc.), a Warning Board should be placed at not less than the emergency braking distance in the rear of the Gate Stop Signal. The board should be vertical 2000 mm by 450 mm with alternate black and yellow strips 125 mm width painted on it at an angle of 45 degree. The top of the board should be 4 meter above rail level. The board need not be lit at night but should as far as possible be provided with scotchlite or other effective light

	Spl. Class	A Class	B1 Class	B2 Class	C Class (Manned)	Other Stipulations
TVU->	>50000	>30000 and <50000	>25000 and <30000	>20000 and <25000	>3000 Cat I and >2500 Cat II	
						reflectors or retro- reflective tape.
						ii) Where level crossing is situated outside station limits but in close proximity thereof, the clear distance between the level crossing and an outer signal should not be less than the full train length.
<i>Note: All manned level crossing gates both within and outside station limits falling on suburban sections and Automatic Block Signalling section shall be interlocked irrespective of the classification/TVUs of the gates.</i>						
c) Normal Position of Gate	Shall be normally kept open to Road Traffic				If Interlocked, shall be normally kept open to Road Traffic	
<b>2. Telephonic or any other Approved type Communication from the Gate Lodge</b>						
Within or outside Station Limits	Telephone or any other approved type be provided with ASM’s office with all Manned Level Crossing Gates.					In Block Sections having large number of Level Crossing Gates, the connections should be uniformly distributed between the Block Stations.
	Ref. Railway Board letter no. 2010/Tele/11(11)/1 Pt. dated 31.10.17					
<b>3. Warning Bells or Hooters Operated by Approaching Train at Interlocked LC Gate</b>						
Within or Outside Station Limits	Provision of Warning bell or hooter operated by Approach Train at Interlocked LC Gates in suburban section and non-suburban sections be provided on sections having Automatic Signalling. (Ref. RB’s letter No. 2011/SIG/WP/LC/IR/1 dated 20.02.2013)					

	Spl. Class	A Class	B1 Class	B2 Class	C Class (Manned)	Other Stipulations
TVU->	>50000	>30000 and <50000	>25000 and <30000	>20000 and <25000	>3000 Cat I and >2500 Cat II	
4. Type of Lifting Barrier						
a) Within or Outside Station Limits	Electrically Operated Lifting barrier	Electrically Operated Lifting barrier	Electrically Operated Lifting barrier	Electrically Operated Lifting barrier	Electrically Operated Lifting barrier in Sub-urban Section.	In Non-Suburban Section, Electrically Operated Lifting barrier be provided, where Power supply is Reliable.
5. Approach Locking						
(i) To be provided in Sub-urban Section. (ii) Dead Approach Locking with Timing of 60 Sec in other sections.						
6. Warning Bell or Hooter for Road User						
Provision of Warning Bell or Hooter may be provided at all interlocked LC gates for road users which will sound during closing of gate.						

## **Chapter 15: Cables**

### **Section 1: General**

15.1.1 Railway signalling circuits shall be carried on cables.

- (a) Cables for signalling circuits shall be of approved types.
- (b) Extant guidelines from Railway Board, RDSO and PCSTE for cable laying to be followed.

#### **15.1.2 Planning for Cabling**

- (a) While planning for cabling on a route, the number of conductors required, depending upon the circuits should be first determined. Recommended core sizes as per specifications shall be used.
- (b) Adequate spare conductors to a minimum of 20% of the total conductors used shall be provided for in each main cable up to the farthest point zone, beyond this there should be a minimum of 10% spare conductors of the total conductors used. No spare conductors are required if the total number of conductors used is 3 or less. The spare conductors shall be provided on the outermost layer.
- (c) Where a number of cables have been laid along a route, the circuits shall be so distributed that cables can be disconnected for maintenance purpose with the least possible dislocation to traffic. Line wise and, if necessary function wise cable shall be provided. Auxiliary signals shall be taken in different cables.
- (d) After deciding the size and the number of conductors in the different types of cables to be used on a route, a foot survey along the track should be done to determine the best route for the cable.
- (e) The route shall be shown clearly on a cable route plan showing the actual alignment of track, giving offsets from permanent way or permanent structures. The diagram should indicate the various road and track crossings, crossing with power cables, water and sewage mains and other points of importance. It is preferable to chart the route on a route plan on which the existing routes of power cables, etc. are shown. Changes if any should be incorporated in the chart/plan.
- (f) Cable route plan shall also be approved by Engineering and Electrical departments. Approval of S&T open line is also required where ever it is prepared by other than open line. In case of Construction works cable route plan shall be signed by Engineering and Electrical departments of executing agencies as well.
- (g) As far as possible low lying areas, platform copings, drainages, hutments, rocky terrains, points and crossings, shall be avoided. Proximity to Electrical Sub Stns/Switching stns shall be avoided.
- (h) Separate cables of suitable size shall be laid for point operation.

- (i) In case of Tunnel, provision of cable duct should form part of the Tunnel design.
- (j) Provision of suitable duct/pipe/other arrangements shall be incorporated in the bridge design itself for laying of cables on bridges.

#### **15.1.3 Storage and Transportation of Cable**

- (a) Cable drums shall not be stacked on flat side. Suitable stoppers shall be placed for stability.
- (b) Cable drums shall have access for lifting and moving.
- (c) When rolling the cable drum either for unloading or transportation, the drum shall always be rotated in the direction of the 'arrow' which is marked on the drum.
- (d) The drums shall not be rolled over objects that could cause damage to the protective battens of the cable.
- (e) When unloading is carried out from the vehicle, the drum shall not be dropped on the ground directly to avoid damage due to impact. Fork lifter or ramp shall be used.
- (f) During all stages of storage, it is essential that the ends of the cable are effectively sealed by end cap or in any other approved manner to avoid water entry into the cable.
- (g) It is desirable that cable drums are stored in covered shed to protect against direct exposure to sun.

### **Section 2: Paying Out, Trenching & Laying of Cables**

#### **15.2.1 Paying Out and Testing of Cable**

- (a) For paying out cables, the cable drums shall be mounted on cable wheels. It should be ensured that no kink is formed while paying out the cable.
- (b) The drum on the wheel shall be brought to one end of the trench, the end of the cable freed and the cable shall be laid along the trench.
- (c) A party of labourers shall move along the trench carrying cable at suitable intervals so that cable is not damaged due to dragging along the ground or bent unduly.
- (d) Before the cable is laid in the trench, a visual inspection of cable shall be made to see that there is no damage to the cable. It shall be tested for insulation and continuity of the cores. Thereafter the cable shall be laid in the trench. Record of insulation and loop resistance must be maintained.
- (e) In cases where the wheels are not available, the drum shall be mounted on an axle at one end of the trench and cable paid out and carried by labourers.
- (f) In no case, shall the drum be rolled off on to the road for laying the cable and the cable dragged on the ground for laying purposes.

- (g) Whenever mechanized equipment is used, the work shall be carried out by a trained operator under the supervision of SSE/JE(Signal), in charge of the work.
- (h) Where the cable drum is in damaged condition the cable may be placed on a horizontal revolving platform and the cable paid out in the same manner as given in paras above.
- (i) Paying out of cable should be done by rotating the cable drum and not by pulling the cable with excessive force.

#### **15.2.2 Trenching**

- (a) The width of cable trenches should commensurate with number of cables. The minimum width shall be kept as 0.3 meters. The bottom of the cable trench should be levelled and got rid of any sharp materials. In the soft ground, the cable should be laid at the bottom of the trench previously levelled. In the rocky ground, the cable should be laid on a layer of sand or sifted earth of 0.05 meters thickness previously deposited at the bottom of the trench. In both the above cases, the cable should be covered with a layer of sand or sifted earth of 0.10 meters thickness and thereafter a protective cover of trough or a layer of bricks or split DWC-HDPE pipe of approved type or any other approved means should be placed.
- (b) Bottom of Trench shall be cleared in such a way, so as to remove all the boulders having sharp edges. In rocky soil, the bottom of the trench shall be filled with river sand or any other soft material and cable shall be laid on smooth surface.
- (c) In block section horizontal directional drilling method may also be used based on site conditions for the laying of Quad and OFC cables across the track at sufficient depth to avoid damage due to future work of doubling etc.
- (d) Where it is not feasible to achieve required depth due to rocky soil/other obstructions, protective measures as shown in [Drg. No.15-D2](#) shall be taken.
- (e) Where feasible, trenching may be done with suitable machinery, with due precautions towards safety of the running trains. For carrying out such works, the rules governing the working of machinery along the track shall be followed scrupulously. Suitable instructions in this regard shall be issued by the Railways in the form of a joint circular.

#### **15.2.3 Laying Of Cables**

- (a) Cables shall be laid generally as per instructions given in this chapter. However, special precautions to be taken in the station yards etc., where a number of other utilities may be existing, may be detailed in a joint circular issued by the Civil Engineering, Signalling and Electrical Department(where applicable) of the Railway.
- (b) Cables may be laid underground, either in the trench, in ducts, in cement troughs, in pipes or in any other approved manner.

- (c) The main cable laid parallel to the track shall normally be buried at a depth of 1.0 meters from top of cables to ground level, including those laid across the track (1.0 meter below the rail flanges). The depth shall not be less than 0.50 meters for tail cables. In theft prone areas, the cables may be laid at a depth of 1.2 meters with anchoring at every 10 meters.
  - (d) Half Cut DWC-HDPE pipe/RCC or any other approved type of ducts/pipes shall be used while laying the cable for protecting it.
  - (e) The ducts being used shall be of such design and length to prevent/minimise damages to cable by any other future digging activities in the vicinity. The ducts shall have suitable covers to prevent water collection in the duct.
  - (f) When cables are to be laid in rocky area, where depth of 1.0 metre is not feasible, it is desirable that such cables are protected as shown in [Drg. No: 15-D2](#).
  - (g) Cables belonging to other department must not be laid in the same trench along with Signal & Telecommunication cables.
    - (i) A distance of approximately 10 cm must be maintained between cables of other department and signalling cables.
    - (ii) The signalling cables must be separated from LT power cables by a row of bricks or any other approved means and from HT power cables a minimum of 3 meters separation shall be maintained.
  - (h) Where several cables of different categories have to be laid in the same trench, they shall be placed as far as possible in the following order starting from the main track side, so that in the event of failures, the maintenance staff may easily recognise the damaged cables.
    - (i) Telecommunication cable
    - (ii) Signalling cable
    - (iii) Power cable
  - (i) Signalling cables for outdoor circuits should not normally be laid above ground. In exceptional cases where it becomes unavoidable, the following precautions should be taken.
    - (i) The cable should be suspended in wooden cleats, from cable hangers or in any other approved manner so that no mechanical damage occurs to the cable even under exposed condition.
    - (ii) The cable supports shall be so spaced as to avoid sag.
    - (iii) In station yards, cable shall be laid in ducts suitably protected.
    - (iv) Indoor signalling cable should normally be laid on ladders, channels or in any other approved manner. The cables should be neatly tied/laced.
- Note: For laying cables in RE area, please refer to [Section 3 of this Chapter](#).*
- (j) Where it is necessary to take the cable between the tracks, it shall be carried in trunking/Duct/pipe kept sufficiently below the ballast level.

- (k) While laying the cables in accordance with the above instructions, the following instructions should be adhered-
  - (i) Outside the station section, the cables should generally be laid at not less than 5.5 meters from the centre of the nearest track.
  - (ii) Within the station section, the trenches shall preferably be dug at a distance of not less than 3 meters from the centre of the track, width of the trench being outside the 3 meters distance.
  - (iii) At each end of the main cable an extra loop length of 6 to 8 meters should be kept.
- (l) After laying the cables, back filling of the trenches should be done properly. The soil excavated shall be put back on the trench, rammed and consolidated.
- (m) Cable joints of approved type shall be used.
- (n) Cable markers of approved type shall be provided which should be placed at suitable interval and at diversion points to mark the route.
- (o) Where the cables are entering the Cable room/Relay room/apparatus case etc., the cables shall be firmly held with suitable clamping arrangement, so as to avoid downward displacement. Suitable ducts, ladder supports, cable guides etc., shall be provided for the cables inside the Cable room/Relay room. Sharp cable bends shall be avoided.

#### **15.2.4 Cable Crossing**

- (a) When a cable has to cross the track, it should be ensured that-
  - (i) The cable crosses the track at right angles.
  - (ii) The cable does not cross the track under points and crossings.
  - (iii) The cable is laid in concrete/GI/DWC-HDPE pipes of approved type, suitable ducts or in any other approved manner while crossing the track.
  - (iv) Wherever feasible horizontal directional drilling method may be used.
- (b) Wherever practical, the cable may be taken underground across the drain bed at a suitable depth for crossing small culverts with low flood level, horizontal directional drilling method may be used where ever feasible.
- (c) When the cables have to cross any roads, high banks etc. where necessary, horizontal directional drilling method may be used.
- (d) When cables have to cross a metallic bridge, they should be placed inside a metallic trough/GI pipe which may be filled, as an anti-theft measure, with sealing compound or any other suitable means. The cable should be supported across the bridge in a manner which would involve minimum vibrations to the cable and which will facilitate maintenance work. Adequate cable length to the extent of 2 to 3 meters shall be made available at the approaches of bridge.
- (e) It is desirable that the excavation of the trenches is not done in long lengths and does not remain uncovered for long period. It is preferable that cables are laid and refilling done on the same day.



- (f) During excavation, the soil of the trenches should not be thrown on the ballast. The soil should be thrown by the side of the trenches away from the track.
- (g) In places where cables to be laid within 1 meter from sleeper end, digging beyond 0.50 meter shall be done in the presence of an official from Engineering Department, and the laying of the cable and refilling of trench should be done with least delay.
- (h) The work shall be supervised at site personally by an official of the Signal and Telecommunication Department not below the rank of a JE/SSE (Signal).

### **Section 3: Cable Laying in RE Area**

15.3.1 Only unscreened approved type underground cables shall be used for signalling purposes.

The following precautions shall be taken:

- (a) The cable shall be so laid that it is not less than one meter from the nearest edge of the mast supporting the catenary or any other live conductor, provided the depth of the cable does not exceed 0.5 meters. When the cable is laid at a depth greater than 0.5 meters, a minimum distance of 3 meters between the cable and the nearest edge of the O.H.E structure shall be maintained. If it is difficult to maintain these distances, the cable shall be laid in DWC-HDPE/Concrete Ducts or any other approved means for a distance of 3 meters on either side of the Mast. When so laid, the distance between the cable and the mast may be reduced to 0.5 meters. These precautions are necessary to avoid damage to the cable in the event of the failure of an overhead insulator.
- (b) In the vicinity of traction sub stations and feeding posts, the cable shall be at least one metre away from any metallic part of the O.H.E and other equipment at the substation, which is fixed on the ground, and at least one metre away from the substation earthing. As far as possible, the cable shall be laid on the side of the track opposite to the feeding post. In addition, the cable shall be laid in concrete or DWC-HDPE pipes (approved type)/Split RCC pipes or other approved means for a length of 300 meters on either side of the feeding point.
- (c) In the vicinity of the switching stations, the cable shall be laid at least one metre away from any metallic body of the station, which is fixed in the ground, and at least 5 meters away from the station Earthing. The distance of 5 meters may be reduced to one metre provided the cables are laid in concrete pipes/DWC-HDPE-pipes of approve type/ducts or any other approved means.
- (d) Where an independent Earth is provided for an O.H.E structure, i.e. where the mast is connected to a separate Earth instead of being connected to the rail, the cables shall be laid at least one metre away from the Earth.
- (e) Where there are O.H.E structures along the cable route, the cable trenches shall as far as possible, be dug not less than 5.5 meters away from the centre of the nearest Track.

- (f) The use of G.I pipes or any form of metallic pipes is prohibited within a distance of 300 meters from feeding post. Similarly galvanized iron metallic pipes are prohibited in close proximity to switching station earth or traction mast. (Para 20706 (vi) of ACTM)

#### **Section 4: Insulation Resistance Testing of Signal Cables**

15.4.1 These instructions apply only to the cables used for Railway Signalling and do not cover internal wiring.

- (a) The insulation resistance tests should be made when conductors, cables and insulated parts are clean and dry.
- (b) A 500 V insulation tester should be used for insulation testing of signalling cables and 100 V insulation tester shall be used for Quad cables.
- (c) Any metallic sheath or metal work of any rack or apparatus case should be bonded to earth during test.
- (d) Disconnect all cores of a cable at both ends. The disconnection may be made through links of ARA/Modular terminals, if provided.
- (e) Connect one terminal of the insulation tester to the conductor under test and other terminal to all the other conductors being bunched together and connected to earth.
- (f) Similarly test remaining conductors of the cable one by one as in above Paras.
- (g) Insulation Resistance so measured should not be less than 5 mega ohms per km at buried temperature, if the insulation resistance is found to be lower than 5 mega ohms, the cause should be investigated and immediate steps taken to repair or replace it.
- (h) Insulation Resistance tests should be made in such a manner that safe operation of trains is not affected. It should be ensured that no unsafe conditions are set up by the application of test equipment.
- (i) All conductors in signalling cables must be tested for their insulation before commissioning.
- (j) The conductors of the cables may accumulate electrostatic charge. The cable conductors should be shorted or earthed to completely discharge any accumulated charge.
  - (i) Before connecting the insulation tester while commencing the test.
  - (ii) After the insulation tester is disconnected when the test is completed. This is in the interest of safety of personnel and protection of equipment.
- (k) The results of the insulation resistance tests should be recorded in approved proforma. A comparison of test results between successive tests carried out on a cable under similar conditions will give an indication of the trend towards deterioration of the cable.

## Section 5: Maintenance of Cables

### 15.5.1 Testing of Cables

- (a) All conductors in signalling cables must be tested for their insulation in dry weather once in three years provided cables are monitored through ELD else annually preferably before monsoon as per instructions specified in section 4. Reading shall be recorded as per the format mentioned in [Annexure: 15-MS1](#). Tail cables should be tested for insulation once a year. A comparison of the test results between successive tests carried on a cable under similar conditions will give an indication of the trend towards deterioration of the insulating material over a period of time. If a sudden fall in insulation is observed, the cause should be investigated and immediate steps taken up to repair or replace the cable.
- (b) In addition to the regular testing of cables in dry weather, random tests in wet weather may also be carried out, where considered necessary, to localise any sudden deterioration in insulation of cables.
- (c) All cables termination devices, pillar boxes, cable heads and glands shall be kept clean and dry. These parts shall be frequently inspected and any tendency for moisture or water leak shall be immediately attended to.
- (d) No excavation in the vicinity of underground signal cables shall be undertaken without a representative of the signal & telecommunication department present and without taking suitable precautions for the safety of the existing cables. Suitable instructions in this regard shall be issued by the Railway in the form of a joint circular.
- (e) The protective works provided for the cables at places like track crossings, culverts, bridges etc shall be regularly inspected by the maintenance staff, special attention being paid to these protective works soon after the monsoon.
- (f) **Earth Leakage Detector (ELD):** Shall be provided in all signalling installations and shall be interfaced with Datalogger (where ever feasible) for remote monitoring.

*Note: For Maintenance Schedules of ELD, please refer to [Annexure: 15-MS2](#).*

### 15.5.2 Periodical Testing of Signalling cables shall be as under;

- (a) First measurement of insulation of the cable should be carried out after laying of the cable and after first monsoon for all the conductors.
- (b) After major work in a yard, all cables should be meggered afresh.
- (c) In all other cases, Insulation Resistance shall be tested periodically as given below.

Type of Cable	Periodicity
i) Main Cable	Every 2 years
ii) Tail Cables – Signal/Track/Points etc	Once in 1 year
iii) Spare conductors	Once in 1 year



Note: This Chapter has under mentioned Annexures in [Appendix I](#)

S.No	Annexure No	Description
1	<a href="#">15-MS1</a>	Maintenance Schedule of Cable, Cable Insulation Resistance Test Sheet, Instructions for Insulation Resistance Testing of Signalling Cable.
2	<a href="#">15-MS2</a>	Maintenance Schedule of Earth Leakage Detector (ELD).



Note: This Chapter has under mentioned Drawings in [Appendix II](#)

S. No	Drawing No	Description
1	<a href="#">15-D1</a>	Drawing for RCC cable marker.
2	<a href="#">15-D2</a>	Drawing for cable laying when rock faced at; 300 mm (Sheet 1 of 3), 400 mm (Sheet 2 of 3), 600 mm (Sheet 3 of 3).
3	<a href="#">15-D3</a>	Drawing for RCC duct 500 mm (Sheet 1 of 2) & Drawing of RCC split pipe. (Sheet 2 of 2).
4	<a href="#">15-D4</a>	Drawing of DWC split pipe (120 mm dia).
5	<a href="#">15-D5</a>	Drawing for Road/Track crossing.
6	<a href="#">15-D6</a>	Drawing for Cable trough for metallic bridge.
7	<a href="#">15-D7</a>	Drawing for Cable laying on culverts.
8	<a href="#">15-D8</a>	Drawing for Cable laying on culverts with high flood level.
9	<a href="#">15-D9</a>	Cable core plans for a; 4-Road station with PI (Sheet 1 of 3), 6-Road station with Distributed EI (Sheet 2 of 3), 6-Road station with PI with either side cable Huts. (Sheet 3 of 3 ).
10	<a href="#">15-D10</a>	Cable Plan for Electric Lifting Barrier (ELB) at Station.

# **Chapter 16: Power Supply Systems for Signalling Installations**

## **Section 1: Power Supply General**

- 16.1.1 Power supply for different types of signalling installations shall be in accordance with policy approved by the Principal Chief Signal and Telecommunication Engineer of the Railway, if standard power supply scheme from Railway Board/RDSO is unsuitable for a specific application.
- (a) At all locations, secondary batteries of appropriate capacity shall be provided for signalling circuits.
  - (b) Normal power supply for signalling installations shall be 230 V AC (single phase) or 415 V AC three phase. Any other supply may be used with the specific approval of the Chief Signal and Telecommunication Engineer incharge of the work.
  - (c) Power supply system shall be such that fixed stop signals for approaching train do not become blank when main power supply source fails.
  - (d) Power supply system with secondary batteries of approved type and adequate capacity shall be used for signalling applications.

## **Section 2: Sources of Power Supply**

### **16.2.1 Railway Electrified Area**

- (a) Electric supply for signalling and telecommunication installations in RE areas shall normally be provided through Auxiliary Transformers (ATs) of suitable capacity by tapping 25 KV OHE.
- (b) On double/multi line sections, the power supply shall be drawn from 25 KV OHE through ATs provided on up and down OHE lines separately. It shall be ensured that supply from at least one AT is available in the event of power block.
- (c) On single line section where power supply is drawn from a single AT, a DG set of suitable capacity shall be installed.
- (d) At stations where local power supply is also available, it shall act as a stand-by source of power supply.
- (e) In big yards, DG sets of adequate capacity shall be installed in addition to supply from ATs and local source.
- (f) The power supply from Auxiliary Transformers (ATs), local source and DG set (s) shall be brought and terminated at a power supply control panel in ASM's office/cabin or at LC gate as required. The power supply control panel shall be provided with the facilities for automatic change over between source supplies. In addition, manual change over facility shall also be provided in the control panel. The power supply control panel, in coming cable (other than from DG set) and other associated arrangements shall be provided and maintained by Electrical Dept.

- (g) The supply from the power supply control panel as provided by Electrical Dept. shall be taken to various S&T locations by S&T Dept.

The supply from the power supply control panel shall be extended through separate MCBs to cabins, LC gates, telecom installations etc, If these are falling within two km of power supply control panel. For locations which are at two km or beyond, a separate set of ATs and power supply control panel shall be provided.

- (h) In case of IB Signals, separate set of ATs shall be provided, with Automatic change over switch.

Note: Please refer to Para No. 20713 of ACTM, Volume-II, Chapter-VII.

- (i) DG sets, where installed, shall be provided with push button start/stop facility. As per site requirement and feasibility, it shall also be possible to operate remotely.

#### 16.2.2 Non Railway Electrified Area

- (a) For Colour Light Signalling (CLS) installations, local power supply shall be used as main source of supply. In addition, two standby diesel generators shall be installed. These generators shall be of standard make and of adequate capacity for reliable and trouble free service.

- (b) The output supply of these generators, along with local supply, shall be brought to the ASM office and connected to auto/manual change-over panel compatible to RE.

- (c) **Solar Photo Voltaic System/Solar Panels** (approved type) may also be used as power supply at wayside stations, LC gates in those areas having sufficient sun light and are not theft prone.

- (i) A solar panel consists of a number of modules (Typically 12 V each) which are connected in series and parallel configuration to provide a specific voltage and current to charge a battery bank, which in turn supplies necessary power supply to signalling and telecommunication applications.

- (ii) They may be used to charge battery bank of Integrated Power supplies or may be used in for signal lighting by using invertors. Main components of solar photo voltaic system are;

- Solar Array
- Battery bank
- Solar charge controller
- Field junction box
- Solar Module Mounting Structure
- Earthing Kit
- Cables

The number of solar panels to be installed, shall be decided based on requirement of charging current and voltage. Regular cleaning to be done on the surface solar panels to remove dust.

- (d) For all new installations even in Non RE area, power supply arrangements shall be designed suitable to RE.

### **Section 3: Distribution of Power Supply**

#### **16.3.1 Arrangements**

- (a) The selected supply from the auto/manual change-over panel shall be distributed to installations/cabins at the station through underground power cables of approved type. Proper capacity HRC fuses/Miniature Circuit Breakers (MCBs) shall be provided to protect against overload/short circuits.
- (b) Visual Indications showing availability of power supplies from various feeders shall be provided for information of the ASM/Gate man.
- (c) 230 V power supply which is selected from the auto/manual change-over panel shall be distributed to various power equipments such as IPS, transformer-rectifier sets, battery chargers, transformers etc. through a distribution panel. Proper capacity HRC fuses/MCBs, lightning and surge protection devices shall be provided for protection of the equipment against overload and lightning/surges.
- (d) Power supply system shall be monitored through Datalogger as required.

### **Section 4: Power Supply Equipment**

#### **16.4.1 Equipment General**

- (a) All power supply equipment such as battery chargers, transformers, voltage regulators, transformer-rectifier sets, Inverters, Batteries etc. shall be procured as per approved specifications.
- (b) Battery chargers for axle counters shall have in-built filters to maintain ripple content below specified value.
- (c) Standby power equipment such as battery chargers, transformers, Voltage regulators, Transformer-rectifier sets etc. may be provided.
- (d) Secondary cells of prescribed capacities shall be provided for DC circuits. DC-DC converters of approved type with isolated outputs may be used to obtain different voltages from a common Battery bank.
- (e) Integrated power supply system of approved type shall be used at CLS installations.
- (f) Maintenance free cells wherever provided, shall be used only with charger suitable for charging maintenance free cells as per approved specification.

- (g) AC supply for signal transformers shall be derived from a voltage regulator of approved type.
- (h) Separate Transformer shall be used for feeding signals and track feed chargers.
- (i) The current rating of battery charger may be derived from the following formula - Current rating of charger = Load current + AH/10 capacity of cell.
- (j) Battery chargers shall not directly feed the line circuit of Block Instruments.

## **Section 5: Installation of Secondary Cells**

### **16.5.1 Charging & Installation**

- (a) Secondary cells of approved type shall be used. The cells shall be installed as per approved drawings.
- (b) The batteries shall be installed in separate room/apparatus case to avoid damage to power equipment due to fumes. The battery room shall be provided with acid proof flooring and acid proof tiles on walls up to a suitable height. The battery room shall be well ventilated and provided with exhaust fan(s).
- (c) The batteries shall be so installed that they are away from direct rays of sun and any heat radiating equipment.
- (d) The batteries shall be installed on wooden racks/insulated masonry surface of suitable height with acid proof tiles to permit easy access for maintenance. The racks shall be protected by two or more coats of acid resistant paint of approved type. The racks shall be level and mounted on approved type of insulators. Where batteries are housed in location boxes, these housings shall be painted with acid resistant paint and shall have suitable openings/holes for ventilation.
- (e) The batteries shall be kept properly aligned and suitably numbered. An adequate clearance shall be kept between the cells.
- (f) Initial charging of the batteries shall be done as per instructions of the manufacturer and the date of charging shall be suitably painted on the batteries, or on a separate board kept near the batteries.
- (g) Battery grade sulphuric acid conforming to IS 266, diluted with distilled water conforming to IS 1069 shall only be used as electrolyte.
- (h) A glass, porcelain, rubber or any other acid proof container shall only be used for mixing acid and water. Metal utensils except lead must not be used as these will contaminate the electrolyte.



- (i) Always acid shall be added to water. During mixing, the solution must be stirred constantly so that its temperature does not exceed 50°C. Suitable protection like goggles, rubber gloves & an apron shall be used while working on electrolyte.
- (j) On receipt of charged secondary cells, level of the electrolyte shall be noted. If it is below the prescribed level, the loss may be due to spillage during transit. The level of the electrolyte can be restored by adding battery grade acid of recommended specific gravity.
- (k) Hydrometer of approved type shall be available in the battery room.
- (l) At the time of installation, capacity test shall be done and record shall be maintained, by an official not below the rank of SSE/JE (Signal).

## **Section 6: Installation of Power Supply Equipment**

### **16.6.1 Procedure for Installation**

- (a) The power supply equipment shall be so installed, as to facilitate easy replacement of equipment without affecting the other circuits as far as possible. It is desirable to provide ring main type of power supply arrangement at large stations.
- (b) Transformers and battery chargers of adequate capacity and of air-cooled type shall be provided.
- (c) Power equipment shall be housed in well ventilated locations/rooms.
- (d) Wires connecting equipment shall be of adequate size so that there is not more than 0.5% loss in voltage.
- (e) Battery leads shall be colour coded (Red for positive, Black for negative and Green for earth terminal) and cut to correct length. They shall be crimped/soldered to appropriate terminal.
- (f) Maintenance instructions for self-regulating battery charger as per IRS:S: 86-2000 are given in [Annexure:16-MS2](#). Installation shall be done by an official not below the rank of SSE/JE (Signal), as per RDSO specification No. IRS. S86-2000 or latest.
- (g) All power equipment along with suitable SPDs shall be connected to earthing, having earth resistance <1 ohm.

## **Section 7: Installation of DG Set**

- 16.7.1 (a) Environmental friendly DG sets shall be installed at suitable location with proper foundation.
- (b) The diesel generator set shall be mounted on anti-vibration pads.

- (c) If DG Set is installed inside the room, exhaust pipe shall be extended outside the generator room and the silencer fixed away from the premises. Exhaust pipe shall be appropriately insulated.
- (d) The starting battery shall be of adequate capacity to meet the starting load. Where automatic start has been provided, the generator once started should stop only with a time delay after main supply is resumed.
- (e) The connection between the battery and the DG Set shall be done with wires of sufficient cross section to avoid drop in voltage.
- (f) The self-starting battery shall normally be on trickle charging mode.

### **Section 8: Maintenance of Secondary Cells**

- 16.8.1
- (a) Maintenance, testing and repair work on the cells, which may interfere with safe operation of trains shall not be started until movements are fully protected. Temporary repairs or adjustments shall be made in such a manner that safety of train operation is not impaired when repairs and or adjustments are made. Tests shall be immediately carried out to ensure that the connected equipment functions satisfactorily.
  - (b) The battery room and location boxes shall be kept well ventilated, free from water, oil or dust. Surroundings and batteries shall be kept clean.
  - (c) Connecting cables shall be flexible and sufficiently long, to prevent strain on the battery terminals.
  - (d) The electrical connection shall always be kept tight.
  - (e) The terminals and connections shall be coated with pure vaseline or petroleum jelly to prevent corrosion. Grease shall not be used.
  - (f) The Electrolyte shall be maintained at the correct level by topping up as often as necessary with distilled water.
  - (g) Electrolyte lost due to spillage shall be recouped with electrolyte of the same specific gravity as that of other cells in the circuit. Electrolyte shall not be added in any other circumstances.
  - (h) Each cell shall be tested periodically and its cleaning and charging arranged so that its voltage and specific gravity are within specified limits. Test results and dates of cleaning and charging adjustments shall be recorded on the format enclosed as [Annexure:16-MS3](#), [Annexure:16-MS4](#). A separate card shall be maintained for each battery set. The voltage of individual cell shall not fall below 1.85 Volts.

## **Section 9: Maintenance of Power Supply Equipment**

- 16.9.1 (a) Change-over panel in ASM office shall be kept in good working condition. Defects, if any, shall be advised to Electrical Department for prompt rectification.
- (b) The working of power supply modules like DC-DC converters, voltage regulator transformer, battery charger rectifier, inverters etc., provided in power equipment room shall be checked including proper working of switches, fuses, MCBs, SPDs, terminals, meters etc. during scheduled maintenance. Units shall be switched from active to standby as per local instructions.
- (c) The power equipment shall be cleaned by blower or any other suitable device to remove dust etc.
- (d) The wiring shall be checked to ensure that wires are in good condition and connections are properly tightened.
- (e) Record of voltages and load current of all power equipments shall be maintained on the prescribed format. Remedial action shall be taken in case any abnormality is observed.
- (f) Insulation of transformers shall be meggered at 500 V annually.

## **Section 10: Maintenance of DG set**

- 16.10.1 (a) Fuel tank shall be cleaned periodically. Fuel shall be filled through a wire gauge filter which shall form part of fuel tank. Before filling up, unused fuel shall be decanted/replaced if the DG set has been idle for a considerable time.
- (b) Lubricating oil shall be periodically checked and proper level maintained.
- (c) The maintenance of DG set shall be undertaken by qualified and trained mechanics. During testing of DG set, the maintenance staff shall wear rubber hand gloves and take necessary safety precautions.
- (d) After specified hours of run prescribed by the manufacturer, the diesel generator sets shall be overhauled by OEM or his authorised representative or by designated railway staff.
- (e) Leakage of fuel oil, lubricating oil and radiator water shall be effectively checked.
- (f) Radiator fan shaft shall be grease lubricated and worn out shafts replaced. Radiator hose and fuel oil hose shall be checked for leakage and replaced in time.
- (g) Automatic starting device, where provided, shall be tested periodically for effective starting during power failures and low voltage condition.

- (h) Flexible coupling between the engine and the alternator shall be checked for elongated holes and replaced in time.
- (i) The no load and on load voltages of the alternator shall be maintained within limits and the governor shall be adjusted during periodic maintenance to the RPM specified and for a steady output of 50 Hz. The DG set shall be run for 5-10 minutes on load to verify its proper working during periodic maintenance check.
- (j) A log book shall be maintained at every location which shall bear the history of performance and maintenance of DG set together with the signatures of Technicians and SSE/JE(Signal).
- (k) Wherever auto start is not reliable, the same shall be disconnected and steps taken for manual start/hand cranking of the generator during power failure and also to stop the engine as soon as power supply resumes. Steps shall be taken to rectify the auto start as early as possible.
- (l) Adequate number of consumable spares, as required for regular upkeep, shall be kept ready with the SSE(Signal).
- (m) Where standby generators are provided at way side stations/LCs for signalling purposes and starting and stopping the standby engine is done by Traffic Staff/ Engineering staff, suitable instructions for maintenance of fuel account shall be issued locally. The log book shall be maintained by the ASM/Gate man.
- (n) Automatic fire detection and alarm system with or without automatic fire suppression system (as applicable) may be provided. Firefighting equipment shall be kept in the power supply equipment room.



**Note: This Chapter has undermentioned Annexures in [Appendix-I](#)**

S.No	Annexure No	Description
1	<a href="#">16-MS1</a>	Maintenance Schedules for Integrated Power Supply System.
2	<a href="#">16-MS2</a>	Maintenance Schedules for IPS with Battery Bank Readings.
3	<a href="#">16-MS3</a>	Maintenance Schedules for Discrete Power Supply.
4	<a href="#">16-MS4</a>	Maintenance Schedules for Conventional Power Equipment (Stabilizer, Charger & Inverter) with Battery bank Readings.



**Note: This Chapter has under mentioned Drawings in [Appendix-II](#)**

S. No	Drawing No	Description
1	<a href="#">16-D1</a>	Scheme of Power Supply Arrangement for Distributed Electronic Interlocking (Sheets-4).
2	<a href="#">16-D2</a>	Power Supply Arrangement for Central Electronic Interlocking (Sheets-4).
3	<a href="#">16-D3</a>	IPS Arrangement for Interlocked LC Gate & IBS (Sheets-2).

# Chapter 17: Train Detection - Track Circuits & Axle Counters

## Section 1: Track Circuits

### 17.1.1 Track Circuits General

- (a) A closed type track circuit shall be provided to prove the clearance of rail track.
- (b) Double rail track circuits shall be provided on non-RE areas. In RE areas, Single Rail track circuit for D.C track circuit and Double Rail track circuit for AFTC shall be used.
- (c) **Minimum Length:** The length of a track circuit shall not be less than the maximum wheel base of any vehicle. The Track circuits shall cover at least two rail lengths (26 meters).
- (d) **Series Connection of Tracks:** The various portions of tracks in a line shall, as far as possible, be connected in series.
- (e) Track relays shall be of an approved design.

### 17.1.2 Permanent Way Requirements of Track Circuits

- (a) Glued Joints or Insulation Joints of approved type shall be provided for defining boundary of track circuit. In all future works of track circuiting, glued insulated joints should be provided. Glued joint should be tested before insertion.

*Note: Where ever Insulation Joint is mentioned, it also applies to glued insulated joint.*

- (b) Where staggering cannot be avoided the distance between staggered joints shall not exceed the minimum wheel base of the vehicles.
- (c) Rail ends of glued/insulated joints shall be square and true. All rough edges and burrs shall be removed from bolt holes. Battered ends shall be put right and the gap between the rails should be equal to the thickness of the end post.
- (d) Fish bolts at the joints must be kept tight and the sleepers well packed in the vicinity of the joints.
- (e) Proper drainage should be ensured so as to avoid flooding of tracks during rains, particularly in yards where watering of coaches is done and in water columns. It would be desirable to provide washable concrete aprons on platform lines at originating stations, in track circuited areas.
- (f) Ballast shall be kept clean throughout the track-circuited section and care should be taken to see that the ballast is kept clear off the rails and rail fastenings. The clearance from the foot of the rail should not be less than 50 mm. Well screened ballast right up to the formation level shall be provided.

- (g) Rail ends shall be kept free from brake-dust, dirt, sand, rust, other foreign materials etc. All rough edges and burrs at rail ends must be removed.
- (h) To avoid crushing of end posts of insulated rail joints due to creep, at least one rail length on either side of insulated joint should be provided with anti creep devices.
- (i) Rail screws should preferably be used in place of dog spikes at insulated joints.

*Note: The requirements mentioned in the [para no. 17.1.2\(a\) to \(i\)](#) are covered in the chapter II, Part "H" of Permanent Way Manual.*

- (j) Wooden sleepers, concrete sleepers or any other approved type of insulated sleepers shall be provided for track circuiting. Concrete sleepers where used, shall have a minimum resistance of 500 ohms between insert to insert.
- (k) Where short welded rail panels are used, SWR shall not butt against insulated joint. Two rail lengths of 13 meters/12 meters shall be interposed to isolate short welded rail from insulated joint. This standard length of rails shall be anchored effectively to arrest movement in either direction.
- (l) In case of turnouts and crossings, insulated stretchers, insulated gauge tie plates and insulated crossing plates shall be provided as per approved drawings.
- (m) GFN liners shall be provided in the track circuited area using concrete sleepers.
- (n) Track circuited area shall be free of vegetation. Only insulated trolleys shall be used.

## **Section 2: Installation of DC Track Circuits**

### **17.2.1 Location of Track Relays**

- (a) Track relays shall be located at the entry end of the track circuits wherever possible.
- (b) Where track relays cannot be located in the cabin/Relay Room, they shall be housed in locations of an approved type.
- (c) Where relays are likely to be subjected to vibration, suitable anti-vibration measures may be provided. They shall be mounted on shock absorbers such as rubber pad, foam etc.
- (d) Connections between the track relays and track repeating relays shall be made in accordance with the approved wiring diagram and must invariably incorporate both cross protection and double cutting arrangements.
- (e) The feed and relay ends shall be connected by separate and individual cables.

- (f) Relay End and Feed End of the track circuit should be located at the boundaries of the track circuit.
- (g) **Loading of Track Relay Contacts:** All the contacts of the track relay shall be loaded as far as possible. Where spare contacts are available, they shall be connected in parallel to the loaded contacts.

#### 17.2.2 Jumper Connections

- (a) Jumper connections shall normally be so made that the whole of track circuit is in series excluding traction return rail. When the rails of a track circuit are in parallel, care shall be taken that the jumper connections are effective.
- (b) Jumper connections, preferably duplicated, shall be so arranged that they are as far as possible protected from damage.
- (c) All connections to the track shall be of sufficient length and allow for rail creep. Connections shall be firmly fitted to the web of the rail.
- (d) For short jumpers, galvanized iron wires and for long jumpers cables, may be used. Where galvanized iron jumper is used, duplicate jumpers shall be run. The cross section of galvanized iron wire shall not be less than 8 SWG. Where cables are used, the size shall not be smaller than 7/0.750 mm.
- (e) The lead wires used for connecting the feed set to the feed end boot leg/track lead Junction Box (JB) and the track relay to the relay end boot leg/track lead JB shall preferably be of copper conductor having a minimum cross section of 2.5 sq.mm. Lead wires crossing the track should be protected through suitable means.
- (f) Track lead JB shall be clear of ballast.
- (g) The Feed as well as Relay Ends +ve & -ve leads shall be connected by using individual 2 x 2.5 sq.mm cable, duly paralleled at each end.

#### 17.2.3 Bond Wires and Rope Wires

- (a) Bond wires/Rope wires shall be of an approved type. Duplicate wires shall be installed close to the fish plate, it is desirable to use bond wire clips for securing the bond wire.
- (b) Bond holes shall be drilled with a twist drill and the bonds driven-in immediately. The wires may be fixed by using channel pins in the holes or by brazing/welding.
- (c) The resistance of rail and bonding per 1000 meters of track shall not exceed 0.5 ohm for track circuits longer than 700 meters. A rail and bond resistance up to 1.5 ohm per 1000 meters of track may be allowed for length of track circuit less than 700 meters.
- (d) The rail bonding and connections to the relay and feed set shall be made according to approved drawings.
- (e) The lugs of impedance bond connections shall be firmly fixed by pressing rivets into the web of the rail with a bond press.

#### 17.2.4 Track Circuit Terminations

- (a) For track circuited points or lines in a station, track circuit termination shall be provided sufficiently before the Fouling Mark\* so as to avoid infringement to the standard dimension by any portion of the vehicle. The distance between track circuit termination and Fouling Mark shall not be less than 3 meters.
- (b) **Cut Section (Fed Over) Arrangement of Track Circuits:** Where cut section track circuits are installed, the track relays concerned, when de-energized, shall open the track feed and shunt the track circuit.

*\*Note: Fouling marks should be fixed at the point at which the spacing between the tracks, begin to reduce to less than the minimum as laid down in the schedule of dimensions, i.e. not less than 4.265 m for existing yards and 5.3 m for new yard lines. (Para No. 650 of IRPWM)*

#### 17.2.5 Insulated Rail Joints

- (a) All components of insulated joint shall be of approved type and shall conform to RDSO drawings. The components shall be installed using correct sizes and combinations.
- (b) Insulated Rail Joints shall, as far as possible, not be provided on the outer rail in curves. Insulated rail joints shall be so placed to minimise dead zone (where a standing vehicle is not detected).
- (c) Before an insulated joint is installed, it shall be ensured that permanent way requirements stipulated in [Para no. 17.1.2](#) are complied with. The installation of glued rail joints shall be done by Civil Engineering Department. The installation of Nylon insulated rail joints shall be done in accordance with RDSO's booklet No.STS/E/IRJ/IMI - Installation and Maintenance Instructions for Nylon insulated rail joint. Particular attention shall be paid to the following:
  - (i) Hammer driving offish-bolt shall be avoided, as this will damage nylon bushes, If the rail hole and the fishplate holes are in their proper position and alignment, the fish bolt can be easily inserted by hand pressure.
  - (ii) If an end-post, projects above the rail at the ends, it shall be trimmed and brought to the level of the rail table, especially when inserted between the worn-out rails, before first wheel of a train passes over it.
  - (iii) The distance of 13 meters between the insulated Block Joint or Detection Point and the starter Signal can be reduced from 13 meters to 3 meters for Signaled movements. The insulated Rail Block Joint or Device of Axle Counter or Joint Less Track Circuit shall be so fixed that their boundary shall be within zero to 3 meters in advance of the starter signal.
  - (iv) In the case of point track circuits, the insulation joint shall not be in the stock rail joint but in the rail joint ahead of it wherever feasible.
- (d) Only 'J' type clip shall be used in glued joint portion of track.



**17.2.6 Track Indicators:** At Track circuited stations where track indicators are provided, the following arrangements shall be made:

**(a) At Panel Interlocked/Route Relay Interlocked Stations**

- (i) Normally, the track indicators would show no light when the line is unoccupied. When action is initiated to set the route for taking off a signal and the concerned route is set, the track indicator light for the route shows Yellow/White, if unoccupied. However, if any portion of the track circuited area is occupied, a "RED" indication is shown on the panel diagram, irrespective of the route being set or not.
- (ii) The track indicators would show white/yellow light when the track is cleared after the intended movement is completed till the route signal button or switch is restored to normal unless the panel interlocking/route relay interlocking is provided with Automatic Route Release facility in which case the indication would be lit until the sub route/sectional route/route is released.
- (iii) In case of berthing track having multiple track circuit sections, it is desirable to show individual indications of each track circuit on the panel.

**(b) At Other Stations:** The indicator shall show yellow/white Light when the line is unoccupied and RED when line is occupied.

**17.2.7** Limiting resistance of DC track circuits shall be adjustable and of an approved type.

**17.2.8 Track Relays**

- (a) DC track relays of approved design shall be used. In future installations, only plug in type track relays (9 ohm) shall be used, both in Non-RE & RE areas.
- (b) Q series track relay must be used in conjunction with Q series slow to pick up relay as a repeater relay.
- (c) **Excitation of DC Track Relay:** The relay shall be excited at minimum 125% of its rated pick up voltage under minimum ballast resistance condition and normal working voltage of the supply. The maximum excitation shall not exceed 235% for QBAT Relays and 300% for other plug- in type relays.

**17.2.9 Maximum Length of Track Circuits:** Maximum length of track circuit under different track parameter conditions shall not exceed the limits as given in the following table. Maximum length of track circuit under different track parameter conditions shall not exceed the limits as given in the table below.

Sl. No.	RE/ Non-RE	Sleeper	Section (Yard/ Block)	Min. Ballast Resistance in Ohm per Km	TSR in Ohms	Max. Length of Track Circuit in meters	Type of Track Relay to be used
1	Non-RE	*Wooden/PSC	Block	4	0.5	1000	QT type 9 ohm
2	Non-RE	*Wooden/PSC	Yard	2	0.5	670	-do-
3	RE	*Wooden	Block	4	0.5	450	QT 9 ohms AC immune
4	RE	*Wooden	Yard	2	0.5	450	-do-
5	RE	PSC	Block	4	0.5	450	-do-
6	RE	PSC	Yard	2	0.5	350	-do-
7	RE	PSC	Yard	2	0.5	750	QBAT in conjunction with QSPA1 with B type choke at relay end

(\* where existing)

#### 17.2.10 Track Feed

- Approved type of secondary cells shall be used for feeding track circuits.
- Secondary cell(s) shall be used along with battery charger/solar panel of adequate capacity.
- Separate feed shall be provided for each track circuit.

### Section 3: Maintenance of DC Track Circuits

#### 17.3.1 General: Track circuits shall be so maintained that:

- There is always a good connection between power feed and track, Relay and track and also between adjoining rails, through jumpers and rail bonds.
- The ballast resistance always remains high and does not fall below prescribed minimum values.
- The limiting resistance shall be as high as possible.
- The insulating joints are of high resistance.
- The surface of rail is clean and is free of dust, sand and foreign materials.
- The circuit is properly energised during wet weather on minimum ballast resistance conditions and during dry weather on maximum ballast resistance conditions. The track circuit shall not be over-energised to such an extent that the shunting value drops below 0.5 ohms for all types of track circuits. These values shall be obtained irrespective of whether the track is provided with concrete sleepers or wooden sleepers.
- The connection of DC track relay shall be quarterly interchanged to prevent permanent magnetisation.

### 17.3.2 DC Track Relays

- (a) Pick up and drop away values shall be maintained within the limits specified by the manufacturer.
- (b) Track relays shall be inspected visually every quarterly by the JE/SSE and the following visual checks conducted:
  - (i) Movement of armature and contact carriage
  - (ii) Wiping of contacts
  - (iii) Arcing of contacts, if any
  - (iv) Pitting or charring of contacts
  - (v) Dust on contacts
  - (vi) Electroplating
  - (vii) Corrosion, rusting of components
  - (viii) Cracks or breakage in components
  - (ix) Presence of fungus, if any
  - (x) Charring of cover near contacts (for plug-in relays)
  - (xi) Correctness of label
  - (xii) Presence of seal
- (c) The defective track relay should be immediately replaced and a brief report stating the nature of the defects shall be submitted to ASTE/DSTE/ Sr.DSTE. On no account should any attempt be made by the field staff to rectify the relay.
- (d) Plug in type track relays have to be replaced on completion of 12 years or earlier if warranted by the actual condition of the relay and/or its usage.

**17.3.3 Insulated Rail Joints (IRJ):** Insulated Rail Joints shall be maintained in accordance with the instructions given in Booklet No. STS/E/IRJ/IMI "Installation and Maintenance Instructions for Nylon Insulated Rail Joint" issued by the RDSO/Lucknow, with particular attention being paid to the following:

- (a) Before opening an insulated rail joint, the components required for replacement, conforming to the rail section, shall be kept ready by the side of the track.
- (b) For replacement of an end-post when there is no gap at the Insulated Rail Joint, loosen the rail fastening and pull back the rail and insert end-post between the rail ends.
- (c) It is imperative that when an insulated rail joint is provided at least three sleepers on either side of the insulated rail joint shall be packed properly.

- (d) Fish bolts shall be kept tight. Nuts shall be tightened several times during the first two weeks after installation/replacement, until all components of an insulated rail joint are firmly set.
- (e) A metal flow is seen often at the rail-table at the joints. Such metal flow of metal forms a lip and creates sharp burrs at the rail ends. Projections formed at the rail ends shall be chiseled without damaging the end post so that these do not bridge the rail expansion gap and cause a short circuit.
- (f) Brake block dust, which may accumulate on the head and sides of the end post and top surfaces of the fish-plates, shall be brushed off frequently so that the possibility of electrical conductivity being established between the rail ends is eliminated.
- (g) Opening & fixing of fish plates of Nylon insulation joint for installation/replacement of joint shall not be done by S&T staff (as it is the responsibility of Engineering Department).
- (h) Special type pandrol clips ('J' type) shall be provided at Nylon insulation joints/glued joint to avoid touching of pandrol clip with the fish plate.
- (i) Periodic coating by insulating varnish/epoxy over the nylon-insulated joint/glued joint to avoid shorting due to brake dust shall be done.

A faulty insulated joint may be detected by taking the voltage readings across the track relay terminals and noting if this reading changes when the adjacent track circuit feed is shunted or disconnected. Any change in the voltage reading will indicate a faulty insulated joint.

#### **17.3.4 Stretcher Bars and Point Rodding Connections**

Insulation for stretcher bars and point rodding shall be periodically checked to see that they are in sound condition. All defective insulation shall be changed.

#### **17.3.5 Bond Wires/Rope Wires**

- (a) Bonds shall be inspected frequently and maintained in good condition.
- (b) Bonds shall be painted with aluminum paint, where bond corrossions are excessive.
- (c) Voltage reading may be taken at every 15 rail lengths or less as required by special track circuits, to determine if the variation in voltage is gradual throughout the track circuit. If any unusual variations are found between any two readings, defective bonding may be detected by taking readings every rail length in that section or by inspection of each bond.

#### **17.3.6 Jumper Connections:** Jumper connections shall be inspected frequently and maintained in good condition. Long jumper connections shall be properly secured.

**17.3.7 Ballast:** Minimum ballast resistance of track should not be less than 2 ohms per km in station yard and 4 ohms per km in the block section.

*Note: Wherever PSC Sleepers are used, availability of insulated liners upto a minimum level of 97% shall be ensured.*

**17.3.8 Drainage**

- (a) Special attention shall be paid during the rains to track drainage. Defects, if any, shall be reported to the SSE/JE(P-Way).
- (b) All cases of defective valves of overhead water pipes in track circuited area shall be reported to the Inspector of works SSE/JE(Works).

**17.3.9 Joint Inspection of Track by S&T and Permanent Way Inspector**

- (a) The track circuited portion of the track shall be jointly inspected by SSE (Signal)/incharge and SSE(P-way)/incharge and jointly by Sectional SSE/JE (Signal) & SSE/JE (P-way) at least once in six months.
- (b) This is in addition to routine inspections to be carried out by each Branch. The condition of rail and insulation at the rail joints, ballast and sleepers, abnormal collection of brake dust, rusting of the rail and drainage system of the yard shall be particularly noted, it shall be ensured that percentage of missing liners for track circuit length not to exceed 3%. Maintenance work found necessary on insulation joints after such inspection should be carried out jointly.

**17.3.10 Train Shunt**

- (a) A Train shunt test shall be taken every quarter and every time the track circuit is adjusted or any alteration is made.
- (b) Shunt test shall be taken not only at relay end but also at other parallel portions of the track, such as, turnouts and crossovers.

**17.3.11 Track Circuit Test Record Card**

- (a) Track circuit test record Card No.S&T/TC-1, [Annexure: 17-MS1](#) for DC track circuits, shall be maintained for each track circuit. For other types of track circuits, suitable record card may be framed by the Principal Chief Signal and Telecommunication Engineer. Readings shall be recorded every six months. Suitable remedial action shall be taken when abnormal readings are noticed at any time.
- (b) Test cards shall be easily accessible for inspection by officials.
- (c) The test card shall be kept up-to-date in accordance with the instructions given on the cards.

**17.3.12 Track Batteries/Track Feed Apparatus:** Track batteries or the track feed apparatus, where provided, shall be so arranged that the track relay will operate under the most adverse conditions. Batteries shall be kept in good fettle and special care shall be taken in maintenance of the cells.

**17.3.13 Rusty Rails:** Where there are rusty rails in the track circuited areas zig-zag welding using steel wire shall be done by P-Way staff on top of rail to ensure shunting of track circuit by the vehicle. Such identified locations to be provided with Axle Counters. Till such time axle counters are being provided, working instructions should be issued that points are operated only after physical verification of complete arrival of train by ASM, and facility of sectional route release be restricted to be provided only where it is essential. (Axle Counters shall not be provided in parallel to “Rusty Rail Track circuit”)

*Note: Refer to [Annexure: 17-MS2](#) for maintenance schedule of DC Track Circuits.*

## **Section 4: Audio Frequency Track Circuits (AFTC)**

### **17.4.1 Audio Frequency Track Circuits (AFTC) – General**

- (a) The use of audio frequency permits the physical limits of an individual track circuit to be defined by tuned short circuits between the rail rather than the insulation in the rails themselves. These types of track circuit have distinct advantage of not requiring IRJs (except Point Zones) and offers considerable saving in IRJs and impedance bond, especially on tracks subjected to high speed, high axle load traffic or where there is an intensive service.
- (b) Main features of Audio Frequency Track Circuit are:
  - (i) Built in time delay, therefore a slow to pick up QSPA1 Relay as TPR is not required.
  - (ii) Can be used in most AC, DC electrified and non-electrified areas.
  - (iii) Can be used in end or centre-fed configuration.
- (c) Only approved type Audio Frequency track circuit shall be used.
- (d) Track circuit shall not be configured in single rail mode operation.
- (e) Audio Frequency Track Circuit may be operated as local fed or in a remote fed mode.
- (f) Audio Frequency Track Circuit's components are
  - (i) Tuning unit
  - (ii) Transmitter
  - (iii) Receiver
  - (iv) Power Supply
  - (v) Track Connections
  - (vi) Impedance Bond (as applicable)

#### 17.4.2 Installation and Maintenance of AFTC

- (a) Installation of track circuit shall strictly follow the instructions given for that type of track circuit.
- (b) Tuning area shall be devoid of check rails, level crossing, insulated bond and each fish plated joint shall be bonded with jumpers of adequate thickness.
- (c) Special precautions shall be taken to ensure the tightness of connection of rail and tuning unit.
- (d) A frequency assignment scheme for the track circuit shall be decided in advance and it shall be strictly followed.
- (e) Terminal junction on insulation joint to track circuits with the same frequency is prohibited; however, frequencies not belonging to same pair can be used.
- (f) Cable cores of same cable shall not be used for connecting transmitter & receiver of a track circuit.
- (g) When wiring and installing track circuit, circuit pairing should be observed in the line cables. Each transmission or reception shall use conductors from one same pair. Circuit pairing results in cable transmission parameters being changed and may induce significant cross talk levels in adjacent circuits.
- (h) The design and installation of field equipments should take in account the requirements for mechanised track maintenance and should not be hazard for men walking along the track.
- (i) Protection against atmospheric voltage surges shall be installed on each pair of conductors providing a link to the outside in order to limit the harmful effect of lightening on electronic equipment. This protective arrangement shall cover against both common mode and differential mode voltages on line.
- (j) Transmitter, receiver and power supply shall be mounted in standard relay rack in a manner to allow maintenance and testing staff to view the track relay while making adjustments.
- (k) TUs and ETUs shall be mounted at a minimum distance of two meters away from the near rail as it gives good safety margin to staff.
- (l) In case of failure of track circuit, attempt shall not be made to pick up the track circuit by adjusting the gain of receiver of TC without investigating the cause of drift in the receiver voltage.
- (m) Impedance bond within track circuit shall be tuned with the correct resonating capacitor across the auxiliary coil and this tuning shall match with the frequency of track circuit.

- (n) Maximum length of track circuit depends upon various factors like ballast resistance, frequency adopted, track layout (whether any level crossing or bridge falls within track circuited area) and vendor of AFTC, and it cannot be laid down in absolute terms. Broadly its length is limited to 700 meters in end fed mode.

*Note: (i) AFTC shall not be used for new works. Existing one shall continue to be maintained.*

*(ii) Refer to [Annexure: 17-MS3](#) for maintenance schedule of AFTC.*

## **Section 5: Precautions for DC Track Circuits & AFTC in RE Area**

### **17.5.1 Track Circuits in RE Area**

Track circuit on AC electrified section may use IRJs (Insulated Rail Joints) or ESJs (electrical separation joint) and may be configured as single rail or double rail track circuit. Track circuit which use electric separation joint shall be configured only as double rail track circuit.

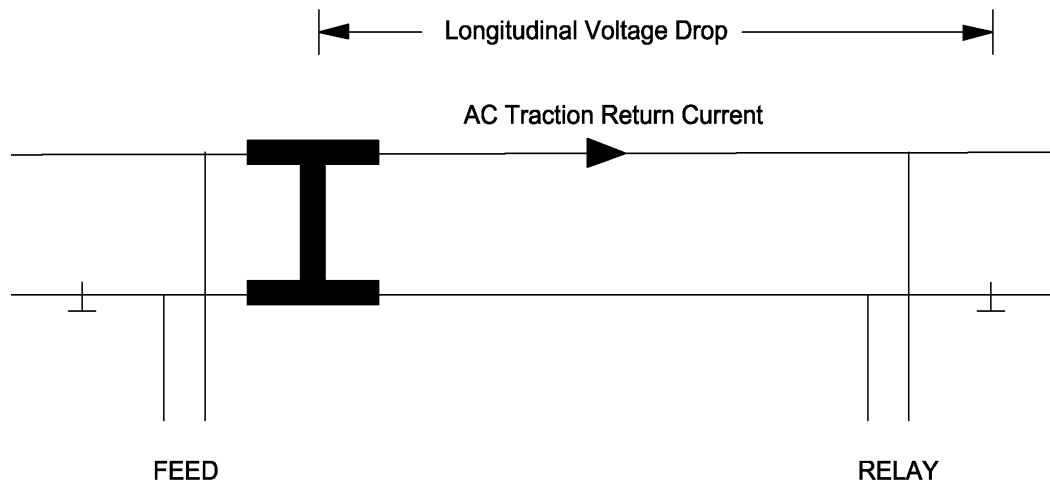
### **17.5.2 Single Rail DC Track Circuit**

- (a) With single rail track circuits, one of the rails is reserved for the traction return current. This rail is referred to as the uninsulated rail. Any connection from the O.H.E. mast or other structure shall be made only to the uninsulated rail. Similarly, connections for the return current at feeding points as well as from booster transformers and return conductors shall be made only to the uninsulated rail.
- (b) As far as practicable, the rail adjacent to the O.H.E Mast shall be utilised as the uninsulated rail. However, this may not always be possible, particularly in yards where there are a large number of points and crossings or where the O.H.E masts are not always on the same side or where track circuits are staggered. In such case O.H.E. bonds crossing the track circuit rail shall be provided with suitable precaution by electrical department like insulating sleeve and clearance from bottom of the rail to avoid shorting of track circuit rail with uninsulated rail.
- (c) In single rail track circuits, in the event of a break in the uninsulated rail, very heavy current will flow through the track relay as well as the equipment at the feed point. To avoid this, the uninsulated rails of the adjacent tracks shall be cross-bonded at intervals of not more than 100 meters. In case the track circuit is less than 100 meters, the cross bonding shall be provided on the uninsulated rail at either end of the track circuit. (Ref: [Drg no. 17-D3](#))
- (d) In the case of adjacent track circuits, the return rail shall be staggered.



### DC Track Circuit in RE Area (Single Rail)

(a) This track circuit can only be configured to work as single rail track circuit.



- (b) Interference Mechanism, With reference to fig. above traction return current flowing in the single traction return rails creates a longitudinal AC voltage along its length, which is a function of the current value and the impedance of the traction return rail. A wheel set at the feed end will impress this interfering voltage on the relay, whilst a wheel set at the relay end will similarly impress the interfering voltage on the feed set. The track circuit equipment must be immune both to false operation and to damage from such impressed voltages.
- (c) Approved type of AC immunised track relays shall be used in AC traction area.
- (d) Length of DC track circuit is restricted depending upon rail return current. With catenary current restricted to 300 Ampere on single track section and 600 Amperes on double track section, length of DC track circuits shall be restricted depending upon the use of type of relay and sleeper.
- (e) The length of track circuit can be extended upto 450 meters when QTA 2 plug-in relay is used.
- (f) Restriction on the track circuit length due to use of concrete sleeper can be relaxed upto 450 meters by PCSTE of Railway (if adequate ballast resistance can be consistently obtained).
- (g) In view of the increased AC immunity due to the presence of biased magnetic arrangement, QBAT relays can be used upto a maximum length of track circuit of 750 meters using one additional 'B' type choke at the relay end, under minimum ballast resistance of 2 ohms/km. Operation of track circuit with this type of relay will require four cells delivering 8.8 V. QBAT relays shall be used in conjunction with QSPA1 relays conforming to BRS 933A.

- (h) As an interim measure, length of DC track circuit may be retained at the existing level at higher catenary current of 800 Amperes on single-track section and 1000 Amperes. On double track section by providing one additional 'B' type choke in series with track relay. Audio Frequency Track Circuit or any other approved type of device shall be used on sections where catenary current exceeds 300 Amperes on single-track section and 600 Amperes on double track-section.
- (i) Before installation of single rail DC track circuits in AC Electrified areas, measurements of stray DC currents shall be taken in accordance with the instructions in [Annexure: 17-A1](#). The total stray current as measured, shall not exceed,
  - (i) 10 milli-amperes, if length of track circuit is less than 100 meters.
  - (ii) 100 milli-amperes, if length of track circuit is 100 meters and above.
  - (iii) If measured value of current exceeds the specified limit as above, other type of track circuit suitable to work in A.C. traction area shall be used.
- (j) To protect the equipment from the effects of the rail voltage, a choke coil of approved type shall be provided in series with the feed resistance.

#### **17.5.3 Audio Frequency Track Circuit for RE Area**

- (a) In double rail track circuits, since both rails are used for traction return current, impedance bonds shall be provided at the IRJs.
- (b) No O.H.E mast or any other structure shall be connected to either of the rails. The Electrical Department shall run separate earth wire for earthing the O.H.E masts.
- (c) Connections at the feeding points and from booster transformers and return conductors shall be made to the center points of impedance bonds.
- (d) Only approved type Audio Frequency Track Circuit shall be used.
- (e) Audio Frequency Track Circuit shall be configured only as double rail track circuit and like any double rail track circuit it requires both rails to be balanced with respect to earth and with respect to current flow in each rail.
- (f) Impedance bond shall be used where there is no provision in design of Audio frequency track circuit to balance the traction rail return current.
- (g) Electric Traction Units shall be critically examined for harmonics generated by them before they are brought into service.

#### **17.5.4 Impedance Bonds (as applicable) in RE Area for AFTC**

- (a) Impedance bonds used on 50 Hz electrified lines shall be of approved type.
- (b) The principles of operation of impedance bonds are equally applicable whether the traction return current is AC or DC. The traction current rating of DC impedance bonds is usually much higher than those designed for AC traction systems. Thus, impedance bonds designed for DC traction current can usually be used on AC traction systems, although their bulk and cost is greater than a purposely designed AC impedance bond. Conversely, impedance bonds designed for AC traction systems are not suitable for use on DC traction systems.
- (c) Generally, AC impedance bond shall be capable of supporting a current of 400 Amperes continuously (200 Amperes in each rail), with a peak loading of 1000 Amperes for a period of up to five minutes, without suffering damage or overheating.
- (d) Leads between impedance bonds across IRJ on the same track shall be capable of carrying the traction current. It shall be PVC sheathed cables, terminated by compression lugs of an approved type and bolted to the impedance bond termination.
- (e) The design and installation of impedance bonds should take into account the requirements for mechanised track maintenance and should not be a hazard for men walking along the track.
- (f) The provision and maintenance of connections between rail and impedance bonds, and from one impedance bond to another on the same track is the responsibility of the S&T department.
- (g) Cross bonds, earth wires, connections to sub-station current return busbars and connections to booster transformers must be terminated on the centre tap of impedance bonds. The installation and maintenance of these connections is the responsibility of the electrical department.

#### **17.5.5 Installation & Maintenance of Track Circuits in RE Area**

- (a) RDSO's guidelines shall be followed.
- (b) It is, however, important to recognize that the operation of track circuit is dependent upon the integrity of traction return bonding. It is therefore important that attention is given to the testing during installation and also during maintenance of traction return bonding.

### 17.5.6 Track Bonding in RE Area

(a) The Objectives of Track Bonding are:

- (i) To provide a path for traction return current, which ensures that no component of the track/traction return network rises above 25 V to remote earth, under normal traction load conditions and 430 V under traction short circuit conditions.
- (ii) To ensure that protective equipment operates satisfactorily.
- (iii) To minimize damage to installations due to traction short circuit.
- (iv) To maintain correct operation of track circuits.

(b) Planning for Track Bonding

- (i) When planning electrification schemes, base plans will be provided. The plans will be issued to the signal department showing the track layout and proposed position of all electrification and associated structures.
- (ii) The signal department will then indicate on these plans the proposed position of insulated joints, impedance bonds, signal structures and track circuit bonding and in single rail track circuited areas, will identify the track circuit rail by marking with a thickened line. In double rail track circuited areas S&T department shall specifically indicate the provision of earth wire for structure earthing.
- (iii) The plans must then be returned to electrical department who will indicate the position of continuity bonds, cross bonds, structure bonds and all earth connections to the traction system. The plans will then be returned to the signal department for final approval and issue to concerned parties.

(c) Bonding of Single Rail Track Circuits in RE Area

- (i) The track circuit rail must be series bonded in order to ensure that defective bonding cannot cause a wrong side failure of the track circuit. Accordingly, the bonding arrangement of the track circuit rail must ensure that the conductive path between the track circuit feed connection and the relay or receiver end connection is interrupted in the event of a disconnection.
- (ii) Because of traction return considerations, it is not possible for the traction return rail to be series bonded. It is therefore essential to avoid bonding disconnection to minimize the risk of loss of train shunt.
- (iii) In single rail track circuits, in the event of a break in the uninsulated rail, very heavy current will flow through the track relay as well as the equipment at the feed point. To avoid this, the uninsulated rails of the adjacent tracks shall be cross bonded at intervals of not more than 100 meters. In case the track circuit is less than 100 meters, the cross bonding shall be provided on the uninsulated rail at either end of the track circuit. (Ref: [Drg no. 17-D3](#))

- (iv) On single line track circuited sections, a continuous earth wire is provided on the traction mast capable of carrying full traction return current. The uninsulated rail shall be connected to each of the traction masts by a structure bond, which shall be riveted at both ends. The arrangement for Double Line and Single Line Sections is as illustrated in given at [Drg No.17-D3](#).
  - (v) Typical bonding examples with single rail track circuits are shown in [Drg No.17-D3](#).
- (d) Double Rail Track Circuits
- (i) No structure bonds, cross bonds or connections to earth wires or return conductors shall be connected to the running rails where double rail track circuits are in use. If necessary, an impedance bond must be specially installed to provide a neutral point for these connections.
- (e) Types of Bonds in RE Area
- (i) Rail Joint Bonds: Rail joints in track circuited areas shall be bonded using two 8 SWG bare galvanized steel wires or copper bonds/steel wires or flats secured by means of channel pins or welding/riveting. The S&T department is responsible for the installation and the maintenance of all rail joint bond.
  - (ii) Rail bonds and Cross bonds: Where rail bonds and cross bonds are required for traction return purposes they shall be installed by and remain the responsibility of the electrical department.
  - (iii) The longitudinal bonding on a non track circuited track adjacent to a track circuit shall be extended for a distance of 50 meters beyond the track circuit.
  - (iv) In addition, the two rails of the non-track circuited track outside any track circuit or in between two track circuits shall be bonded together immediately after the block joints.
  - (v) It is essential that the traction return and track circuit bonding is maintained in its design condition. The SSE/JE (Traction) and SSE/JE (Signal) of section will arrange for physical inspection at six months intervals to ensure conformity with approved Bonding Plan. In the event of faulty connection or bond being found immediate remedial action will be taken to restore system Integrity. The results of the joint inspections shall be entered in a register maintained by the SSE/JE (Signal) and put up within a month for the scrutiny of the Sr. Divisional Signal and Telecommunication Engineer/Sr.Divisional Electrical Engineer (OHE). Responsibility of maintenance of traction bonds is with electrical department.
  - (vi) Detailed instructions for bonding of track are given in the AC Traction Manual.

## **Section 6: Axle Counters - General**

17.6.1 Axle Counter consists of track device (axle detector) mounted on the rails, track side electronic equipment provided near the track and connected with track device & evaluator. Evaluator monitors the counts of track device(s) to give clear/occupied indication. Evaluator/track side electronic equipment may be kept in relay room or site.

(a) Digital Axle Counters of approved type may be used in lieu of track circuits to prove the clearance of a portion of track.

(b) Axle Counters may also be provided in lieu of conventional track circuits for block working, viz. Intermediate Block Signalling, Automatic Signalling, Block Working controlled by track circuits, etc.

(c) Digital Axle Counter (DAC) may be preferred on girder bridges in lieu of DC track circuits.

17.6.2 Typical usage of Axle Counters is for following applications:

(a) Intermediate Block Stop Signalling.

(b) Automatic block signaling.

(c) Station Section having poor drainage, flood prone sections.

(d) Block Section Proving of Clearance (BPAC).

(e) Tracks having problem of rust.

(f) Tunnels and bridges as per site requirement.

### **17.6.3 Trolley Suppression**

Axle counter shall not count standard 4 spoke wheels of push trolleys.

*Note: In those sections where certain models of Motor/Light motor/Moped/Scooter trolley in use which may not get detected shall be taken care of, by suitable provisions in Station Working Rules, working Time tables and subsidiary Rules. Such Trolleys shall be run as per GR 15.25 for working of Motor trolleys.*

## **Section 7: Installation of Axle Counters**

17.7.1 The installation of Axle Counters shall be done as per prescribed installation guidelines of OEM and approved pre-commissioning checklist.

17.7.2 The important features of the installation procedure are:

- (a) **Trolley Suppression:** On sections where trolleys are in operation and existing axle counters do not have inbuilt trolley suppression arrangement, the arrangement shall be provided to prevent the operation of system by insulated trolleys. Trolley suppression arrangement shall be closed track circuit and track devices shall be fixed on rails within the boundaries of track circuit. It is possible to dispense with the provision of trolley suppression arrangement for track devices provided on point zone portion by using approved circuits for this purpose. On sections where non-metallic wheels are used, trolley suppression arrangement can be dispensed with.

*Note: In future, digital axle counters having inbuilt provision of trolley suppression shall only be provided.*

- (b) The distance between the two adjacent axle detectors of different axle counters shall be at least 2 meters or as specified in OEM manuals, so as to minimise mutual interference.
- (c) To protect axle detectors against damage (from hanging parts of moving trains), deflectors shall be provided, on both sides of the axle detectors on single line and one side on double line.
- (d) The track side electronic equipment shall be housed at a location close to the axle detectors so that the length of cable between the track side electronic and the axle detectors is minimum and does not exceed the limit recommended by the manufacturer. The equipment shall be placed at a level well above the flooding level of the area.
- (e) The incoming cables from axle detectors and evaluator may first be terminated on a cable distribution board to provide facility for testing.
- (f) Wherever applicable, the transmitter and receiver coil cables between axle detector and associated track side electronics shall be laid in different pipes as prescribed by OEM.
- (g) Ensure minimum of 400 mm Sleeper spacing & packing of sleepers in between track device (sensor) are fitted & fitting do not vibrate under train movement & packing of the same shall be done, if required
- (h) Track side electronic equipment shall be operated from Central power supply like DC–DC converter of approved type preferably used for feeding evaluator with adequate battery backup. At remote locations track side electronic equipment may be provided with separate power supply. The input power supply shall have a maximum ripple of 50 mV peak to peak/10 mV rms.
- (i) The evaluator shall be installed preferably in a relay room or at a location which is not accessible to unauthorised persons. Equipment shall be installed at a high level, well above the flooding level of the area and protected from rain water. It shall be fixed on a separate shelf away from signalling relays. As far as possible, it shall be located away from any source of heavy electromagnetic interference like industrial machinery, motor/generator or welding plants, etc.

- (j) The power to evaluator is fed from a power supply like DC-DC converter of approved type with adequate battery backup. Each evaluator shall be provided with a separate DC-DC converter for better availability. The input power supply shall have a maximum ripple of 50 mV peak to peak/10 mV rms.
- (k) All lead connections to and from battery and DC-DC converter shall have adequate current capacity to ensure that the voltage drop does not exceed 0.2 V. These connections at terminals shall be secured properly and should preferably be made through lugs to give firm contact.
- (l) Connections between battery, battery charger and DC-DC converter shall not be bunched with any other wires. These wires shall preferably be laid at least 150 mm from any other bunch of wires. Positive and negative wires shall be twin twisted to avoid interference pick up especially when the lead wires are long.
- (m) Where ever Integrated power supplies are provided, power for axle counter shall be taken from nominated DC-DC module.
- (n) Redundancy in train detection devices may be provided for all train detection device in Block section and at vulnerable Track sections within station section. Redundant system shall be independently powered through independent power source and separate cable.

#### **17.7.3 Communication Media**

- (a) The quad cable or PIJF Telecom Cable used with axle counters shall be of approved type. The Transmission loss, cross talk measurements shall be within limits specified for the axle counter to be installed. Optical Fibre Cable (OFC) may also be used for communication with suitable interfaces.
- (b) All precautions prescribed for laying and installation of communication cables shall be strictly followed.

#### **17.7.4 Axle Counter Resetting - Block Section/Intermediate Block Signalling/ Automatic Signalling:**

- (a) Preparatory reset arrangement shall be provided, so that whenever the axle counter shows fault condition; the same can be reset by the on duty Assistant Station Master/Station Master, after ensuring that the monitored portion is clear of vehicles.

The following precautions shall be followed for resetting.

- (i) Once the Axle Counter has failed and the concerned signal cannot be taken off, the on duty Station Master (ASM) of Train dispatching station shall positively verify the clearance of the block section with the on duty Assistant Station Master (ASM) of Train receiving station by exchange of private numbers and record the same in Train Signal Register (TSR) by both the stations. After ensuring that the block section is clear of vehicles, Axle Counter's reset operation shall be initiated by cooperative effort between the ASM's of the dispatching and the receiving stations.
- (ii) The circuitry shall be such as to obviate the possibility of the resetting by the dispatching/receiving station independently.



- (b) The reset box shall be operated by a key which shall be kept locked in a separate box kept in the SM's office. Each and every operation of the reset button shall be counted on a non-resettable type counter and shall be recorded in the Train Signal Register by both the SMs, indicating the movement before and after the operation of the reset button. During inspection of the stations the Signal and Traffic Inspecting officials shall specifically checkup and ensure that the system of exchange of private number is being followed meticulously.
- (c) The procedure of resetting, verification of clearance of concerned axle counter section from any obstruction/vehicles before resetting is initiated and piloting of the first train shall be clearly laid down in the Station Working Rules.

**17.7.5 Axle Counter Resetting - Station Section:** Where Axle Counter is provided in station section, the following procedure shall be followed for resetting:

- (a) **Cooperative Type for Point Zones/loop lines/siding:** Once the Axle Counter has failed and is showing fault condition, the on duty ASM/ Station Master (SM) shall first arrange to verify that line on which train is to be received is physically clear of any obstruction. Such physical verification of failed Track section shall be done through Line verification box (LV box) which shall be installed close to the line to be verified. The resetting shall be cooperative and done jointly by the on duty ASM along with another Operating Staff, who shall verify physical clearance of Line and operate the line verification box for the failed Track section of axle counter.
- (b) **Main lines/Run through lines:** Preparatory reset arrangement shall be provided.
- (c) The reset box shall be operated by a key which shall be kept locked in a separate box secured in the SMs office. Each and every operation of the reset button shall be recorded in the Train Signal Register by the ASM and during inspection of the station; the Signal and Traffic inspecting officials shall specifically check up the procedures being followed in respect of the above resetting device and ensure that laid down procedure for resetting is being followed.
- (d) This procedure of ensuring that the monitored portion is free of any vehicle before resetting is done, shall be clearly laid down in the Station Working Rules.
- (e) The first train after the reset operation may be either received on calling-on signal or piloted as per the extant rules after verification of the clearance of the reception line.

*Explanatory Note: An overview of Axle Counter resetting is shown in Table-below.*

<i>S. No.</i>	<i>Line/Section (1)</i>	<i>Type of Reset (2)</i>	<i>To be applied by (3)</i>	<i>Axle Counter status (4)</i>
1	Block Section/ Auto/IB section	Preparatory Reset	On duty ASMs at both ends of Block Section	After operation in Column (3) and will show 'clear' only after matching 'count in' with 'count out'
2	Main line/ Run through line	Preparatory Reset	On duty ASM	-do-
3	Point zone/loop line/Siding	Conditional Reset	On duty ASM and another operating staff	Will show 'clear' after operation in Column (3)

17.7.6 If Axle Counter cannot be reset, due to any reason or it fails again after resetting, it should be treated as failed and the Signalling maintenance staff should be advised immediately for rectification.

## **Section 8: Maintenance of Axle Counters**

17.8.1 Maintenance of axle counters shall be done as per RDSO's guidelines and maintenance recommendations of equipment manufacturers.

- (a) In case of double rail mounted track devices there shall be no differential creep between the two rails of the track to the extent as to alter their inter distance beyond the permissible tolerance, it is, therefore, necessary that 4 rail lengths on either side shall be well anchored.
- (b) Anchoring of track on either side of the rails where track devices of axle counters are fixed, shall be closely watched by the Permanent Way staff to ensure that there is no differential creep.
- (c) Tie Tamper shall not be used for 4 sleepers on either side of the track devices. Incidentally they should be manually maintained.
- (d) Replacement of components of Axle Counters shall be done with utmost care and as per technical manuals of OEMs. As a general rule, any maintenance activities in track device area, like, ballast packing & rail changing etc. that require disconnection of track devices and adjustments of axle counter parameters shall not be done in working system. Where required, maintenance staff shall take proper disconnection, duly de-energizing the related sections of Axle Counters from CT rack/disconnection terminals before starting indoor/outdoor maintenance activities. Once work is completed the section should be connected/energised following all precautions related to resetting, checking of parameters as stipulated and physical clearance of track section before reconnection. Activities like measurement of parameters, cleaning etc. which does not interfere with working of system, may be carried without disconnection.

- (e) Periodic preventive checks by maintenance staff shall be done to ensure that track device/axle detector is properly fitted at site and fixing nuts/bolts are properly tight and intact. Connections of track device cables are also proper. Any damage/irregularity noticed in nuts/bolts/cables near the trackside shall be immediately attended by duly disconnecting the associated track section while attending the same for damages/irregularities.
- (f) Wherever feasible, It is desirable to monitor working of axle counters through Dataloggers with a suitable interface.



*Note: This chapter has under mentioned Annexures*

S.No.	Annexure No.	Description
1	<a href="#">17-A1</a>	Measurement of Stray Direct Current before Installation of DC Single Rail Track Circuits



*Note : This chapter has under mentioned Maintenance Schedules in [Appendix I](#)*

S.No.	Annexure No.	Description
1	<a href="#">17-MS1</a>	Maintenance Schedule of Track Circuit Test Record Card
2	<a href="#">17-MS2</a>	Maintenance Schedule of DC Track Circuit
3	<a href="#">17-MS3</a>	Maintenance Schedule of Track Circuit – AFTC
4	<a href="#">17-MS4</a>	Maintenance Schedule of Analog (Universal) Axle Counter (UAC)
5	<a href="#">17-MS5</a>	Maintenance Schedule of Digital Axle Counter (DAC)
6	<a href="#">17-MS6</a>	Maintenance Schedule of Multi Section Digital Axle Counter (MSDAC)



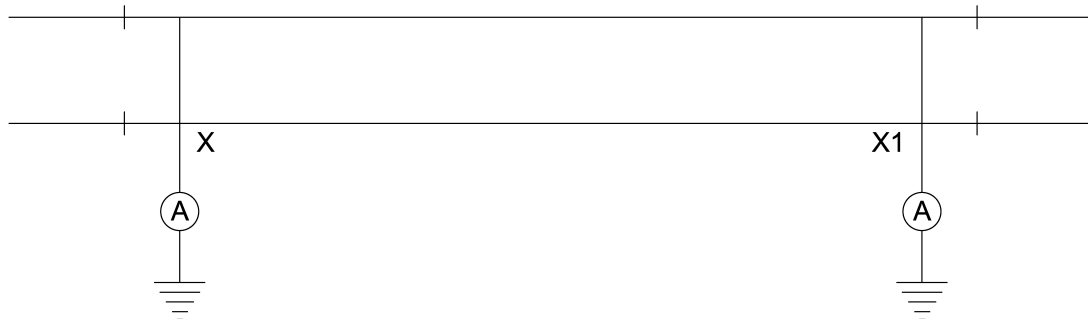
*Note: This chapter has under mentioned Drawings in [Appendix II](#)*

S.No.	Drawing No.	Description
1	<a href="#">17-D1</a>	Drawing for Track Lead Cable Connections
2	<a href="#">17-D2</a>	Track Circuit Bonding Diagram for Typical 4 Road Station (Double line)
3	<a href="#">17-D3</a>	Cross Bonding in Double line and Single line Track Circuits, Earth Wire in Single line

### Measurement of Stray Direct Current before Installation of DC Single Rail Track Circuits

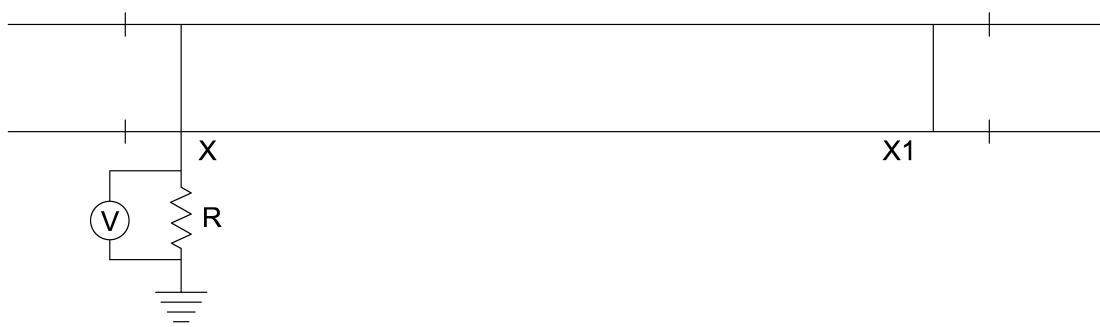
- 1.0 Before installing a DC Track Circuit in areas, which are to be AC Electrified, stray Direct Current tests shall be carried out so as to ensure that DC Track Relays shall not operate with the stray currents.
- 2.0 These Tests shall be carried out only on non-electrified sections.
- 3.0 If there are already existing track circuits in the area, these shall be disconnected to safeguard against false readings being recorded in case of leakage of Block Joints.
- 4.0 The length of the track required being track circuited should be insulated by means of Block Joints on either end of the rails. The rail joints in the track-circuited length may or may not be bonded for purpose of these tests.
- 5.0 electing a suitable earth, which shall not exceed 5 ohms in resistance, test shall be carried out.
- 6.0 A suitable type of milli-volt meter and milli-ammeter shall be used for recording voltages.
- 7.0 These stray current and rail earth voltage measurements shall be recorded in accordance with the diagram for measurements indicated below:

**FIG. 1 Measurement of Stray Current**



*Note: For measurement of stray current set up the circuit as shown above and measure the current simultaneously.*

**FIG.2 Measurement of Rail-Earth Voltage**



*Note: Where 9 ohms, 4 ohms or 2.25 ohms relays are used, use 9 ohms, 4 ohms or 2.25 ohms resistance and measure the voltage once at 'X' and next at 'XV'.*

8.0 These measurements shall be recorded at different periods of the day - one in the morning, one in the afternoon and one in the evening. These tests shall be extended for three days.

9.0 Where stray current/voltages are observed, the length of the Direct Current track circuit shall be cut down so as not to exceed the following limits for each length of Track Circuit:

- (a) The Rail-Earth voltage as measured across 9 ohms, 4 ohms, or 2.25 ohms shall not exceed 0.1 V.
- (b) The total stray current as measured shall not exceed 100 mA. Where all track circuits to be installed on the line are less than 100 meters long, the highest acceptable figure of stray current is 10 mA.

## Chapter 18: Block Instruments, BPAC & IBS Working

### Section 1: Block Instruments General Requirements

#### 18.1.1 General

- (a) All block instruments shall be of robust construction and approved type only.
- (b) On sections where AC voltages are induced due to power line parallelism, suitable block instruments with appropriate protective measures shall be provided as per Section.
- (c) Block instruments shall normally be worked on physical conductors. Where required, block instruments may also be worked on Radio/Optical Fibre Cable with appropriate security features.
- (d) **Lightning Discharger:** All Block instruments shall be provided with lightning discharger to approved specification. Where a return line wire is used, lightning discharger must be installed on both wires.
- (e) **Prevention of Irregular Operations:** There shall not be any opening giving access to the interior of the instrument through which it is possible to operate the mechanism by any irregular means.
- (f) **Locking and Sealing Facilities:** Facilities shall be provided for locking and sealing the Block instruments. The doors of the Block instruments giving access to the internal mechanism shall be provided with a double lock, the key of one of which shall be in the custody of the Station Master on Duty and the key of the other will be with the technician signal in charge of the maintenance of Block Instruments. It shall not be possible to open the door of the Block Instruments without the co-operation of both the agencies.
- (g) **Prevention of Unauthorized Operation:** A lock or other device shall be provided to enable the Station Master on duty to prevent unauthorized manipulation of the instrument during his absence.
- (h) **Isolation of Telephone Circuit:** Telephone instrument shall be provided in conjunction with block instruments. It is desirable that the condenser or other means provided for isolating the telephone circuit from the instrument circuit is located within the instrument or in such a way as to be inaccessible for outside interference.
- (i) **Bell Push:** A Bell push button or a bell plunger shall be provided on the instrument for exchange of bell codes.
- (j) An isolated power supply (battery in standalone mode or DC-DC Converter with isolated output) shall be used for line circuit for each block instrument. This power supply shall only feed the block instrument and not any other circuits. The power supply housing shall be locked and sealed if provided in the SM's Room.

*Note: Where Integrated Power supplies (IPS) are used for Block working, isolated DC-DC convertor Modules shall be used for each Block separately.*

- (k) Tokenless Block Instruments worked on physical conductors shall be worked on metallic return circuits.

- (l) If section is installed with Embedded type Block working i.e. Block working built into Electronic Interlocking, VDU kept in ASM room shall have Block Indication display in both the VDU with hot standby feature. Display Descriptions shall be followed as per Drawing No. RDSO/S/32019.

#### 18.1.2 Special Requirements of Single Line Token Block Instruments

- (a) **Fixed Indications:** The instruments shall be provided with visual indication clearly giving the following indications:
- (i) When the instruments are normal and there is no train in the block section, "Line Closed" at both the stations.
  - (ii) When Line Clear for a train to leave the Block station in rear has been given, "Train Coming From" at the receiving station.
  - (iii) When Line Clear for a train to leave a Block station has been received from the Block station ahead, "Train Going To" at the sending station.
- (b) **Current Indicator:** An indicator, indicating the polarity of current, shall be provided to indicate incoming and outgoing line currents.
- (c) **Operation:** "Train going to" and "Train Coming From" - The instruments shall be such that the cooperation of the Station Master at the other end of the section shall be necessary. Even with the co-operation of the Station Master at the other end, the Station Master has to go through one or more definite moving operations on the instrument in addition to working of bell plunger.
- (i) Before he can grant Line Clear to the Station Master at the other end of the section to release a token, or
  - (ii) Before he can obtain Line Clear and extract a token.
- (d) **"Line Closed":** Both the instruments shall be restored to normal before a further operation of setting the instrument to "Train Going To"/"Train Coming From" can be carried out. It shall not be possible for the instruments at either end of the section to be restored to normal without the cooperative features indicated in [para 18.1.2\(c\)](#).
- (e) **Operation of "Line Clear" Receiving and Granting Mechanism:** It shall not be possible for the mechanism which permits a "Line Clear" to be received and that which permits a "Line Clear" to be granted to be in operation at the same time.
- (f) The instrument that is set to "Train Going To" for initiating a train movement shall be the first one to be restored to "Line Closed" on complete arrival of the train at the receiving station.
- (g) **Extraction of Token:** It shall be possible to extract one token only when the instrument has been set to "Train Going To". It shall not be possible to change the "Train Going To" condition until the token has been inserted in one of the instruments of the Block section.

- (h) Token instruments shall be so installed that a token of one block section cannot be placed in the instrument of an adjacent section and preferably such that if the token is over carried, it cannot be placed in an instrument at the next station.
- (i) The Tokens of each section shall be engraved with the code name of the stations at both ends of the block section and with a serial number.

### 18.1.3 Special Requirements of Single Line Tokenless Block Instruments

- (a) **Fixed Indications:** In addition to the fixed indications specified in [para 18.1.2\(a\)](#) the instrument shall be provided with means to indicate "Train on Line" at both the sending and receiving stations when a train has entered the block section.
- (b) **Immunity from Extraneous Currents:** Single Line Token less block instruments shall work on coded impulse/frequency modulated current system so as to be immune from the effects of extraneous currents.
- (c) **"Train going to" and "Train Coming From":** The instrument shall be such that even with the cooperation of the Station Master at the other end of the section, the Station Master has to go through one or more definite moving operations on the instrument in addition to the working of bell plunger.
  - (i) Before he sets his instrument to "Train Coming From".
  - (ii) Before he sets his instrument to "Train Going To".
- (d) **"Train on Line":** Means shall be provided to ensure that the instruments are set to "Train on Line" automatically by the entry of the train into the block section and maintained in that position until the train has cleared the block section. This indication shall be in addition to the "Train Going To" or "Train Coming From" indications of the handle.
- (e) **"Line Closed":** Both the instruments shall be restored to normal before a further operation of setting the instrument to "Train Going To"/"Train Coming From" can be carried out. It shall not be possible for the instruments at either end of the section to be restored to normal without the cooperative features enumerated in [para 18.1.3\(c\)](#).

### 18.1.4 Operations: Push Button Tokenless Block Instruments

- (a) **"Train going to" and "Train Coming From":** The co-operation of the Station Master at the other end of the section may be dispensed with. The instrument shall be such that a button in addition to the bell button shall be operated for "Train Going To" position.
- (b) **"Train on Line":** Means shall be provided to ensure that the instruments are set to "Train on Line" automatically by the entry of the train into the block section and maintained in that position until the train has cleared the block section. This indication shall be in addition to the "Train Going To" or "Train Coming From" indications.



- (c) **Line Closed:** Both the instruments shall be restored to normal before a further operation of setting the instrument to "Train Going To"/"Train Coming From" can be carried out. The instrument shall be such that a button in addition to the bell button shall be operated by the receiving station for setting both the instruments to the "Line Closed" condition. This feature can be dispensed with where an automatic device of closing the Block section is provided.
- (d) Operation of **"Line Clear"** receiving and granting mechanism - It shall not be possible for the mechanism which permits a "Line Clear" to be received and that which permits a "Line Clear" to be granted to be in operation at the same time.
- (e) Token less block instruments shall be provided with
  - (i) Audible indicators to warn the receiving station.
    - When the train enters the block section at the sending station.
    - When the train has passed the Home Signal at the receiving station.
  - (ii) Shunting key suitably interlocked with the Block instrument for use as an authority for shunting behind the Last Stop Signal and up to the opposing First Stop Signal.

#### 18.1.5 Special Requirements of Double Line Block Instruments

- (a) **Indicators for Up and Down Lines:** The Instruments shall be provided with Visual indicators separately for Up and Down Lines to show the following three conditions:
  - (i) Line Closed
  - (ii) Line Clear
  - (iii) Train On Line
- (b) **Current Indicator:** The indicators provided as per [para 18.1.5\(a\)](#) may also serve as the current indicators.
- (c) **Operation before Granting or Receiving Line Clear:** The instrument shall be such that the Station Master has to go through one or more definite moving operations on the instrument besides working the bell or plunger before he can grant Line Clear.
- (d) **Audible Indicator:** Where required, the instruments may be provided with audible indicators
  - (i) to warn the receiving station when the train has passed the Home Signal, and
  - (ii) to warn the sending station when the train has passed the Last Stop Signal.

### 18.1.6 Non-Co-operative type Instruments

The requirements indicated in para 18.1.5 will apply to these instruments. In addition, the following shall be provided in these instruments.

- (a) **Automatic "Train On Line":** Means to ensure the instruments are set to "Train On Line" position automatically by the entry of the train into the block section and maintained in that position until the train has passed the Home Signal at the receiving station and the instrument set to "Line Closed" condition.
- (b) **Audible Indicator:** Audible Indicator to warn the receiving station when the train enters the block section at the sending station.
- (c) **Shunting Keys:** Two Shunting keys, one for each line, suitably interlocked with the block instruments for use as an authority for shunting in the block section.

**Train Detection for Proving Block Section to be Clear:** On sections where use of track circuits/Axle counters for proving the block section to be clear is to be introduced, the following equipment shall be provided:

- (a) Track circuits or Axle Counters extending from the Last Stop Signal of the block station at one end of the block section to the other end First Stop Signal of the block section.
- (b) An indicator in each block station to show whether the block section is occupied or not.
- (c) A control to ensure that the Last Stop Signal of the block station in rear is automatically replaced to 'ON' by the passage of a train and maintained in that position until the train has cleared the block section.
- (d) A control to ensure that the First Stop Signal is automatically replaced to 'ON' by the passage of the train.
- (e) On single line, a control to ensure that the opposing Last Stop Signals of the Block section cannot be taken 'OFF' at one and the same time.

### Section 2: Special Requirements of Block Working in RE Area

18.2.1 In 25 KV electrified line only following type of block instrument shall be used:

#### (a) Single Line:

- (i) Single Line Token instrument (Neal's)
- (ii) Single Line Token less Block Instrument Handle type (Daido)
- (iii) Block working with Axle Counter
- (iv) Block Proving by Axle Counter
- (v) Block working directly from EI

*Note: (i) Neal's Token instrument shall be progressively phased out.*

*(ii) Push button type block instrument may be used on non-electrified section taking off from electrified section, if length of parallelism does not exceed 1.5 km.*

**(b) Double Line:**

- (i) Double Line Block Instrument (SGE)
- (ii) Block working with Axle Counter
- (iii) Block Proving by Axle Counter
- (iv) Block working directly from EI

*Note: If any other block instrument is to be used, prior approval of Railway Board shall be obtained.*

**18.2.2 Media**

- (a) Block instruments may use special PVC insulated quads in the aluminum sheathed cable/4 or 6 quad jelly filled telecommunication cable or other suitable communication means, like OFC and radio, for their working.
- (b) When quad cable is used for the working of block instruments, Block Telephone and Block Bell circuits shall be worked through a transformer utilizing the two pairs of block quad. The Block circuits shall be worked on the phantom pair or by other suitable means.
- (c) When OFC, Radio or other communication means are used for block working, Universal Fail Safe Block Interface (UFSBI) of approved design shall be used. UFSBI shall be installed in relay room and the connected block panel shall be provided in ASM room. In case the distance between UFSBI and block instrument is more than 500 meters, block filter and block bell and telephone shall be inserted in cable pairs connecting them.

**18.2.3 Others**

- (a) Protective Devices of approved type consisting of two chokes connected in series with a four terminal condenser connected across the junction between two chokes and earth shall be used. A surge arrestor of suitable type shall also be provided across the condenser to absorb surges under faulty conditions. The arrangement is illustrated in [Drg. No. 18-D4](#).
- (b) The Block Bell shall be worked through Block Bell equipment of approved type.
- (c) Separate line battery or DC-DC converter shall be used for each block instrument. This battery shall feed only the block instruments and not any other circuit.

*Note: Two different earths shall be provided separately for SPD and Block. However, the protective earth for SPDs of all Block equipments should be connected to common ring earth of Indoor Signalling system.*

#### 18.2.4 Single Line Token Block Instrument in RE Area

- (a) Where earth return is used, the rest contact of the instrument shall be substituted by the contacts of a slow release relay. The arrangement shall be such that the relay is energized during the operation of plunger but is dropped only after the condenser has discharged to a safe limit. The circuit details are illustrated in [Drg. No. 18-D5](#).
- (b) Whenever stray DC is present in the earth, metallic return is provided for block circuit. Metallic return should be used with a modified filter circuit eliminating the condenser. The chokes and surge arrestors shall be retained and shunt resistors shall be provided across the Galvo (150 ohms) and Polarised Relay (77 ohms). The resistors shall be of substantial rating so that they do not get open circuited. The circuit details are illustrated in [Drg. No. 18-D6](#). In this case, slow to release relay is not required.

#### 18.2.5 Double Line Block Instrument in RE Area

- (a) IRS type Block Instrument with Block filter shall be used for Double Line section electrified with 25 KV AC. The circuit details are illustrated in [Drg. No. 18-D7](#).
- (b) The voltage of the Battery shall be sufficient to ensure not less than 18 ma and not more than 25 mA current through the polarized relay. Needle coil resistance shall be modified to obtain this level of current.

### Section 3: Installation of Block Instruments

#### 18.3.1 General Fixture

- (a) All block instruments shall be of approved type only.
- (b) The Table or other fixture on which instruments are placed must be substantial and the Instruments are securely fixed there on.
- (c) Turn-table arrangement may be provided for fixing the Token and Handle type instruments to enable easier maintenance but the plate on which the instrument turns shall be securely fixed to the table.
- (d) **Block Instruments, Distinction of:** Where two or more block instruments are located in the same room, they shall be fitted with bell units/ bell buzzers of distinctive tones.

*Note: Painting of Block Instruments shall be in accordance with the painting scheme in [Annexure: 18-A1](#).*

### 18.3.2 Transmission Media and Wiring

- (a) **Line Wires:** The line wires from the point where the lines of two adjacent block sections meet to the terminating point on or near the building shall either be insulated or be so erected as to be not less than 150 mm from any other wire. The provision of insulated wires should be preferred. The insulated line wires must be terminated on pot-head insulators. The line wires must not be easily accessible. Alternatively, a cable, suitably protected, may be used, but a separate cable should be provided for each instrument circuit. The insulated line wires must be led in sloping upward to the building, otherwise a drip loop should be provided.
- (b) **Leading in Wires:** The wires leading into the building from the terminating point shall be adequately separated from the wires of other circuits and shall be single, braided or metal sheathed, run in one length from the pot-head insulator to the test panel. Alternatively, a cable, suitably protected, may be used, but a separate cable should be provided for each block instrument circuit.
- (c) **Indoor Wires:** Indoor wires must be run in troughing or other suitable form of trunking which provides protection from interference and separation from the wires of any other circuit.
- (d) **Radio/Optical Fibre Cable:** Where radio channel or optical fibre cable is used in lieu of line wires, approved type block interface shall be provided.

*Note: All wires or cables shall be in accordance with the Indian Railway Standard Specification or other approved specification.*

### 18.3.3 Protective Measures against Power Line Parallelism

- (a) Lightning Dischargers shall not be located in the Block Instrument but installed separately and shall be the demarcating point for test purposes.
- (b) It shall be ensured that induced voltage due to power line parallelism does not exceed 150 V and the short circuit fault current does not exceed 430 V as prescribed by CCITT.
- (c) If the induced voltage goes beyond these limits, overhead block circuit shall be transferred to an underground telecom PET quad cable/OFC/Radio, so as to bring the induced voltage within the permissible limits.
- (d) Since the immunity of PR relay is only up to 10 V, block filters shall be used in all block instruments using this relay where this limit is exceeded.
- (e) Block filters shall be used with Handle type Block instruments using frequency coded signal.
- (f) Use of single line push button token less block instruments is permitted in sections where length of parallelism does not exceed 1.5 km, so as to ensure that the DC coding used in these block instruments is not distorted.

### 18.3.4 Earthing

- (a) A separate earth shall be provided for each instrument. The earth shall be of an approved type and should be buried at a depth of not less than 1.5 meters and at a distance not less than 2.5 meters from any other earth. The resistance of the earth should not be more than 10 ohms.

*Note: Separate earth is applicable for only those equipments which work on earth return. (This does not apply to block instruments which work on metallic return) Also the protective earth for SPDs of block instruments to be connected to common ring earth of Indoor Signalling system.*

- (b) The length of the Earth wire shall be as short as possible and cross section of the wire not smaller than the size of the line wire and in any case shall not be smaller than 4 mm dia. The earth wire shall not have a sharp bend or spiral. Earth wire should be adequately protected from mechanical injury and be efficiently connected to the earth. All connections to the earth shall be well soldered.

### Section 4: Installation of Single Line Token Instruments

- 18.4.1 (a) The Token instruments shall be so installed that the token of one section cannot be placed in any other instrument at that station. It is also desirable that the installation be such that if the token is over carried, it cannot be placed in any instrument at the next station.
- (b) Consecutive block sections shall be provided with tokens of configurations A, B & C. Following block sections shall also be provided with similar configuration in the same order. Where a junction station falls in between or new crossing station is opened, tokens with special configuration (D&E) shall be provided.
- (c) Block Instruments must be mounted level (spirit level may be used) so that tokens will not get into any particular race in case of ball Token instrument and the token will not tilt in case of tablet type Token instrument.

### 18.4.2 Tests to be Conducted After Installation and Before Commissioning

- (a) Check that correct polarities are connected to the instruments at both the ends.
- (b) Check that all mechanical parts are free to move without undue friction and that there is no jamming of moving parts.
- (c) Check that the commutator does not change unless the token gets into the races in the case of Ball Token instruments and slides down the rail beyond the tablet receiver in the case of Tablet Token instrument.
- (d) Check that the insulation of electrical components and internal wiring of the block instrument is proper and free from leakage from the instrument body/earth.

*Note: RDSO Booklet STS/E/BTI/IMI may be referred to for detailed instructions regarding installation & testing.*

## **Section 5: Installation of Single Line Tokenless Block Instrument**

- 18.5.1 (a) The instruments shall be mounted level. The instruments shall be so placed as to have an easy access and space for their maintenance.
- (b) Before installation, the instrument shall be checked for the following:
- (i) Free from mechanical damage, corrosion. All nuts and bolts shall be secure and complete.
  - (ii) The Front Panel shall be free from splitting, twisting or warping in case of Push Button type instruments.
  - (iii) The seal of all the relays and counters shall be intact.
  - (iv) Sealing.
- (c) All the external connections to the block instrument shall be removed and insulation resistance measured between individual insulated circuits and Earth. The minimum value between each individual insulated circuit and Earth shall not be less than 10 mega ohms.
- (d) Block release shall be by operation of two track circuits sequentially.

### **18.5.2 Testing of Single Line Tokenless Block Instruments**

- (a) Check that the Last Stop Signal at the sending station cannot be taken 'OFF' until the receiving station instrument is set to "Train Coming From" condition and the sending station instrument is set to "Train Going To" condition.
- (b) Check that the Line Clear can be granted only when reception signals and the Last Stop Signal are proved at 'ON'.
- (c) Check that the Last Stop Signal is replaced to 'ON' by the entry of a train into the block section and the same is maintained in the 'ON' position until the train has cleared the block section and the instruments are brought back to the 'Line Closed' condition and fresh "Line Clear" is obtained.
- (d) Check that the opposing Last Stop Signals of the block section cannot be taken "OFF" at one and the same time.
- (e) Check that the circuit for proving the arrival of a train is directional.
- (f) Check that the shunting key can be taken out only when the instruments are in "Line Closed" condition or "Train Going To" condition.

## **Section 6: Installation of Double Line Block Instruments**

18.6.1 (a) Quick acting relays shall not be used for stick circuits of the block instrument. Two immunized plug-in type 'Q' series relays connected in tandem or one 'Q' series slow to pick up AC immunized relay shall only be used. The total pick up time of relays used shall not be less than 300 msec. DC 3-position polarized line relay of approved type shall only be used in the line circuit for block working.

(b) Block release shall be by the operation of two track circuits sequentially.

### **18.6.2 Tests to be Conducted at the Time of Installation**

(a) Check that the commutator handle is locked first before the "Train on Line" indication appears on the indicator when the handle is turned from "Line Clear" to "Train on Line" position.

(b) Check that the Block Clearance Relay picks up only after the commutator is turned to "Train on Line" position.

(c) Check that the Last Stop Signal cannot be taken 'OFF' when the commutator is in other than "Line Clear" position.

(d) Check that the Last Stop Signal is automatically replaced to 'ON' when the train enters the block section and continues to remain in the 'ON' position until the train has arrived at the receiving station and a fresh "Line Clear" is obtained.

(e) Check that when the commutator is turned from "Line Closed" position to "Train On Line" position, the commutator is free for return to "Line Closed" position.

## **Section 7: Maintenance of Token Instruments - General**

### **18.7.1 Register of Block Instruments**

The Senior Section Engineer (Signal) shall maintain a register containing the following information:

(a) The type of instrument, its serial number, location, and name of manufacturer.

(b) Date of installation.

(c) Date of last overhaul.

(d) Particulars of all tokens working in each block section and particulars of tokens either removed or lost irrecoverably during the course of working and of those introduced as replacement.

18.7.2 **Census of Tokens:** Each Sectional JE/SSE (Signal) shall take a census of the tokens working in various block sections at least once in six months and shall keep their record in the register of Block Instruments. He should also record this information in the Signal History Book at every station and keep it up to date in this respect.



### 18.7.3 Damaged Tokens

- (a) Tokens, which are cracked or deformed or have worn to a size smaller than the normal size or are damaged in any other way and are liable to jam in an instrument and cause a failure shall be removed, broken up and returned to Stores. Advice of tokens that have been removed shall be given to all concerned.
- (b) Token so removed shall be replaced with another token of the same number and all concerned advised.

### 18.7.4 Lost Tokens

- (a) When a token has been lost and cannot be found after a thorough search, a joint certificate to that effect shall be given to the Senior Divisional/ Divisional Signal and Telecommunication Engineer by the supervisors of the Signal and Telecommunication Department and the Operating Department. On receipt of the certificate, a joint circular shall be issued by the Senior Divisional/ Divisional Signal and Telecommunication Engineer and the Sr.Divisional Operating Manager giving full particulars and cancelling the lost token for the information of the staff. The particulars of the lost token shall be published in the Railway's Gazette.
- (b) Particulars of lost tokens on Card No. S&T/TL, as per [Annexure: 18-A2](#) shall be conspicuously exhibited near the relevant instrument for the information of the Operating Staff.
- (c) If a lost token is not found for six months, it shall be replaced with a token of next higher number in continuation of the series in use on the section. The lost token, if found subsequently, shall be broken and returned to stores.

### 18.7.5 Balancing of Tokens

- (a) Technicians shall, whenever necessary, transfer tokens from the instrument in which they have accumulated to the instrument at the other end of the section. Each Technician in charge of single line token instruments shall be provided with a "Token Balance Book" consisting of Form No. S&T/TB, as per [Annexure: 18-A3](#), serially numbered. Each book before issue shall be endorsed by Senior Section Engineer (Signal) as under: "Page \_\_\_\_\_ to \_\_\_\_\_ checked and found correct".
- (b) Technicians shall fill up portions 'A' and 'B' of Token Balance Book form and take the signatures of – The Station Master of the Station from where tokens have been extracted to verify that token numbers as mentioned were extracted from the instrument with his permission; and the receiving Station Master to verify that token numbers mentioned in the book have been correctly deposited in the relevant instrument.
- (c) An entry in the "Train Signal Register" shall be made to this effect.
- (d) Station Masters shall have instructions to advise the Technician (signal) by wire/control message as soon as the balance of tokens in their token balance register falls to "Six".

- (e) Extracting of/replenishment of tokens in Token instruments shall be done when the instruments are in the "Line Closed" position.
- (f) Token pouches shall be kept in proper repair by the Traffic Department and damaged pouches shall not be allowed to be used.

*Note: Also refer to [para No. 18.9.1](#).*

#### 18.7.6 Responsibility of the Operating Staff

- (a) Staff operating the instruments is responsible for the safe working of the instruments, which is dependent on the correct use of the code of bell signals and the correct operation of the instruments being carried out in proper sequence.
- (b) **Importance of Bell Signals:** The provision of telephones does not do away with the necessity for use of authorised code of bell signals.

### Section 8: Maintenance of Block Instruments & their Ancillary Apparatus - General Instructions

- 18.8.1 (a) Technician shall ensure by a fortnightly check that
- (b) **Locks:** Electrical or Mechanical Locks are in a condition that they are not liable to be forced.
  - (c) **Indicators:** Indicators operate fully and return to the normal position correctly when released.
  - (d) **Contacts:** All contacts are clean and free from pitting, if surfaces are pitted, they shall be cleaned with chamois leather and refurbished.
  - (e) All springs are in good condition and kept properly adjusted.
  - (f) **Relay Armatures:** Relay armatures are free and return to their normal position when no current is flowing.
  - (g) **Track Circuits:** Instructions as laid down in [Chapter 17](#) of SEM shall be adhered to.
  - (h) **External Wiring:** All wiring is in good condition and free from joints. Joints, wherever necessary, are properly soldered and insulated.
  - (i) **Terminal Screws:** All terminal screws, lock nuts and locking screws are kept tight and split pins opened.
  - (j) **Batteries:** All batteries are kept clean, terminals tight and free from dirt or corrosion and maintained in accordance with instructions in [Chapter 16](#) of SEM.
  - (k) **Lightning Protector:** Lightning and power protective devices and earth connections are effective and in good condition.

- (l) **Block Instrument Telephone:** Block instrument telephone, its flexible cord and the condenser or other means provided for isolating the telephone from the Block instrument circuit are in good condition. The isolation is such that there is no direct path for the current to flow from one circuit to the other.
- (m) Receiver diaphragms are not buckled and are at the correct distance from the pole pieces.
- (n) Receiver ear piece fits correctly and is screwed tight.
- (o) When a pair of block instruments of a block section falls in different contiguous Railway/Division, both instruments and their associated equipment shall be maintained by one agency.

**18.8.2 Overhauling of Block Instruments:** Periodical overhauling interval shall not exceed ten years for Single Line Token Block Instruments and seven years for Double Line Block Instruments and Handle type Single Line Token less Block instruments. Push Button Token less Block Instruments, UFSBI Block panel, and Embedded block working in Electronic Interlocking etc. do not require overhauling. The associated polarised relay shall also be overhauled along with the Block instrument.

### **18.8.3 Block Earths**

- (a) Block earths and their connections shall be examined at intervals of not more than one month by the Section Engineer (Signal) and at intervals of three months by the Senior Section Engineer (Signal).
- (b) Block earths shall be tested for resistance at intervals of not more than 12 months by the Section Engineer (Signal) or Senior Section Engineer (Signal) in accordance with [Annexure: 19-A3](#). Where the resistance exceeds 10 ohms, action shall be taken to reduce the resistance by providing additional earths in parallel.
- (c) In AC electrified areas, two different Earths shall be provided for Discharger and Block Earth.
- (d) The four Terminal Condenser used in filter shall be connected in such a way that the DC circuit is completed through the plate or foil of the condensers. It shall be ensured that any break in the foil or Earth connection, which might affect the efficiency of the filter, puts the circuit itself out of use.

## Section 9: Maintenance of Single Line Block - Instructions

### 18.9.1 Single Line Token Instruments

- (a) Care shall be taken to see that the safety catch provided near the spring clutch shaft is in position and functioning properly and free to move about the fulcrum without any friction.
- (b) Token indicator shall be checked to see if it is free to move. The pin shall be oiled once a fortnight with axle oil medium grade to IS: 1628. Effectiveness of 'No token' lock shall be checked. It shall not be possible to take handle to "Train Going To" position when token indicator shows Red.
- (c) Care shall be taken to see that "Train going to" and "Train Coming From" locks rocker arm is free to move about its fulcrum pin. The locks shall be about 1 mm above the rack; if not, the locks shall be changed. The edge of the lock shall be square.
- (d) It shall be ensured that all parts of the instrument, which undergo wear and tear, are replaced at the time of overhauling.
- (e) The locking Pawl shall be checked to ensure that it is correctly shaped, square ended and the width is 9.5 mm.
- (f) Care shall be taken to see that in the case of Tablet instrument, the tablet holding arm release lever is working satisfactorily and the tablet can be released only after full rotation and release of the instrument handle in the Train Going To" position.
- (g) It shall be checked that the notches in the rack are correctly shaped and square.

*Note: (i) RDSO Booklet No. STS/E/BTI/IMI may be referred to for detailed instructions regarding maintenance of Token instruments.*

*(ii) Stipulation as given in section 7 of this chapter may be referred.*

**18.9.2 Single Line Tokenless Instruments – Push Button Type:** The tests enumerated in [para 18.5.2](#) shall be carried out during routine maintenance.

**18.9.3 Double Line Block Instruments – SGE Type:** Locking assembly shall be replaced during each overhauling irrespective of its condition. It shall also be ensured that all parts of the instrument which undergo wear and tear are replaced at the time of overhauling as per approved instructions.

*Note: (1) Tests enumerated for Double Line Block Instruments in [para 18.6.2](#) shall also be carried out during routine inspection.*

*(2) Maintenance Schedule for Block Instruments are given in [Annexure: 18-MS1](#) in Appendix I. At stations having heavy traffic the Railways may prescribe more frequent inspections, if considered necessary.*

## **Section 10: Maintenance of Block Proving by Axle Counter**

### **18.10.1 Block Proving by Axle Counter using UFSBI Block Panel**

- (a) Various parameters of Axle Counter track equipment and UFSBI shall be maintained within permissible values as per the instructions issued from time to time and as per the OEM manuals.
- (b) It shall be ensured that various signal levels at prescribed points of electronic equipment are within permissible limits as per laid down instructions.

## **Section 11: Maintenance of Embedded type Block working**

### **18.11.1 Block working built into Electronic Interlocking**

- (a) Maintenance and parameter of Embedded type Block working shall be maintained as per maintenance schedule of Electronic Interlocking and Video Display Unit (VDU) maintenance schedule issued from OEM maintenance manual.
- (b) It shall also be ensured that all equipment connected with EI related with Block working shall work as per laid down instructions

## **Section 12: Intermediate Block Signalling (IBS)**

### **18.12.1 General Requirements**

- (a) IBS is an arrangement made for increasing the section capacity by splitting of a relatively a long block section into two portions namely rear section and advance section by placement of IBS at the point of near bifurcation, subject to other considerations, such as presence of steeper gradients on approach of the IBS, neutral section, visibility of signals etc. If required, up & down IBS may be staggered to suit the local condition.
- (b) The rear section i.e. "station controlled intermediate block section" starts from LSS of the rear station and ends at IBS including 400 meters block overlap in that direction.
- (c) Advance section i.e. "block controlled Intermediate Block section" starts from IBS and ends at home signal of advance station including block overlap in that direction.
- (d) Track sections both in Rear section i.e. "station controlled intermediate block section" & Advance sections i.e. "block controlled Intermediate Block section" are monitored either by Axle Counter or by Track circuit.
- (e) Train entry into rear section i.e. "station controlled intermediate block section" is controlled by LSS of rear station in that direction.
- (f) Train entry into advance section i.e. "block controlled Intermediate Block section" is controlled by IBS in that direction.

- (g) A Signal Post Telephone (SPT) or any approved type communication shall be provided at the IBS post for communication with the station in the rear.
- (h) IBS system needs distant and inner distant signal where applicable for pre warning of IBS.
- (i) IBS works like Class C station & IB Distant signals are to be provided to match with the section signaling.
- (j) IBS block overlap of 400 m shall be separately monitored.
- (k) Where axle counters are provided, resetting arrangements are also to be provided.
- (l) Provision must be there to indicate that a train has passed IBS at “On” Position/blank.
- (m) IBS system needs panel with various indications and push buttons at each block station pertaining to direction of traffic.
- (n) IB Signal shall be provided with a marker consisting of a white coloured disc with letter 'IB' in black.
- (o) Control of IBS lies with the SM of station in rear.

**18.12.2 Resetting Operations:** There are two types of resetting operations which requires co-operation of the other end Station Master.

- (a) When a train passes IBS at “On” position/blank.
- (b) When Axle Counter fails.

**18.12.3** IBS system will permit only one train in the entire block section, when a train passes IBS at “On” position or axle counter is not clear even after the passage of the train beyond the axle counter section.

Procedure to be followed by the Loco Pilot to pass IBS at “On” position/blank as per GR 3.75:

- (a) When phone communication is available between IBS and rear station, the loco pilot shall stop his train in rear of the IBS and contact the SM of block station in rear on SPT, then pass the defective IBS, if authorized by SM.
- (b) When phone communication is not available between IBS and the rear station, the loco pilot after waiting for 5 minutes can go beyond IBS at a speed not more than 15 kmph which should be reduced to 8 kmph in case of inadequate visibility like fog, night conditions etc. The loco pilot should proceed at restricted speed till he reaches advance station.

Monitoring is required through indication for IBS blank.

#### 18.12.4 IBS in Double Line:

- (a) IBS should be interlocked with any of the approved means of block working for Double line.
- (b) IBS shall not be taken off for Train unless line clear has been obtained from Block Station in advance.
- (c) DLBIs/Block Panel of BPAC etc. pertaining to the monitoring of advance section are placed at the rear and advance stations.


#### 18.12.5 IBS in Single Line:


- (a) Provision shall be there, to establish the direction of traffic for IBS in single line.
- (b) First direction of traffic shall be established and then line clear shall be obtained from the Block station in advance as per the established direction of traffic. Only after establishing the direction of traffic the train movement in the station controlled intermediate block section shall be permitted.
- (c) IBS shall not be taken off unless the line clear has been obtained from Block Station in advance and direction of traffic is established.
- (d) IBS should be interlocked with any of the approved means of block working for Single line.

----- 00000 -----


*General Note: (1) IB Signal shall be located in such a way, to split the block section into near halves subject to other criteria. IB Signal shall not be provided in a Block section with steep falling gradients, unless the brake power is adequate to enable the trains being stopped at IB signal.*

*(2) One of the methods of providing IB signals using OFC (optical fiber cable) and Multi Section Digital Axle Counter (MSDAC) is given at [Annexure: 18-A4](#) as an example for guidance only.*

 Note: This Chapter has under mentioned Annexures		
S.No.	Annexure No.	Description
1	<a href="#">18-A1</a>	Painting Scheme - Block Signalling Equipment
2	<a href="#">18-A2</a>	Tokens Lost/Tablets Lost
3	<a href="#">18-A3</a>	Token Balance Book
4	<a href="#">18-A4</a>	Intermediate Block Signalling (using OFC, MSDAC)

 Note: This chapter has under mentioned Maintenance Schedule in [Appendix-I](#)

S.No.	Annexure No.	Description
1	<a href="#">18-MS1</a>	Maintenance Schedule of Block Instruments (Single Line, Double Line, Push Button)
2	<a href="#">18-MS2</a>	Maintenance Schedule of Block Instrument – Double Line (Lock & Block)
3	<a href="#">18-MS3</a>	Maintenance Schedule of Tokenless Block Instrument - Single Line (Push Button type)
4	<a href="#">18-MS4</a>	Maintenance Schedule of Analog Block Axle Counter Systems (BPAC): CEL MAKE
5	<a href="#">18-MS5</a>	Maintenance Schedule of Tokenless Block Instrument - Single Line (Handle Type)
6	<a href="#">18-MS6</a>	Maintenance Schedule of Universal Fail-Safe Block Interface (UFSBI)

 Note: This chapter has under mentioned Drawings in [Appendix-II](#)

S.No.	Drawing No.	Description
1	<a href="#">18-D1</a>	IB Hut Layout Plan (Double line/Single line)
2	<a href="#">18-D2</a>	IB Signalling with MSDAC & OFC (Double line) - (Sheets-2)
3	<a href="#">18-D3</a>	IB Signalling with MSDAC & OFC (Single line) - (Sheets-2)
4	<a href="#">18-D4</a>	Filter Unit for Block Circuits
5	<a href="#">18-D5</a>	Protective devices for AC Electrified Area of Neale's 'A' Type Token Instrument - Earth Return
6	<a href="#">18-D6</a>	Protective devices for AC Electrified Area of Neale's 'A' Type Token Instrument - Metallic Return
7	<a href="#">18-D7</a>	Double line Block working with Protective Device for AC Electrified Area.



## Painting Scheme – Block Signalling Equipment

### 1. Single Line Ball Token/Tablet Token Block Instruments

- |     |   |     |              |
|-----|---|-----|--------------|
| (a) | Body  | ... | Grey Enamel  |
| (b) | Operating Handle, Bell except<br>Gong, Station Master's Control<br>Lock | ... | Black Enamel |

### 2. Single Line Tokenless Block Instrument

#### (A) Handle Type

#### (B) Push Button Type

- |     |                          |     |              |
|-----|--------------------------|-----|--------------|
| (a) | Body                     | ... | Grey Enamel  |
| (b) | Operating Handle, if any | ... | White        |
| (c) | Base                     | ... | Black Enamel |

### 3. Double Line Block Instruments

- |     |              |     |               |
|-----|--------------|-----|---------------|
| (a) | Wood Work    | ... | Spirit Polish |
| (b) | Metal Casing | ... | Green Enamel  |

### 4. Token Delivery nets

... White

### 5. Line clear pick up apparatus

- |     |          |     |       |
|-----|----------|-----|-------|
| (a) | Post     | ... | White |
| (b) | Fittings | ... | Black |

**Tokens Lost/Tablets Lost**

..... RAILWAY

**SIGNAL & TELECOMMUNICATION DEPARTMENT**

BLOCK SECTION.....

Division .....

Station .....

Type of Block Instrument .....

Serial No.....

Date of Installation .....

Serial No. of Token Lost	Date Lost	Serial No. of New Token used	Date Inserted	Signature and remarks of SSE/JE (Signal)

**Token Balance Book**

..... Railway

**Signal & Telecommunication Dept.**

Division .....

Block Section.....

Name of Maintainer.....

Designation.....

Section .....

Quantity of Token in use on Section .....

Portion A					Portion B				
Tokens taken from ..... (Name of Station)					Tokens taken from ..... (Name of Station)				
Date & Time	Serial Number of each token taken away	Total No. of Tokens taken away	Signature of Maintainer	Signature of Station Master	Date & Time	Total No. of Tokens taken brought	Serial Number of each token brought	Signature of Maintainer	Signature of Station Master
1	2	3	4	5	6	7	8	9	10

### Intermediate Block Signalling (using OFC, MSDAC)

For Intermediate Block Section, the block section is divided into two sections of approximately equal length where two trains can be accommodated simultaneously in each direction of traffic. For Intermediate Block signaling, various schemes are in use in Indian Railways based on different types of vehicle detection devices and mechanism used to drive the remote IB Signals. Presently, the typical IB signaling schemes in existence are

- (i) Conventional IB with copper cable
- (ii) IB with Quad and copper cable
- (iii) IB with EI and OCs
- (iv) IB with UFSBI.

In all these above schemes, Analog axle counters/Single Section Digital Axle Counters/Dc Track Circuits are used for track vacancy detection and to drive the signals at IB, to read the status back and for resetting mechanism, various schemes have been used.

In addition to above, Multi Section Digital Axle Counters (MSDACs), with dual detection in distributed architecture may also be used for track detection as well as exchange of signaling information and resetting.

Reliability of conventional IB signaling may face two problems.

- (i) The SSDACs are provided without duplication, which may lead to intermittent failures, thus making the system less available.
- (ii) Signaling and Power cables provided along the IB block section are terminated in location boxes with at least 2 RE cuts between Station and IB requiring power supplies in them. These location boxes are in inaccessible locations, which are difficult for regular maintenance and also for attending to failures. With a number of location boxes in the circuit, the probability of failure also proportionally increases.

Hence, the scheme with dual MSDAC for detection of track vacancy over OFC and IO-EXBs for exchange of signaling information between two locations, duly minimising signalling & quad cables, with no RE cut sections in between gives reliable working.

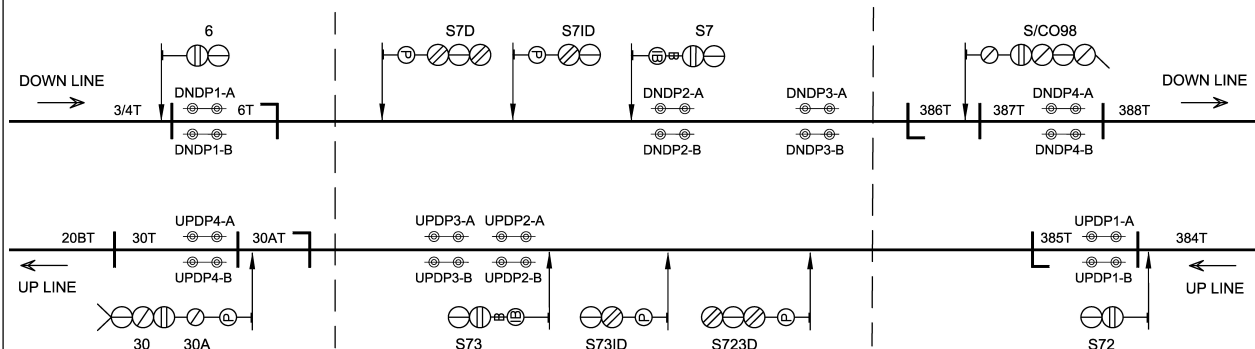
**I. Introduction:** The Intermediate block signalling consists of two major components.

- A) Provision of axle counters for track vacancy detection in rear as well as advance sections
- B) Exchange of signalling and reset information between IB and stations.

In the scheme presented here, dual detection with redundancy at each level including communication media is adopted to achieve higher availability. Track vacancy detection has been achieved through Multi Section digital axle counters and exchange of signalling information is done by using Multiplexing facilities of MSDAC.

## II. Description of the Scheme

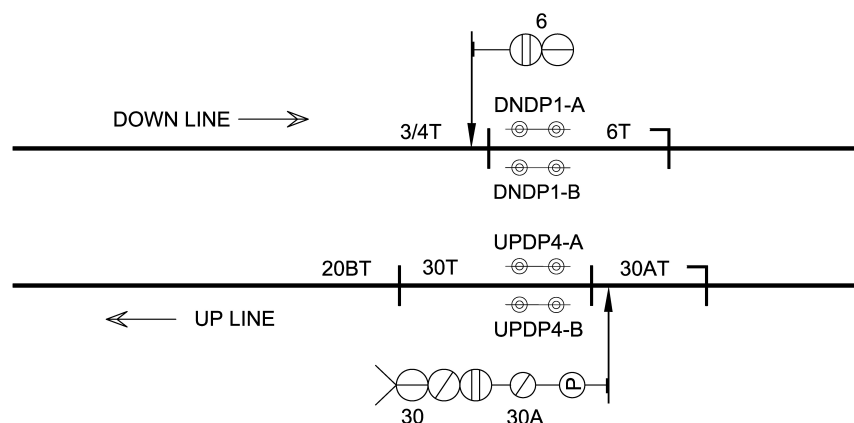
**A. Typical layout of the scheme:** The Intermediate Block Section between Two Stations is referred for easy understanding. The typical layout of the placement of different DPs and Signals is as follows:

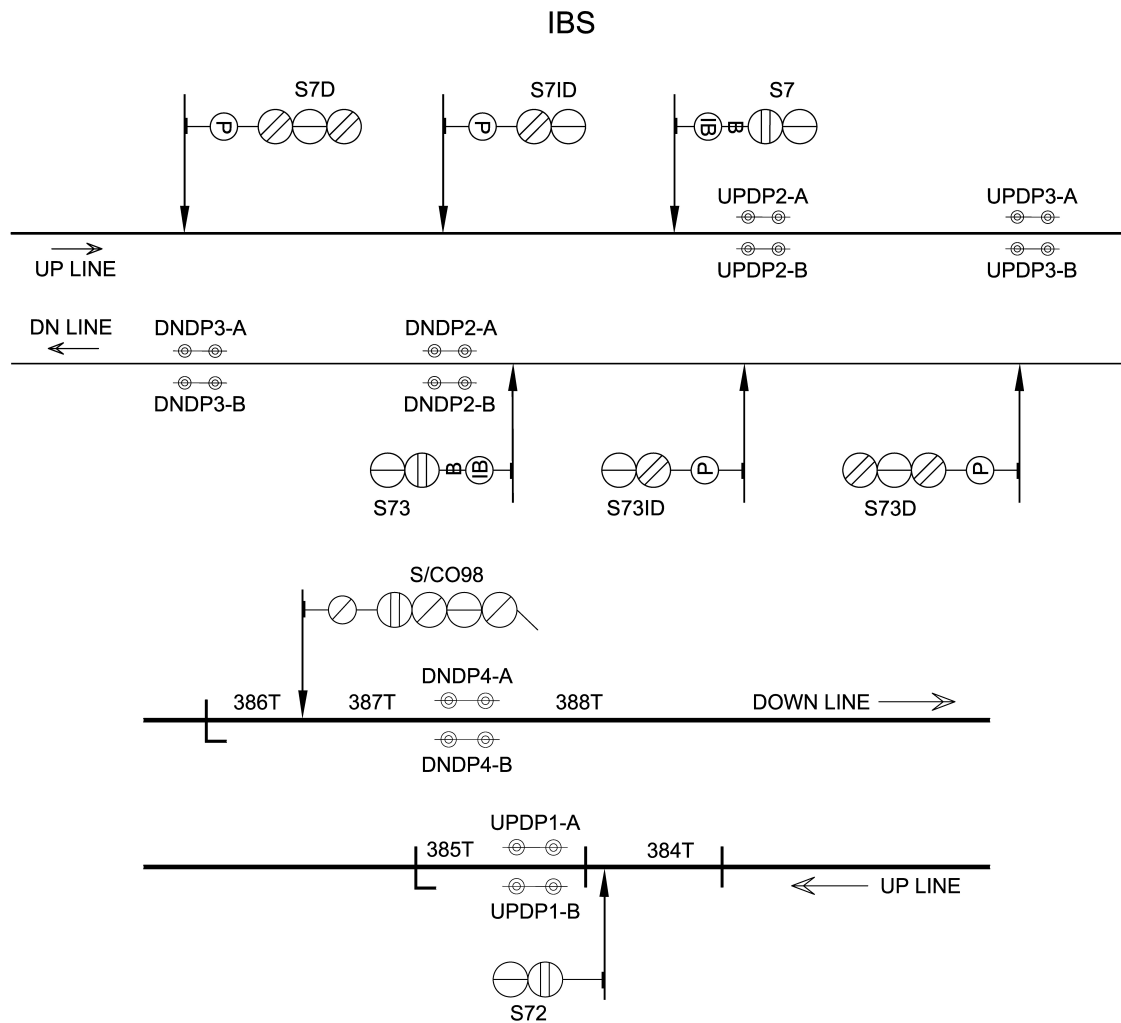


**Fig 1. Typical Layout of IBS**

A Relay hut of size 12 m x 5 m is provided to cater for RBG room at IB location. The IB home Signals are typically planned in such a manner that, the UP and DOWN IB signals are near to Relay hut and as such both signals are driven from the hut including the corresponding distant signals. The nomenclature of DPs in DOWN direction is DN-DP1A, DN-DP1B, DN-DP2A, DN-DP2B, DN-DP3A, DN-DP3B, DN-DP4A, DN-DP4B. Similar nomenclature has been adopted for UP direction also.

**B. Provision of MSDACs for track vacancy detection and defining the boundaries of track section and Supervisory Track Sections:**





DN-MAIN		
FROM	TO	TRACK SECTION
DNDP1-A	DNDP3-A	DN-AC-A
DNDP2-A	DNDP3-A	7 AC-A
DNDP2-A	DNDP4-A	DN-BPAC-A
DNDP1-A	DNDP4-A	DN-SPT-A

DN-REDUNDANT		
FROM	TO	TRACK SECTION
DNDP1-B	DNDP3-B	DN-AC-B
DNDP2-B	DNDP3-B	7 AC-B
DNDP2-B	DNDP4-B	DN-BPAC-B
DNDP1-B	DNDP4-B	DN-SPT-B

**Fig 2. Boundaries of Track Section**

Dual detection has been provided with redundancy for all other equipment as well as communication media. The Typical IB section consists of Three track sections in each direction.

- (i) AS track section, which starts from the foot of LSS and ends at 400 meters ahead of IB home signal (DN-AC)
- (ii) IB track section, from the foot of the IB home signal to 400 meters ahead of the signal (7 AC)
- (iii) BPAC section, from foot of the IB home signal to 180 meters ahead of the home signal of the ahead station for proving block overlap (DN-BPAC). A supervisory track section (DN-SPT) covers all these three track sections, which is used for second level of reset as explained in later sections.

### Dual detection:



**Fig3. Dual Detection**

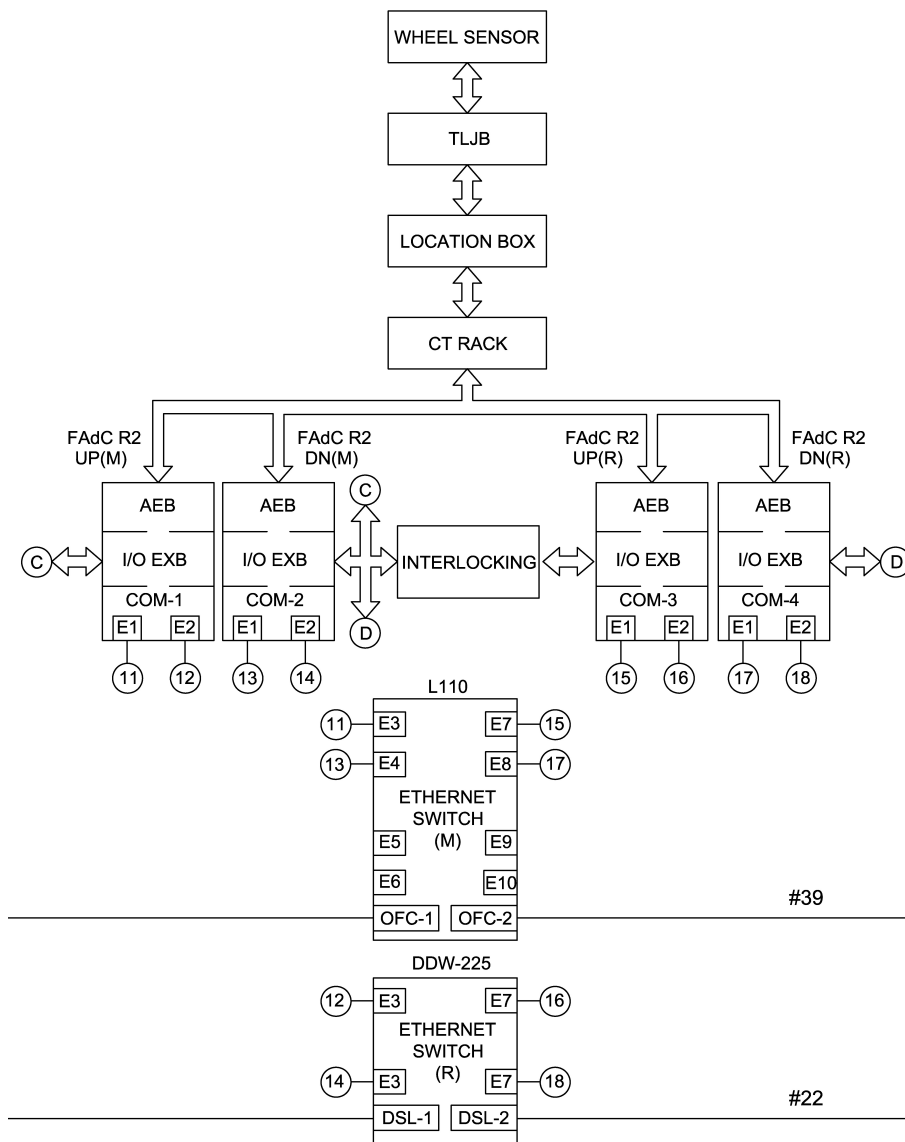
There are few instances where it is observed single detection (whether SSDAC or MSDAC) is prone to failures irrespective of precautions taken.

- (i) Whenever a loaded rake movement is there over the coil portion, due to light weight of the guard brake, there exists a considerable probability of the wheel jumping over the coil causing a miscount and thereby counting mismatch and failure of axle counter.
- (ii) When there is a long haul movement or due to any unavoidable reasons, if the wheel traces a to and fro movement over the portion of coil, the system goes into hang state which requires rebooting of the same. This is prevalently observed not only in SSDAC but also in MSDAC.
- (iii) Unintended count due to food foil: It has been an experience in few cases, where the Aluminum food foil which runs along the track gets struck and attaches to the Rx Coil, which causes unintended out count or in count leading to failure of Axle counter.

In all above cases, if dual detection is provided with staggering of coils, such failures may be avoided through Automatic reset feature.

### Redundancy of other components of MSDAC:

In order to avoid other equipment failures such as Power supply card, communication card, mother board as well as relay driver card and relay failures, all are duplicated including communication media.



**Fig 4. Typical equipment Block diagram**

As shown in Fig.4, the redundancy at equipment level is achieved as follows:

- (i) At wheel sensor level, dual detection is provided with two DP's on either rail in each direction of traffic.
- (ii) Two separate TLJBs are provided with IP65 protection for termination of each DP.

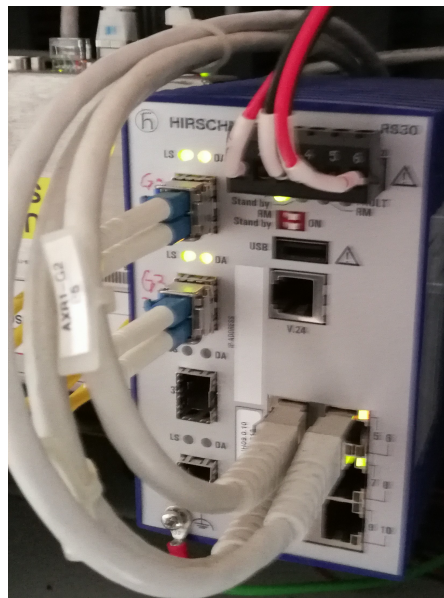


**Fig 5. Termination box for DP**

- (iii) The 6 quad cable from Relay hut to location box is duplicated and provided in two different paths to achieve path redundancy.



- (iv) Each Coil/DP is connected to an Advanced Evaluation Board (AEB) through a surge protection device, for processing of data received from coil.
- (v) Two evaluators (EVs), Main and Redundant (M&R) are provided in IB location as well as adjacent stations. The main DPs of UP and DOWN direction are connected to EV(M) and redundant(R) DPs of UP and DOWN direction are connected to EV(R). The evaluated information is shared to Relay Driver card and COM-AdC. The COM-AdCs at IB as well as adjacent locations are on a common network through ethernet ports and in turn through dedicated OFC, via an unmanaged ethernet switch as shown in Fig.4. The COM-AdCs of both M & R EVs are hot linked and any failure of one of the board does not hamper the track detection.
- (vi) There are two ethernet switches available for shared communication among the MSDACs at all the three locations. One ethernet switch works on dedicated fibres (Tx & Rx). Another ethernet switch works on a pair of quad cable. Alternatively, the second one can also be provided over redundant fibre.



**Fig 6. Ethernet Switch**

- (vii) The Vital Relays (ACPRs) of each track section are picked up at the Entry end of track section (either in IB location or station). The status of vital relays exchanged between two location through IO-EXBs depending on the need.

### **C. Exchange of signaling information between two locations**

The IB signal relay status has to be repeated from rear station to IB location. Similarly the status of IB signal as well as other vital and non vital indications have to be exchanged between IB location and Stations. In order to achieve this, the IO-EXBs are used in either location, with each pair exchanging 3 vital I/Os between them. The vital mode is typically termed as quad mode in which 3 I/Os of vital information can be exchanged, where as the non vital mode is termed as single mode, where 12 I/Os can be exchanged between two locations with a pair of IO-EXBs. The typical Information required to be exchanged between two locations is as follows.

AXR2-C1  
BP-EXB4, EXB3-105  
NW-IBS (DN)

INPUT - QUAD MODE		OUTPUT-QUAD MODE	
INPUT	FUNCTION	OUTPUT	FUNCTION
INPUT 1A	7 DR-B	OUTPUT 1A	7 DECR-B
INPUT 1B		OUTPUT 1B	
INPUT 1C		OUTPUT 1C	
INPUT 1D		OUTPUT 1D	
INPUT 2A	SPARE	OUTPUT 2A	7 RECR-B
INPUT 2B		OUTPUT 2B	
INPUT 2C		OUTPUT 2C	
INPUT 2D		OUTPUT 2D	
INPUT 3A	SPARE	OUTPUT 3A	SPARE
INPUT 3B		OUTPUT 3B	
INPUT 3C		OUTPUT 3C	
INPUT 3D		OUTPUT 3D	

AXR2-C3  
BP-EXB4, EXB2-104  
NW-WADI

INPUT - QUAD MODE		OUTPUT-QUAD MODE	
INPUT	FUNCTION	OUTPUT	FUNCTION
INPUT 1A	UP-CRR-B	OUTPUT 1A	UP-ACPR-INDC-B
INPUT 1B		OUTPUT 1B	
INPUT 1C		OUTPUT 1C	
INPUT 1D		OUTPUT 1D	
INPUT 2A	UP-CO-PR-B	OUTPUT 2A	DN-CRR-B
INPUT 2B		OUTPUT 2B	
INPUT 2C		OUTPUT 2C	
INPUT 2D		OUTPUT 2D	
INPUT 3A	DN-ACPR-INDC-B	OUTPUT 3A	DN-CO-PR-B
INPUT 3B		OUTPUT 3B	
INPUT 3C		OUTPUT 3C	
INPUT 3D		OUTPUT 3D	

AXR2-C1  
BP-EXB4, EXB4-106  
IBS-NW (DN)

INPUT - SINGLE MODE		OUTPUT-SINGLE MODE	
INPUT	FUNCTION	OUTPUT	FUNCTION
INPUT 1A	SPARE	OUTPUT 1A	7D HECR-B
INPUT 1B	SPARE	OUTPUT 1B	7D DECR-B
INPUT 1C	SPARE	OUTPUT 1C	7D HHECR-B
INPUT 1D	SPARE	OUTPUT 1D	7 ID HECR-B
INPUT 2A	SPARE	OUTPUT 2A	7 ID DECR-B
INPUT 2B	SPARE	OUTPUT 2B	SPARE
INPUT 2C	SPARE	OUTPUT 2C	SPARE
INPUT 2D	SPARE	OUTPUT 2D	SPARE
INPUT 3A	SPARE	OUTPUT 3A	SPARE
INPUT 3B	SPARE	OUTPUT 3B	SPARE
INPUT 3C	SPARE	OUTPUT 3C	SPARE
INPUT 3D	SPARE	OUTPUT 3D	SPARE

**Fig 7. Vital and Non-Vital I/O between IB and station**

#### **D. Reset features of MSDAC**

The reset arrangement is given at three levels using Track Sections and Supervisory Track Sections, two of which are automatic reset arrangements and one is manual reset.

(i) L-I : Automatic reset with redundant track section:

Once the train has cleared both the track sections, and any one of the track sections is in failure state, the track section, which is in clear condition will reset the one in failed condition. The track section, which is under reset is kept in preparatory mode and the clear track section information is used to take off the signal.

(ii) L-II : Automatic reset with Supervisory track section:

When a supervisory track section is clear, all the track sections falling completely within the jurisdiction of that supervisory track section can be assumed to be clear. If any track section fails and its corresponding supervisory track section is clear, it will automatically reset the failed track section.

In case of automatic resetting with supervisory track section, the reset track sections will be kept under preparatory mode, and the corresponding signal will continue to be in 'ON' aspect, until a train with low speed enters and exits the track section with equal count at the boundaries of track section.

As shown in Fig.2, DN-SPT is a supervisory track section which covers all the track sections of IB in DOWN direction. If any one of the track sections fail, within the entire IB, DN-SPT resets that track section and keeps in preparatory mode.

(iii) L-III : Manual Reset with Line verification:

In case of failure of Level-1 and Level-2 reset, manual resetting has to be carried out, which resets all the failed track sections in the section under consideration. One reset box at train sending station along with its corresponding Line verification(LV) box at other station is used to manually reset all the track sections between both the stations of a particular direction of movement. This reset can be done only when Station Masters of both the stations have ascertained that all the track sections between the stations are clear of trains in that particular direction. This will reset and set all the failed track sections in preparatory mode. The clearance of train in each section with balancing of count will make the track section clear and bring to its normal mode of working.

#### **E. Power Supply Arrangement**

The IB location is provided with a Mini IPS, for which the input supply of 230 V AC is from UP AT and DN AT. The necessary power supplies for MSDAC are derived from the Mini IPS. MSDAC works on a voltage range of 19-72 V DC. Hence 24 V DC supply with suitable current capacity from Mini IPS serves the purpose. In stations, the necessary power supplies are derived from the Major IPS.

#### **F. Cable requirement**

Signaling Cable: In the stations, Home & Advance starter signals are directly fed from the EI/Relay room with standard signaling cable, with aspect repeating relays at signal locations. IB Signals at IB location are directly fed using a 12x1.5 Sq.mm signaling cable from Relay Hut, without any repeater relay at site, as the distance is not more than 200 meters.

Quad Cable: MSDAC evaluator to each DP requires 1 quad of 4 conductors. A separate 6 quad cable is used for each DP of dual detection (main + Stand-by) from the nearest Half location box provided for Signal cable termination at signal location. From IB Hut to Half location box one 6 quad each is used for UP & DN directions.

The media between Station to IB location is duplicated by providing 6 Quad cable in addition to OFC cable. The OFC as well as Quad ethernet switches work in hot stand-by mode with seamless change over to each other without disturbing the communication working.

***Disclaimer:***

*(1) The scheme given above, was adopted in 2018-19 in Anakapalle - Bayyavaram section in Vijayawada divn/SCRLy, is only for Technical information of signal Engineers and does not indicate endorsement of any particular make of MSDAC.*

*(2) Scheme will have to be suitably modified as per Technical requirements/Facilities in particular make of MSDAC & other equipments being used.*

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*Encl: Drawings are given at [18-D1](#), [18-D2](#), [18-D3](#) in Appendix -II*

## **Chapter 19: Outdoor Signalling - Installation, Testing and Maintenance of Equipment**

### **Section 1: General Instructions on Tools**

- 19.1.1 (a) All staff engaged in the installation and maintenance of signalling equipment shall be in possession of rubber gloves, proper tools pliers, screw drivers, etc.
- (b) While using metal tools like screwdrivers, nose pliers, cutting pliers, etc. near the working equipment, care shall be taken to avoid short circuiting and consequent blowing off of the fuse. Adequate number of insulated tools shall also be maintained.
- (c) A list of specific tools to be maintained, shall be circulated by PCSTE as per specific needs of zonal Railway.
- (d) A rubber floor mat shall be used for attending to circuits carrying more than 110 V.

#### **19.1.2 Soldering Care**

- (a) Staff working in the installation and maintenance of signalling equipment shall be conversant in use of soldering iron/gun for making good soldering joints.
- (b) Care shall be exercised to avoid dropping of particles of solder and clippings of wire on adjacent terminals and apparatus.
- (c) In addition to soldering irons of adequate wattage (65-125 W), for the type of work done, the following shall be at hand:
- (i) A small file for dressing the soldering tip
  - (ii) A fire proof pad for wiping the tip
  - (iii) A mica sheet of adequate size or a suitable stand for soldering iron
- (d) Electrical soldering irons shall be switched off when not in use over extended periods.
- (e) While making a soldering joint, the surface shall be thoroughly cleaned, fluxed and tinned.
- (f) Use of too much solder shall be avoided to prevent lumpy connection.
- (g) Soldering iron shall not be held on the wire connection for too long to avoid damage to insulation.

- (h) Imperfect joints are the result of any one of the following causes, which should be avoided:
  - (i) Soldering iron not sufficiently hot.
  - (ii) Soldering iron held on the connection for insufficient length of time.
  - (iii) Unclean terminal or wire.
  - (iv) A solder of improper composition or inferior fluxing agent.
- (i) A newly soldered connection shall not be disturbed till the solder has thoroughly cooled.
- (j) Railway to conduct the periodical training on proper practices for soldering, in-house or through outside agencies.

### 19.1.3 Wire Termination

- (a) While terminating wires, care shall be taken to bend the wires in clockwise direction.
- (b) Wire strippers shall be used for the purpose of stripping off the wire insulation. Cutting pliers shall not be used for the purpose.
- (c) Washers and check nuts shall be used whilst fastening.
- (d) Not more than two wires shall be terminated on one terminal.
- (e) Multi-strand wires shall be terminated on terminal lugs and covered with insulation sleeves.
- (f) Wires of cable shall be neatly terminated and properly bunched.
- (g) Crimping tools of appropriate design should be used and whenever lugs are crimped, proper soldering should also be ensured.

## Section 2: Installation of Signals

### 19.2.1 Colour Light Signals Installation

- (a) Colour Light Signals shall be multi-unit (approved type) and be provided with LED lamps (approved type).
- (b) **Location of Signal:** The location and spacing of signals shall be in accordance with codal provisions & approved plans. The signal shall be so located to extend a clear view to the Loco pilot of an approaching train and is as close to the track as permissible. The signal shall have a minimum visibility as indicated in [para 7.1.11](#).
  - (i) The height of normal aspect of the Colour Light signal shall be approximately at 3.65 meter from the rail level. Wherever this is not feasible due to local terrain, height of the signal post may be suitably increased or decreased to get a clear view of the signal.

- (ii) Exact location of new signal or shifted signal shall be decided, based on Signal Sighting committee report to be submitted as per [Annexure: 19-A1](#) jointly by SSE(signal), traffic inspector and loco inspector, duly observing Schedule of Dimensions given in [Annexure: 19-A2](#).
- (iii) Signals shall normally be placed on the left hand side of the relevant track. However in exceptional circumstances and due to site constraints, if any signal is to be placed on right hand side, in which case prior approval of competent authority, shall be obtained and such right hand signal shall be provided with an arrow mark (on rectangular plate with white back ground) pointing towards the track to which that signal pertains, to avoid any misjudgment by loco-pilot.
- (iv) A new signal, which is yet to be operational, shall be turned away from Track, must not be lit and shall be provided with a X across it.
- (v) The visibility of existing signals shall be checked jointly by SSE (Signal), traffic inspector and loco inspector and submit Signal Visibility Certification as per [Annexure: 3-A1](#) and a time bound action shall be taken to improve the visibility, as per recommendation of the committee.
- (vi) A Signal post, which is having implantation less than schedule of dimensions, shall have infringing distance marked in red colour on white back ground.

#### 19.2.2 Mounting and Fixtures

- (a) Colour Light Signals may be mounted on a rigid ground post or a signal gantry. Route Indicators/Calling ON unit/Shunt signal unit to be provided as required.
- (b) Each signal unit shall be rigidly fixed in position. Markers to be provided to identify type of signal such as 'G', 'P', 'A', 'AG', 'D', 'ID', 'IB'.
- (c) Signal posts shall be kept plumb and packed with suitable material.
- (d) Suitable packing may be used to close the excess gap from post to signal unit, surface base to post. The cable entry at the signal unit should be provided with wooden plug around the cable to close excess gap to prevent rodent entry.
- (e) Enameled/Retro-reflective Signal number plate shall be provided. It should be white back ground (for other than Gate stop signals) with black letters, as shown in [Drg. No. 19-D10](#) (sheet 3). For Gate stop signals, the back ground shall be yellow colour.
- (f) **Alignment:** Each signal unit shall be aligned correctly for better visibility.
- (g) The signal ladder shall be firmly fixed with clamps and the bottom of ladder ie the ladder shoe, shall be concreted firmly. The ladder alignment shall meet the requirements of schedule of dimensions. Where infringing, the signal ladder shall be blanked off (refer chapter no 1 item no 8 note (c) of schedule of dimensions), by providing a metal sheet around the signal post including ladder.

- (h) The cable entries of the signal unit should be closed properly using cement to avoid rodent entry.
- (i) Signal numbering plate (as per Signalling plan) to be provided with black letters on white back ground.

#### 19.2.3 Hoods and Back Screens

Hoods of adequate size to counter act the effects of sunrays shall be provided. Where required, metallic mesh at suitable spacing shall be provided to protect lenses from outside interference.

#### 19.2.4 Cable Entry

Cables shall be used from the point of operation to the location box/signal unit and/or location box to the signal unit. Cable shall be protected suitably at the entry points of location box and signal post.

- 19.2.5 LED aspect unit consists of a cluster of LEDs in series and parallel combinations. LEDs in a signal aspect shall be arranged in more than one array, so that in the event of failure of a single LED, whole unit does not become blank. LEDs in the arrays shall be so inter leaved so that effect of failure of any array is spread out equally to maintain uniform visibility. Integrated (with built-in current regulators) LED signal aspects for regulating the current shall be used. Red/yellow/green LED aspects shall be used for Main /Subsidiary signals, and lunar white LEDs shall be used for route indicator.

- 19.2.6 Same make of LED aspects shall be used at a station/section for ease of maintenance.

- 19.2.7 **Gaskets and Sealing:** All openings shall be gasketted and cable/wire entrance shall be sealed to make the enclosure water tight, dust-proof and vermin-proof.

- 19.2.8 **Locking:** The housing shall be kept locked.

### Section 3: Installation of IRS Point Machines

- 19.3.1 **Requirements:** Electric Point Machines of approved type shall be used.

- (a) Electric Point Machines shall be installed in accordance with approved plans. Ground fittings of approved design shall be used. Ground connections shall be thoroughly checked for any crack or improper welded joint. Normally the machine shall be installed beside the close switch leading to high-speed movements clear of all infringements. Before installation of the machine, it shall be ensured that.
- (b) The JE/SSE (P.Way) has made all the provisions at the Points as detailed in [para 12.13.2 to 12.13.4 & Annexure: 12-A1 of Chapter 12 of SEM](#).
- (c) The machine has been properly cleaned and lubricated in accordance with the manufacturer's instructions and is working freely.
- (d) Proper alignment and level of connections is maintained between the machine and the point gears.



- (e) The top of sleepers which are to support the point machine are at level and that surrounding ballast is well tamped to prevent sinking during the passage of train.
- (f) The machine shall be so installed that it is clear of all infringements.
- (g) Proper drainage shall be provided to avoid water logging near point area.
- (h) Wiring from the point of operation to the location box/apparatus case nearest to the machine shall be in cable. The cable shall be of appropriate size to keep the voltage drop minimum. The connection between location box/apparatus case and point machine shall be through underground cable adequately protected below track and near point machine, through GI/RCC/DWC-HDPE pipe of approved type or any other approved means. It shall be tested for insulation and continuity before bringing into operation.
- (i) Crossovers shall be operated by separate point machines, one at each end. The detection of setting and locking of the points at the two ends of a crossover shall be connected in series.
- (j) Means shall be provided to cut off the motor feed in case of obstruction to the point movement after a predetermined time lag, based on the type of point machine used. The point operating control circuits shall have track circuit control, overload protection and cross protection.
- (k) The crank handles shall be provided to facilitate operation of points in case of failure of point machines. For this purpose, the points in the yard may be divided into convenient groups and to distinguish particular groups, crank handles with different wards shall be used. The slots provided, in the point machines for insertion of the crank handles shall be suitably modified to take only the crank handle applicable to the group. The crank handles shall, however, normally be locked. It shall be possible to release them for use in point machine by releasing a control from the control panel. With the crank handle released, it shall not be possible to clear the signal for the concerned routes. The interlocking of crank handle can also be achieved by using NX key of different wards.
- (l) The excess gap around cable entry to the machine shall be plugged to avoid rodent entry/water ingress.

### 19.3.2 Point Machine, Notches, Gaskets, Sealing

- (a) Electric Point Machine shall be provided with suitable gaskets and wire entrances shall be sealed to make them water tight and dust proof. All the extra openings shall be closed as far as possible.
- (b) **Locking:** Electric Point Machine covers shall be locked. The cover provided for insertion of crank handle shall also be locked with separate key providing access only for crank handle and crank handle key.
- (c) **Notches in Stretcher Blades:** Notches/Notch profile of the locking, driving and detection slides should not be tampered/reconditioned. Worn-out slides should be replaced with new ones.

## Initial Adjustment of Point Machine

### 19.3.3 Adjustment of Driving Rod

The points shall be adjusted by operating the machine first by hand cranking. The insertion of hand crank should disconnect the power supply to the machine. When the machine has been fastened down, the throw bar connections shall be set up and the point machine hand cranked to one end of the stroke positioning the locking blades so as to allow the appropriate locking dog to pass through notches. The closed switch shall be adjusted to just in contact with the stock rail. Then the connections shall be tightened further by 2 mm to 3.5 mm to impart a springing action to the tongue rail. The machine should be hand cranked to the opposite end of the stroke and the setting repeated for the other switch.

*Note: it is recommended that adjustment for driving rod and lock rod shall be done for the close switch nearest to the point machine first.*

### 19.3.4 Adjustment of Detector Contacts

The machine shall be hand cranked to the end of the stroke to close the tongue rail. Insert 1.6 mm test piece between stock rail and switch rail at 150 mm from toe of the switch and operate the point. Ensure detector contacts just make. A test gauge of 3.25 mm shall be inserted between the switch rail and stock rail at a distance of 150 mm from the toe of the switch. The detector connection of the closed switch shall be adjusted till the appropriate detector contacts are just broken. The same shall be repeated at the other end of the stroke. All the relevant nuts shall be tightened.

*Note: Where lock slide is provided in the machine, during switch detector adjustment the test shall first be done with fictitious locking. After completing the above test, same test be repeated with machine properly locked.*

### 19.3.5 Adjustment of Friction Clutch

- (a) When IRS rotary type electric point machine under obstruction test draws less than 1.75 times the normal operating current, machine needs to be checked for proper functioning at site.
- (b) **Obstruction Test:** The point driving rod and the lock connections of the machine must be so adjusted that with 5 mm thick test piece obstruction placed between the switch and the stock rail at 150 mm from the toe of the switch:
  - (i) The point cannot be locked.
  - (ii) The point detector contacts should not assume the position indicating point closure and
  - (iii) Friction clutch should slip.

### 19.3.6 Testing of Point Machine

- (a) **Obstruction Test:** The point driving rod and the lock connections of the machine must be so adjusted that with 5 mm thick test piece obstruction placed between the switch and the stock rail at 150 mm from the toe of the switch:
- (i) The point cannot be locked
  - (ii) The point detector contacts should not assume the position indicating point closure
  - (iii) Friction clutch should slip

- (b) The Technician shall check whether the current required to operate the machine in either direction is the same (approximately). The reason for unbalance, if any, shall be investigated and eliminated.

*Note: In general, excessive current indicates the friction due to rubbing of rods with rods/sleepers, poor packing, lifting of tongue, improper lubrication, dirt/dust accumulation etc. causing extra load on the machine. The cause to be identified and rectified duly advising Traffic/P.way departments.*

- (c) Test the spring in each switch and ensure sufficient spring. It shall not be too excessive to cause excessive wear on machine part, neither it shall too less to hold the switch against the stock rail. In either of the case, the point drive rod shall be adjusted.
- (d) Friction clutch where provided shall slip at a value prescribed by the Manufacturer.
- (e) Badly worn-out pins shall be replaced; the holes shall be reamed out and fitted with a oversized pin. Split pins where provided shall be properly split out.
- (f) Voltage and current shall be checked periodically at the motor terminals, as per [Annexure: 19-MS2](#). This will indicate any undue friction on the points or improperly fastened terminals at cable terminations.
- (g) Cable and wire insulation and continuity tests shall be done.
- (h) The essential requirement for interlocking of point shall be periodically checked.
- (i) It shall be ensured that during obstruction in the point, the feed to point is automatically disconnected or friction clutch is tripped on overload described by manufacturer and reconnects only when a fresh operation is done. Where sequential operation of point machine is done, the maximum time before disconnection may not exceed to 3.5 times the normal operating time of one machine.
- (j) Each sectional JE/SSE (Signal) shall test the operating values of the machine and adjustments of the machine by obstruction test every month. The Sectional incharge of the section shall carry out these tests once in three months.

## Section 4: Thick Web Switches (TWS)

- 19.4.1 Conventional over-riding type of switches suffer from geometrical deficiencies like:
- (a) Weakness of tongue rail due to severe reduction of section by heavy machining. Tongue rails are further weakened by heavy wear and tear by traffic. So these are to be replaced frequently.
  - (b) Obstruction to the wheel flange at the actual toe of the switch due to thickness of the tongue rail as well as due to switch entry angle. Hence a jerk is experienced by vehicles on account of these obstructions.
  - (c) Twist in the track over a short distance on tongue rails machined from rail of same cross section, due to overriding nature of the tongue rail.
  - (d) Structural weakness of the entire switch assembly to withstand lateral forces at higher speeds.
- 19.4.2 Thick Web Switches (TWS) overcome deficiencies of conventional over-riding type of switches. These are non-over riding type:
- (a) Thick web switch has wider switch opening of 160 mm (as against of 115 mm of conventional over riding type of switches).
  - (b) Ground connection along with clamp lock used for operation of TWS and direct locking of tongue rail with stock rail shall be of approved type.
  - (c) For operation and clamp locking of TWS, electric point machine of approved type with requisite throw shall be used.
- 19.4.3 For ground connection and clamp lock as per RDSO Drg. No. RDSO/S-3454 for 60 Kg rail and RDSO/S-3455 for 52 Kg rail, IRS point machine of 220 mm throw is used.
- (a) Out of 220 mm throw, during first 60 mm throw closed switch rail gets unlocked and open switch rail moves towards stock rail. During subsequent 100 mm throw both switch rails move simultaneously thereby open switch gets closed and closed switch gets opened by 100 mm. During final 60 mm throw, closed switch gets locked and open switch rail moves 60 mm further resulting in total opening of open switch by 160 mm.
  - (b) Provides direct locking between tongue rail and stock rail in closed and open position.
  - (c) No stretcher bar is used and both the tongue rails move independent of each other.

#### 19.4.4 **Spring Setting Device (SSD)**

SSD of approved type shall be provided at junction of Rail head (JOH) to assist in proper setting of switch up to junction of Rail head (JOH).

(a) SSD is placed between sleeper number 13 and 14.

(b) SSD is insulated from both the rails.

(c) SSD installation and maintenance is responsibility of Engineering Department.

19.4.5 Ground connection and clamp lock for Thick web switches shall be installed as per concerned RDSO drawings/approved drawings and installation guidelines.

#### 19.4.6 **Obstruction Test**

The detector slides, lock slides and drive rod must be so adjusted with 5 mm thick test piece placed between the switch and gauge face of stock rail at 150 mm from the toe of the point. The following to be observed:

(a) Friction clutch de-clutches the motor from mechanism.

(b) The point cannot get locked either by clamp lock or by locking segment inside the point machine.

(c) Lock segment does not enter into the notches of locking slides.

(d) Switch detection contacts do not make.

(e) The slipping current is not exceeding twice of the normal working current.

#### 19.4.7 **Insulation Test**

(a) Point machine: Check that point machine is insulated from ground connection.

(b) Spring setting device: Insulated from both the rails.

(c) Clamp lock assembly: Check that it is insulated from both the rails.

## Section 5: Installation of Electrical Point Detector (EPD)

- 19.5.1 Electrical point detector of approved type shall be used. Normally it shall be installed beside the close switch leading to high-speed movement, clear of all infringements as per approved plan and drawing.
- (a) Detectors shall be mounted either on the left or on the right-hand side of a point layout clear of infringements.
  - (b) The detectors shall be mounted on extended sleepers or as per any other approved arrangement.
  - (c) Contacts shall be adjusted so that they make or break at the same time. Shunt contacts shall be adjusted so that they do not make before the detector contacts break. In AC traction area shunt contact shall not be used. Care shall be exercised to check that the detection contacts flex a little after they are closed.
  - (d) All nuts and screws shall be tightened. Check nuts with spring washer shall be provided.
  - (e) After installation before connecting the detector slide, the slides shall be pulled by hand to check for free movement. Binding, if any shall be attended to.
  - (f) The lock slide shall be pulled and it shall be checked that as soon as the roller is lifted above the slot in the lock slide, the normal or reverse contacts are open and the shunt contacts are made. The electrical detector must be so adjusted that with 3.25 mm thick test piece obstruction placed between the switch and the stock rail at 150 mm from toe of the switch - The electrical detector contacts shall not make.
  - (g) To keep the slides in correct position the locating marks on the switch and lock slides shall be made use of.
- 19.5.2 **Circuit Controller:** These shall not be newly installed normally (except in few Installations like LC Gates) and the existing one to be replaced in phased manner. Railways still having these equipments may please refer the earlier version of SEM Part-II, September 2001.

## Section 6: Signalling Relays

For information on Signalling Relays, Refer to [Annexure: 21-A1](#).

- 19.6.1 Relays – General Requirements: Refer to [para 21.2.1](#)
- 19.6.2 Installation of Relays: Refer to [para: 21.2.2](#)
- 19.6.3 Sealing of Plug-in Relays: Refer to [para 21.2.3](#)
- 19.6.4 Maintenance of Relays: Refer to [para 21.2.4](#)
- 19.6.5 Periodical Inspection of Relays: Refer to [para 21.2.5](#)
- 19.6.6 Replacement of Relays: Refer to [para 21.2.6](#)

## Section 7: Fuses

- 19.7.1 (a) Fuses shall be of approved type and appropriate rating. When fuse is not provided with fuse blown off indication, additional indication circuit may be provided.
- (b) At the time of commissioning of any signalling installation, the normal load current of every circuit shall be measured and recorded. These recorded values shall be checked with the theoretically obtained values. Fuse of correct capacity which should be not less than 2.5 times the rated current, shall be provided.
- (c) When there is a case of fuse blowing off, the concerned circuit current shall be measured and compared with the original recorded value. If there is a variation, action shall be taken to locate and remove the defect before a new fuse is inserted.
- (d) For LED signal aspects, fuse of prescribed rating (0.6 Ampere if not prescribed otherwise) shall be used.

### 19.7.2 Fuse change over system:

Fuse Auto Changeover System with monitoring panel and alarm facility along with audio & visual indications suitable for signaling installations of Railways may be used for minimising failures due to fuse blown off. The changing over of circuit operation from main fuse to spare fuse shall be automatic, without affecting the functioning of signaling circuits, when main fuse is blown off. At every change-over, audio/visual indication shall appear and Equipment shall work either on 24 V DC, 60 V DC or 110 V AC, Reverse polarity protection and overload protection voltage may also be provided in the power supply circuit. The system shall be of approved type. These shall be maintained as per [Annexure: 19-MS5](#).

*Note: Electrical signalling equipment shall be painted in accordance with the approved Colour Scheme*

## Section 8: Testing of Signalling Circuits

- 19.8.1 General The checking and testing of signalling installations may be divided into five different groups as detailed below:
- (a) Physical inspection of the installation.
  - (b) Checking of the wiring and cables.
  - (c) Testing of the individual circuits.
  - (d) Testing of the individual apparatus.
  - (e) System testing of the installation.

### **19.8.2 Test Procedure**

- (a) Systematic methods such as marking on Control Tables/Locking/selection tables and suitably and clearly marking on the circuit diagrams while checking the circuits and equipment should be adopted to ensure that all circuits have been completely checked.
- (b) Suitable proforma should be devised for recording the tests of electrical equipment before testing of the installation is taken up to ensure availability of records of the tests and their analysis.

### **19.8.3 Testing Instruments**

Suitable instruments like Multi-meter, Volt meter, Ammeter, Ohmmeter, Frequency meter, Bell tester, Earth Tester, Earth leakage detector, Cable fault locator, Cable route tracer, Relay contact testing/cleaning kit, etc. should be used in the testing of electrical signalling circuits. Calibration of these instruments should be checked periodically.

### **19.8.4 Physical Inspection of the Installation**

It shall be checked that the work has been carried out in accordance with the approved plans and that equipment is of proper type and is in good condition.

The following aspects shall also be checked during site inspections:

- (a) The signals, location boxes and other out-door equipment are as per approved plans and are in good condition. Arrangements for proper ventilation, where provided, are not choked.
- (b) Each location contains all the apparatus required as per approved plans, the apparatus is of approved type and that the power supply equipment, batteries, fuses, etc. are installed according to the approved plan and specification.
- (c) The location of insulation joint, jumper wiring, traction bonding in electrified areas, point machines, switch locks and other apparatus is as per approved plans and their condition is satisfactory.
- (d) The electrolyte, inter-connections between cells, cell voltage etc. are in required condition as per relevant specifications or instructions.
- (e) Each wire is tagged or marked where feasible so that it can be identified at each end and the nomenclature on the tag corresponds to that on the wiring diagram. The tags or other sleeves of identification shall be of insulating material.
- (f) The number of wires terminated on each terminal or relay terminal boards or other devices are counted and tallied with the number of wires shown in the wiring diagrams.
- (g) All connections on terminals and binding posts are properly secured.
- (h) The lightning arrestors are properly connected and earthed as per plan.



- (i) Detailed specifications & instructions for inspection and testing of different types of equipment as applicable to them should be available.
- (j) All other equipment such as lever frames, LC gates, cable sheaths, signal screens, location huts, etc. in AC. electrified areas shall also be properly earthed as stipulated in [Chapter 22 of SEM](#).
- (k) No equipment is due for overhauling.

#### 19.8.5 **Checking of the Wiring:**

- (a) **Point to point testing:** Wiring shall be checked to ensure that it has been carried out as per approved wiring diagram. Point to point testing shall be carried out before plugging in the relays. Wires shall be tested one by one for continuity and insulation. While doing continuity testing, wire count test shall also be done to verify the number of wires present on each contact.
- (b) **Wire Count Test:** Prior to conducting continuity and insulation test, contact occupancy test must be carried out for each relay as per the contact analysis made. The number of contacts allotted and wires at each contact must tally.

***Recommended practice:** while dealing with wiring alterations, it is recommended to adopt a clear system for deletions, additions such as colour code. For example, Green colour for deletions and red colour for additions. Similarly a system of checking of such deletions/additions by a tick and second level checking by cross tick on drawing sheets/separate wiring sheets or any other suitable protocol may be adopted duly explaining to staff concerned, to give clarity and avoid rework.*

#### 19.8.6 **Test of Individual Circuits**

- (a) It shall be checked that each individual circuit is actually controlled by the proper contacts of the relays and other devices as per wiring diagram.
- (b) Where feed to a particular device is controlled through two or more paths in parallel, the check of each path must be carried out separately.
- (c) Cases of intermittent or continuous extraneous feed of even small magnitude or wrong operation of any relay observed shall be investigated thoroughly and remedial action taken to rectify the fault.
- (d) Once the indoor wiring works are completed before conducting the system Integrity testing, simulation test must be conducted by simulating field gears such as Track circuits, Signals & Points on a simulation panel. This will ensure the correctness of indoor wiring before connecting to outdoor gears.

### 19.8.7 Installation, Testing of other equipments & Cables

Installation & Testing shall be done in accordance with specification & instructions applicable to each individual equipment:

- (a) **Train Detection:** Track circuits, AFTC, Axle Counters as per [Chapter 17 of SEM](#).
- (b) **LC Gates** as per [Chapter 14 of SEM](#).
- (c) **Cables:** All signalling cables shall be laid, Tested as per [Chapter 15](#) of SEM.

*Note: At least two cores of cable shall be provided between two ends of the yard to cater for telephone communication for maintenance purposes in non RE areas. Where the yard is extending over a large area, the location boxes may be grouped and one socket may be provided in one of the location boxes in the group so that telephone communication is conveniently available for co-ordination with the cabin during maintenance or rectification of failures of various ground equipments. Where such groups are situated in different directions from the cabin, a separate pair of conductors shall be used for each direction connected to the cabin. In RE area, provision shall be made for telephone communication through a telecommunication cable if already available or a separate telecom cable shall be laid for the purpose.*

- (d) **Power Supply Arrangements:** Power supply systems for Signalling Installations shall be as per Chapter 16.

### 19.8.8 System integrity Testing (SIT): This is a complete testing involving both Indoor & Outdoor signalling equipment for functional working & safety. To be done in a new installation, at every interlocking alteration or periodically once in five years.

- (a) After the individual tests mentioned in previous paras for outdoor equipments and Testing of Relay Interlocking/Electronic Interlocking as given in [Chapter 21 of SEM](#) have been carried out, the signalling installation as a whole must be tested with detailed operational, functional and safety tests as per approved Control Table/Route Chart and Signalling & Interlocking Plan.
- (b) These tests shall be planned carefully with men, material, Tools, public address system, Walkie-Talkie Sets, Transport vehicles & other logistics. In a working installation, Non-interlocking/Disconnection duration shall be reasonable and commensurate with yard complexity and to be decided in consultation with Operating department and planned much in advance. All required sanctions/approvals shall be ensured before hand.
- (c) Requisite number of staff considered essential for carrying out such tests shall be mobilized at site, briefed suitably as per planning made and working protocols explained and deputed to concerned locations with relevant wiring diagrams & Tools. They should be equipped with requisite tools, meters, portable telephones and/or walkie talkie sets, so that they are in contact with the official incharge of testing and other testing parties and take such action as directed.

- (d) Complete System Integrity testing shall be initiated only after all the field functions are connected to the Relay Interlocking/Electronic Interlocking (during Non-interlocking/Disconnection period in a working installation) and simulation testing is completed and all errors removed.
- (e) Complete tests shall be carried out against approved Selection Table/Control Table/Route Control Chart. Checks against signalling plans for main signal routes and a few spot checks of the remaining routes shall also be carried out.
- (f) **Field Correspondence Tests:** Full correspondence of field gears such as aspects of Signals, Condition of Points, Status of Track circuits, LC gates etc. with that of Control Panel/Control Terminal/VDU with respective position of knobs, switches, and indications, must be verified and corrected to obtain 1:1 correspondence, before signing safety certificate (and ending Non-interlocking/disconnection in a working installation) and allowing any signalling installation being opened to Train traffic.

19.8.9 Following simple two line station example is given for an understanding on how to conduct system integrity tests:

**(a) Signal Control Circuits**

Each route shall be set individually by operating control lever or switch(es) and/or button (s) as the case may be. After checking that the signal for this particular route has been cleared, each track circuit controlling the signal shall be shunted individually to check that the signal goes back to danger. Similar tests shall again be made by de-energizing point detection relays and other relays controlling this route. Each such relay will be de-energized individually and it shall be checked, that the signal goes back to danger.

**(b) Approach Locking**

Each route shall be set up individually. After ensuring that the signal for this particular route has been cleared, each track circuit controlling the approach locking shall be de-energised in turn. The signal shall be put back to 'ON'. Efforts shall be made to alter the route under test and to set up conflicting route. It shall be checked that it is not possible to cancel the route set up and/or to set up a conflicting route and/or to individually operate any point in the route under test. This locking shall be effective till the set route is cancelled and the time release circuit has operated, provided the track beyond the signal is not occupied.

**(c) Dead Approach Locking**

Where dead approach locking is provided, the same test procedure as in [para 19.8.9 \(b\)](#) shall be adopted except that there is no controlling track circuit to be de-energised. After the signal has been taken 'OFF', the approach locking shall be effective till the signal is put back to 'ON' and time release circuit has operated.

#### **(d) Route Release**

- (i) Tests shall be carried out to ensure that once a signal is cleared for a particular route, position of none of the points in the route can be changed when track circuit immediately in advance of the signal is de-energised.
- (ii) Where sectional route release is provided, it shall be ensured that a sub route does not release only by picking up of the concerned track relay (s) but the same should be released only after the next track circuit has also dropped and picked up except for the berthing portion of track circuits.
- (iii) Where sectional route release is not provided, tests shall be made to ensure that the entire route remains locked when any of the track circuits beyond the signal up to the track circuit controlling the last point is de-energised.
- (iv) In cases where the route is controlled by single track circuit, the route shall be released after prescribed time delay to be effective after the concerned track circuit has been occupied and cleared by the train.

#### **(e) Time Release**

Time release, where provided, shall be tested to ensure that it will be possible to alter the route or set up a conflicting route or change the position of the points in the route only after the signal is put back to 'ON' and the prescribed time interval has lapsed. Similar tests shall be carried out for overlap release, where time release is provided for releasing the overlap after clearance of last track circuit in rear of berthing track and occupation of the berthing track, if any. Also overlap shall get released only after concerned signal knob/button is normalized wherever required.

#### **(f) Signal Indication Circuits**

Indication of 'ON' position of all signals shall be checked for its correspondence with aspect displayed at site. Each signal shall then be cleared after setting its route and the indication of each aspect shall be checked for its correspondence with the aspect displayed at the site. This test shall be carried out for each signal as well as for direction type route indicator where provided. In the case of later, it shall also be ensured that the indication relay is not energised and the indication does not appear until the minimum number of lamps/LEDs as required are actually lit.

#### **(g) Point Controlling Circuits**

- (i) Each point shall be set to reverse position by operating the controlling lever/switch/buttons. After the point has been fully reversed, each track circuit controlling the point shall be individually shunted in turn and operation of points to normal position shall be attempted. It shall not be possible to operate the point under these conditions. These tests shall be repeated with the point set in normal position, attempt being made to operate it to the reverse position.
- (ii) With the obstruction in the points, the point shall be operated from normal to reverse and reverse to normal and it shall be checked that the over-load relay where provided gets energised and the feed to the motor is cut off immediately. Where over load relay is not provided, the feed to the motor shall be cut off after the lapse of a prescribed time.
- (iii) The out of correspondence test shall be carried out by opening cut out contact of one end of point machine and the point lever/knob/button operated. The other end of the point may operate but the point indication relay shall not energise.

#### **(h) Point Indication Circuit**

- (i) The point shall be operated from normal to reverse and reverse to normal and the position of point detection relay as well as the indication of the point in the cabin/panel shall be checked for correspondence with the position of the points at site. It shall also be checked that with the obstruction in the point, the detection relay is de-energised and both normal and reverse point indication in the cabin/panel are extinguished in case of electromechanical signal and flash in case of PI/RRI installations.
- (ii) The operation of the detection relay to the correct position as well as its de-energisation should be checked by making and breaking the relevant point detector contacts at site.

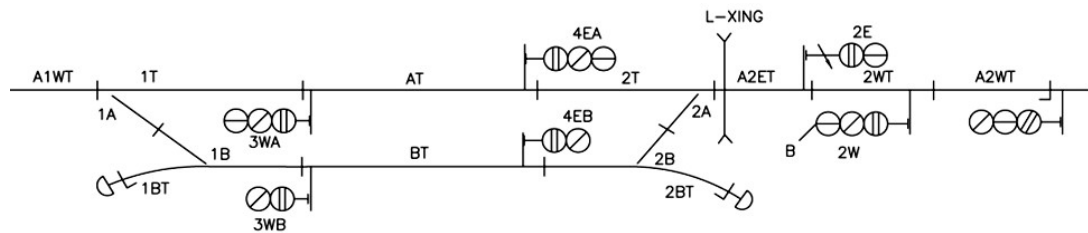
#### **(i) Crank Handle Interlocking**

It shall be checked that when the crank handle is removed from its normal position in Electric Key Transmitter/other approved Relay interlocking arrangement, the signals reading over the concerned route/zone cannot be taken 'OFF' nor the points can be operated from the cabin/panel. It shall also be checked that when the signal reading over the concerned route/zone is taken 'OFF', the crank handle cannot be released from its normal position in Electric Key Transmitter/other approved Relay interlocking arrangement.

### 19.8.10 Testing Procedure for Panel Interlocking/Route Relay Interlocking Installations

It shall be ensured that the interlocking system as per approved plans and drawings. Typical testing procedure for a Relay interlocking installations is given below with an example for a two line station for an understanding. (The actual testing at site shall be as per station layout)

### 19.8.11 Testing of Relay Interlocking



Sl. No.	SIGNAL NO.	ROUTE	ROUTE HELD BY		CONTROLLED BY TRACKS	LOCK & DETECTS POINTS		LOCKS ROUTE POINTS	REMARKS
1.	2W	2WBI	APPROACH TRACKS A2WT (120 Sec time delay)	BACK LOCK TRACK 2WT A2ET 2T 2BT	2WT, A2ET 2T, 2BT, BT IBT	NORMAL 1	REVERSE 2	4EB 2E	Controlled by closed position of LC gate
2.	2W	2WBII	A2WT (120 Sec time delay)	2WT A2ET 2T 2BT	2WT, A2ET 2T, 2BT, BT IBT, IT A1 WT	-	1,2	4EB 2E 3WB	Controlled by closed position of LC gate

(a) Point Locking Operate point No. 2 to reverse position and clear the signal route No. 2WBI by operating signal switch/button. Operate point knob 2 to normal. The point should remain locked. Restore the point knob to reverse. De-energise 2RWKR. Signal 2WBI shall go to 'ON'. Restore the signal switch/button to normal. When point No. 2 is free, shunt the track 2T. Turn the point knob 2 from reverse to normal. The point should remain locked.

#### (b) Approach Locking:

Take 'OFF' signal for route No. 2WBI by setting the points in required position. Normalize the signal switch/button with A2WT clear. The signal assumes 'ON' position. Try to alter the route, it should be free.

Again take 'OFF' signal for route No. 2WBI. Shunt the approach Track A2WT. Normalize the signal switch/button. Try to alter the route. Route should be held till the route is cancelled and 120 seconds time delay has lapsed.

**(c) Interlocking of Signals:**

Clear the signal route 2WBI after setting the route. Try to clear the signal 4EB by operating the relevant switch/button. Signal 4EB should remain in 'ON' position and signal 2W should continue to display 'OFF' aspect. Similar tests shall be carried out for signal 2E also.

**(d) Track Circuit Controls:**

- (i) Clear the signal route 2WBI again. Shunt the track 2WT. Signal should go to 'ON'. Remove the shunt, the signal should not re-clear. Normalize route and re-clear again. Shunt A2ET and other controlling track circuits one by one. Signal should go to 'ON' in all cases. Remove the shunt. Normalize the route.
- (ii) Where track circuits provided with redundancy, its proper working shall be thoroughly tested for redundancy and effectiveness in the signalling circuits. Detailed instruction and precaution for testing and fault rectification shall be issued by Zonal Railway.

**(e) Back Locking:**

- (i) Clear the signal 2W for route 2WBI again. Shunt the track 2WT. The signal should go to 'ON'. Normalize the signal switch. The route should be held. Shunt and clear all the back locking tracks as per selection table in sequence. The route shall be released by sequential proving of tracks as per the provisions of para 4.3.3 of Relay interlocking specification IRS: S 36-87.
- (ii) Clear the signal route 2WBI again and de-energize the Level Crossing Gate control relay. The signal should go to 'ON'. Re-energize the relay, the signal should assume 'OFF' aspect.

**(f) Conditional Locking:**

Wherever conditional locking is provided (for alternate overlap/parallel movements etc. for yard flexibility), the points setting and its route holding, correct proving in the signal circuits shall be thoroughly checked.

**(g) Datalogger Circuits:**

The data loggers connected to various power supplies, relays of internal/external circuits, block instruments, battery chargers and other applications like open/close status of relay room, battery charger/IPS/Invertors monitoring etc. shall be regularly checked/tested. Also ensure the nominated JE/SSEs/staff are receiving the various exception reports generated from the data logger to aid their day to day works/ maintenance/fault restorations in coordination with Fault control JE/SSEs/staff incharge of Datalogger monitoring.

**(h) Miscellaneous Circuits:**

- (i) Miscellaneous arrangements like effectiveness of Station Master's key, cascading of signals on the route, Red lamp protection on the route etc. shall be thoroughly tested for the independent signal/routes.
- (ii) The protection arrangements like Lightning arrestors, Surge protection devices and its associated Fuse/Earthing arrangements shall be regularly tested and Maintained.
- (iii) The relay contacts shall be paralleled, if spare contacts are available.

**19.8.12 Precautions during Testing**

Following precautions shall be taken during testing and checking so that

- (a) No signal taken 'OFF' for a train movement is thrown to 'ON' in the face of the train.
- (b) No signal which will create a conflicting or unsafe movement is taken 'OFF'.
- (c) No point and isolation in a route set for a train movement is disturbed.
- (d) No track relay of an occupied track circuit is energised.
- (e) No voltage higher than permissible levels is applied to the equipment.
- (f) There should be no risk of electric shock to testing or operating personnel.

**Section 9: Maintenance of Outdoor Signalling**

19.9.1 Insulation tests on Cables shall done as per [Chapter 15 of SEM](#).

**19.9.2 Maintenance of Colour Light Signals**

**(a) Cleanliness of LED Lenses**

- (i) Polycarbonate Lenses of LED lamp shall be kept clean. A dry soft cloth free from lint and abrasives shall be used for cleaning.
- (ii) Housing shall be kept clean and opening in inclement or stormy weather avoided. The condition of the gasket shall be checked to ensure that rain water does not have access to the interior of lamp unit.

**(b) Replacement**

- (i) Defective LED lamps must be replaced immediately.
- (ii) The LED lamps shall be replaced as per prescribed codal life.
- (c) New lamp shall be pre-tested as per approved instructions before putting into use.



(d) The following checks shall be made periodically.

(i) The LED lamps bulb shall be seated fixed and fastened properly.

(ii) The signal visibility shall be checked and adjusted periodically.

(iii) All adjusting nuts are properly tightened. Maintenance checks to be done as per [Annexure: 19-MS1](#).

#### 19.9.3 **Maintenance of Electric Point Machine**

(a) **Cleanliness:** Machines shall be kept in good condition free from rust, dust and dirt.

(b) **Lubrication:** All gearing and bearing shall be properly lubricated according to manufacturer's instructions.

#### (c) **Commutator, Brushes & Electrical Connections**

(i) Commutator shall be kept clean, smooth and have bright appearance. Commutator may be cleaned with chamois leather. Under no circumstances, shall emery paper be used.

(ii) Brushes shall be kept clean and properly bedded on the commutator. Brushes shall have proper pressure and shall be free in brush holders.

(iii) All cables connections on terminal, motor terminal etc. shall be checked for intactness.

(iv) All tail cables shall be checked for their insulation as per periodicity given in [Annexure: 15-MS1](#).

(d) **Adjustment of Contacts:** Contacts shall be clean, free from pitting and in proper adjustment.

(e) Rain water drainage arrangements shall be checked especially prior to and during rainy season.

#### (f) **Fixing Nuts & Screws**

(i) Fixing nuts and screws of newly installed point machine often tend to get loose. Care shall be taken to attend to them and readjust where required. To prevent this, check nut with spring washer shall be provided.

(ii) All moving parts including locking Dogs and notches slides, etc. shall be checked for chamfering or undue wear. Where badly worn-out, the relevant parts shall be promptly replaced.

19.9.4 **Testing of Point Machine:** Each sectional JE/SSE (signal) shall test the point machine and do adjustments of the machine by conducting obstruction test as per [para: 19.3.6 & Annexure 19-MS2](#).

#### 19.9.5 **Maintenance of Electrical Point Detector (EPD)**

Maintenance schedule as shown in [Annexure: 19-MS3](#) shall be followed.

#### 19.9.6 **Maintenance of Circuit Controller**

Railways having these equipments may refer to earlier version of SEM Part-II, September 2001. These shall not be used in new installations and the existing one to be replaced in phased manner, except in few cases like LC gates.

#### 19.9.7 **Maintenance of Station Master's Slide Control Frames**

Railways still having these equipments may refer to previous version of SEM Part-II, September 2001. These shall not be used in new installations and the existing one to be replaced in phased manner.

#### 19.9.8 **Maintenance of Electric Key Transmitters, Fuse & Fuse Alarm Systems**

Maintenance schedules as shown in [Annexure: 19-MS4](#) shall be followed for Electric Key Transmitters.

Maintenance schedules as shown in [Annexure: 19-MS5](#) shall be followed for Fuse & Fuse Alarm Systems.

#### 19.9.9 **Maintenance of Thick Web Switch Point Machine:** Maintenance instructions issued by RDSO and Zonal Railways shall be followed.

#### 19.9.10 **Maintenance Schedules**

The maintenance schedule for various Signalling equipment are given in [Appendix-I](#). At stations having dense traffic and high speeds, Zonal Railways may prescribe more intensive schedules as considered necessary.

### **Section 10: Lightning & Surge Protection for Outdoor Equipment**

#### 19.10.1 **Lightning and Surge protection shall be provided for Axle Counter Systems, IPS and Electronic Interlocking, IB huts/Goomties etc.**

#### 19.10.2 **Installations to be Protected:**

- (a) Equi-potential bonding to be provided for all the equipment for effective lightning and surge protection in Signal Equipment Rooms, such as End goomties/cabins.
- (b) External Lightning Protection and Class/Type I, II & III devices are to be provided at
  - (i) External Lightning Protection on Top of Buildings housing S&T Equipment.
  - (ii) Class B/Type-I devices at the Input of Power Supply Equipment.
  - (iii) Class C/Type-II devices at Output of Power Supply Equipment.
  - (iv) Class D/Type-III devices at Indoor and Field Equipment.

## Section 11: Earthing for Outdoor Signalling Equipment

### 19.11.1 Types of Earths

(a) Earths are of two types

- (i) **Functional Earth:** The earth return used for block instruments is a functional earth which is used to conduct the current through earth during normal operation/function of equipment.
- (ii) **Protective Earth:** This earth for dissipating surges, which comes in contact with equipment's connections through Surge Protection Devices (SPD) during Lightning or surges so as to protect the equipment.

(b) Perimeter Ring Earth (PRE) shall be provided around building housing signalling equipment. Chasis of all S&T equipment shall be bonded to BRC (Bonding Ring Conductor) provided inside the Power Equipment Room or Signal Equipment Room. BRC is to be connected to MEEB in Power room and from there to PRE as per extant guidelines. In case, no BRC exists, chassis of the equipment shall be connected directly to MEEB (Main Equipotential Earth Busbar).

(c) Earthing shall be provided as per approved specifications, drawings and code of practice issued by RDSO.

(d) The maximum earth resistance shall be specified as per OEM & RDSO recommendations.

### 19.11.2 Purpose of Earthing

Earthing of cables, equipment, buildings and structures is done for one or more of the following purposes:

(a) Lightning & surge protection of equipment.

(b) Earthing of metal screens of telecommunications cables and equipment for reducing Electromagnetic interference.

(c) Human safety.

### 19.11.3 Earthing to be provided at

(a) The lever frame and other metallic frames of the cabin shall be earthed.

(b) The earthing shall be provided at every location box where cables terminate.

(c) The earthing shall be provided at each signal.

(d) Wherever possible, the common earthing system to be provided for closely located location boxes, signal posts, etc. Separate earth is required for equipment requiring functional earth only.

- (e) Sheath & Armour of Main cables to be earthed. Armour of OFC shall be earthed at both ends. It is not necessary to earth the armouring of unscreened cables when they are used as a tail cables except in special cases where the length of the tail cable exceeds normal prescribed limits.
- (f) In case of signals falling within 2 meters from the electrified track, the protection screen shall be connected to an earth.
- (g) There shall not be any possibility of simultaneous human contact with metallic bodies connected to different earths, where it is not possible to provide suitable spacing or partition between various metallic objects referred to above, they shall be connected to a common earth.
- (h) Common/Equi-potential earth for modern electronic equipment such as EI, DAC, Datalogger etc. to be used in Relay room. Earth value shall not be more than one ohm and shall be measured annually during dry season.
- (i) Earthing wires from subsystems to earth terminal shall be of distinctive color. Green or Green Yellow (GNYE) color is recommended for quick identification of a loose or disconnected earth wire.
- (j) All earth wires shall be as straight as possible and shall never be coiled. Earth wires should be of adequate current carrying capacity and should not be less than 4 Square mm copper cross-section or its equivalent.
- (k) Earth resistance up to 10 ohm is normally permissible for protective earth except when specified otherwise. For electronic equipment, Earth resistance shall not be more than one ohm.
- (l) Earthing of approved type shall be provided for each block instruments and other signalling equipment at a station. Dedicated earthing arrangement to be provided for earth return circuits individually if any.
- (m) The resistance of earth for signalling circuits shall not exceed 10 ohm or as prescribed by OEM/RDSO. If the resistance is more than the required value, steps to reduce the earth resistance shall be taken. If it is still not possible to reduce the value below the required value, even with the adoption of these methods, additional earths may be provided in parallel.
- (n) Where more than one earth electrode is used, the distance between two earthing electrodes shall be as per approved design.

#### **19.11.4 Earthing Leads**

- (a) Earth wires shall be protected against mechanical damage and possibility of corrosion particularly at the point of connection of earth electrode.
- (b) The earthing lead shall be mild steel flat of size 40 mm x 6 mm or as per the approved earthing practice/drawing.
- (c) The earthing lead shall be soldered or crimped on a lug, which shall be bolted to the earth electrode or preferably exothermically welded. The nut & bolt to be painted with anti corrosive paint.

### 19.11.5 Selecting Site for Earthing

- (a) The site for earthing shall be chosen in the following order of preference:
  - (i) Wet marshy ground and grounds containing refuse, such as ashes, cinders and brine waste.
  - (ii) Clay soil or loam mixed with small quantities of sand.
  - (iii) Clay and loam mixed with varying proportions of sand, gravel and stone; and
  - (iv) Damp and wet sand and peat.
- (b) A site which is naturally well drained shall be chosen. A water logged situation, however, is not essential unless the soil be sand or gravel. Perennial wells may also be used as sites for earth electrodes with advantage where the bottom of the earth is rocky.
- (c) Electrodes shall preferably be situated in a soil which has a fine texture and which is packed by watering and ramming as tightly as possible. Where practicable, the soil shall be sifted and all lumps broken up and stones removed in the immediate vicinity of the electrodes.
- (d) Where soil conductivity is poor, the chemical treatment may be resorted to improve the same. Common salt together with charcoal in alternate layers is generally used for this purpose and the addition of less than one part by weight of salt to 200 parts of soil mass may reduce the resistivity by 80% but there is little advantage in increasing the salt content above 3%. Calcium chloride and sodium carbonate are also beneficial.
- (e) Use should be made where possible of natural salts in soil produced by bacteriological action on decaying plants. The resistivity of the soil on which plants are growing will be less than that of a similar soil in the absence of plants.
- (f) As far as possible, the earthing arrangement shall be located in the natural soil. The made-up soil which has not consolidated or is likely to be eroded by weather, shall be avoided.
- (g) The minimum clearance of equipment earths from system earths (e.g. earthing of AT/Transformer etc.) provided by the Electrical Department either of the Railways or of the other Administrations shall be 20 meter.
- (h) Asphalt or concrete cover of about 50 mm thickness around the Earth for a radius of 1 meter to retain the soil moisture is desirable.

### 19.11.6 Earth Resistance

Earth Resistance of an 'earth' is the sum of three separate resistances, viz.,

- (a) the resistance of the conductor joining the earth electrode to the installation.
- (b) The contact resistance between the surface of the earth electrode and the soil, and the resistance of the body of soil surrounding the earth electrodes.
- (c) Normally the first two resistances are negligibly small compared with the third; so, the resistance of an 'earth' is primarily determined by the nature of the soil and not by the electrode itself.
- (d) The material used for a standard electrode system should be corrosion resistant. Under ordinary soil conditions, use of galvanized iron or mild steel electrode is recommended. In cases where soil corrosion is likely to be excessive, it is preferable to use either copper or copper clad electrode. The electrodes shall be free from paint, enamel or grease.
- (e) Earth tester normally used for measurement of earth resistivity comprises of the current source and meters in a single instrument and directly read the resistance value.

### 19.11.7 Connection for Four Terminal Megger

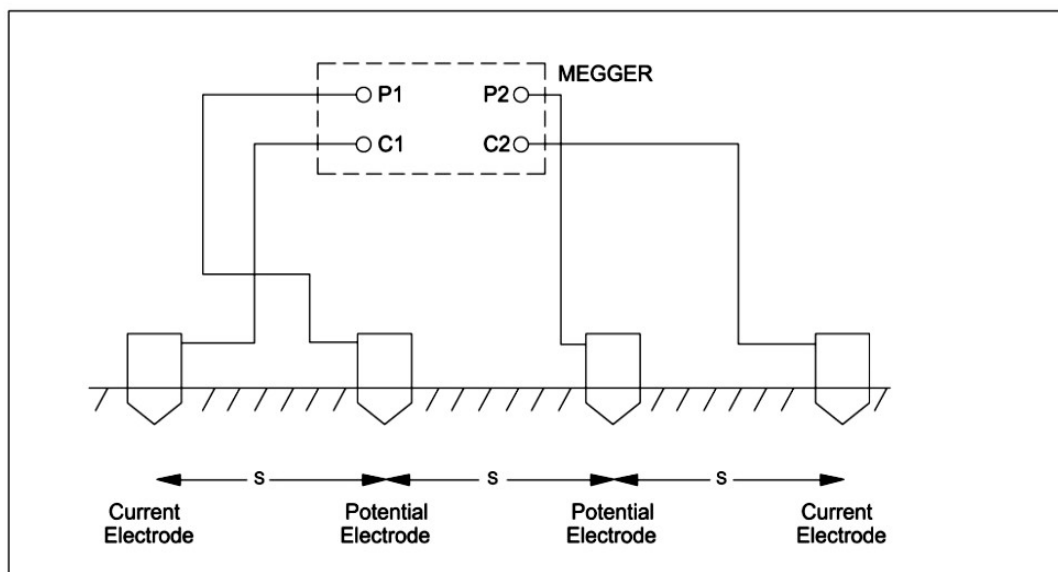
When using a megger as shown below, the resistivity may be evaluated from equation

$$P = 2\pi SR$$

Where,  $P$  = resistivity of soil in ohm meters,

$S$  = distance between successive electrodes in meters,

$R$  = megger readings in ohms.



- (a) Test Procedure: At the selected test site, four electrodes are driven into the earth along a straight line in a chosen direction at equal intervals 'S'.
- (b) The depth of the electrodes in the ground shall be of the order of 10 to 15 cm. The megger is placed on a steady and approximately level base, the link between terminals P1 and C1 opened and the four electrodes connected to the instrument terminals as shown in the fig. An approximate range on the instrument is then selected to obtain clear readings, avoiding the two ends of the scale, as far as possible. The readings are taken while turning the crank at about 135 rev/min (in case of Magneto Generator Type) or pressing concerned button in some Other Type of Meggers. PI see equipment Manufacturers manual and follow as stated there in.
- (c) Resistivity is calculated by substituting the values of 'R' in the equation  $P = 2\pi SR$ .
- (d) The earth resistance shall be measured using suitable method. For measurement of small earthing system like that of single electrode or ring earth, 'Fall of Potential' method can be used.

The typical diagram and measurement method is given in [Annexure: 19-A3](#).

#### 19.11.8 Maintenance of outdoor earths

##### (a) Watering:

Conventional Earths shall be regularly watered. Earth enhancement material should be periodically added to Maintenance free earth to improve the earth resistance. Earth pit to be regularly cleaned.

##### (b) Earth Connections:

All Earth connections shall be carefully examined and kept intact and joints soldered. The wire between each earth and the connected equipment shall be electrically isolated. The exothermic welding termination on maintenance free earth rod shall be checked and cleaned.

#### 19.11.9 Regular Checks/Upkeep of Earths

- (a) Block earths and their connections shall be examined at intervals of not more than one month by JE (Signals) and not more than three months by Sectional SSE(Signal)/Incharge.
- (b) Block earths shall be tested for resistance at intervals of not more than 12 months by Sectional JE/SSE (Signal). Where the resistance exceeds 10 ohms, action shall be taken to reduce the resistance by providing additional earths in parallel.
- (c) If routine testing indicates that existing earth electrode system is not satisfactory, a new earth electrode system (or part of a system to supplement the existing system) shall be provided.



Note: This Chapter has under mentioned Annexures

S.No.	Annexure No.	Description
1	<a href="#">19-A1</a>	Signal Sighting Committee Report - For Shifting of Existing Signals/ Erection of New Signals
2	<a href="#">19-A2</a>	Extract of Schedule of Dimensions (SOD)
3	<a href="#">19-A3</a>	Method for Finding Out the Resistance of an Earth



Note: This Chapter has under mentioned Maintenance Schedules in [Appendix-I](#)

S.No.	Annexure No.	Description
1	<a href="#">19-MS1</a>	Maintenance Schedule of Colour Light Signal
2	<a href="#">19-MS2</a>	Maintenance Schedule of Electrically Operated Points (Inclusive of Clamp type Point)
3	<a href="#">19-MS3</a>	Maintenance Schedule of Electrical Point Detector (EPD)
4	<a href="#">19-MS4</a>	Maintenance Schedule of Key Locked Checking Relay/Electric Key Transmitter (KLCR/EKT)
5	<a href="#">19-MS5</a>	Maintenance Schedule of Fuses & Fuse Alarm System
6	<a href="#">19-MS6</a>	Maintenance Schedule of Earthing and Lightning Protection



Note: This chapter has under mentioned Drawings in [Appendix-II](#)

S.No.	Drawing No.	Description
1	<a href="#">19-D1</a>	Apparatus Case Full Size Foundation
2	<a href="#">19-D2</a>	Apparatus Case Half/Quarter Size Foundation
3	<a href="#">19-D3</a>	Main Signal Post Foundation (Sheets-2)
4	<a href="#">19-D4</a>	Shunt Signal Foundation
5	<a href="#">19-D5</a>	Drawing of Earthing for S&T Installation
6	<a href="#">19-D6</a>	Earthing Arrangements for Signals, Location Boxes
7	<a href="#">19-D7</a>	Copper Plate Earthing Arrangement
8	<a href="#">19-D8</a>	Full Location Wiring Format
9	<a href="#">19-D9</a>	Half Location Wiring Format
10	<a href="#">19-D10</a>	Signal Markers & Number Plates (10 Sheets)



## Signal Sighting Committee Report - For Shifting of Existing Signals/Erection of New Signals

.....RAILWAY

### SIGNAL & TELECOMMUNICATION DEPARTMENT

Name of the station:....., Division....., Name of Work....., Signalling Plan Number:

We, the undersigned members of the Signal Sighting Committee are aware of codal provisions on locating signals, read the guidelines in page 2 and conducted site survey on Dt ..... and propose location of signals as given below as per our best judgment, the same are marked on enclosed drawing/Sketch.

Signal no & Description	Distance from a Fixed structure (mark on drawing/Sketch)	Is the proposed stop signal is on a risky location*	Obstruction by Tree Branches	Interference from Fixed Lights (if any)	Height of the normal aspect of the Proposed Signal above rail level	Implantation of the proposed Signal from the adjacent Left side track	implantation of proposed Signal from the adjacent Right side track	If infringing with SOD, is the distance marked in Red Paint	Is proposed signal is on LH side/RH side	If on RH side, Reason for the same	If on RH side, is Arrow provided (Yes/No)	Screen/Mesh /Caution Board provided if within 2 m of Live Conductor	Visibility of the proposed Signal from loco pilot's point of view	Is Visibility Adequate	Action proposed to be taken to improve visibility (if any)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(12)	(13)	(14)	(15)

Note: (i) Minimum visibility in MACLS territory: Distant signal: 400 meters, Stop signal: 200 meters.

(ii) Placing a signal on RH side requires approval of competent authority.

(iii) \*Risky location is a location, where Train will stop on steep gradients/Girder Bridge/viaduct/Culvert/Cutting/Obstruction to Road/Theft prone area/ vicinity of chemical factories etc.

Signature .....	Signature .....	Signature .....
Name & Designation .....	Name & Designation .....	Name & Designation .....
Date .....	Date .....	Date .....

**Drawing/Sketch showing proposed location of signals shall be enclosed duly signed by Committee members**

S. No	Guidelines for Signal Sighting - For shifting of existing Signals/erection of new Signals
1	<b>Factors to be considered for Locating a signal</b>
	(a) Please refer to <a href="#">Para no: 7.1.13, 7.1.14</a> of SEM for placement of Signals.
	(b) A Stop signal shall be avoided (as far as possible) in risky location, where Train will stop on steep gradients/Girder Bridge/viaduct/Culvert/Cutting/Obstruction to Road/Theft prone area/vicinity of chemical factories.
	(c) Minimum visibility in MACLS territory: Distant signal: 400 meters, Stop signal: 200 meters. Please refer to <a href="#">Para no: 7.1.11</a> .
	(d) Height of normal aspect of the Colour Light signal shall be approximately at 3.65 meter.
	(e) No external light shall dominate a signal aspect. If it cannot be resolved, proper screen shall be provided behind the signal unit to improve contrast.
	(f) Intermediate block signal shall be located, so as to split block section into near halves. It shall not be provided in a Block section with heavy and continuous falling gradients steeper than 1 in 80 unless the brake power of trains on the section is adequate to enable the trains being stopped at IB Signal.
	(g) Automatic signal shall be located normally with a spacing of one km from each other subject to other considerations and headway required. It shall not be provided in a Block section with heavy and continuous falling gradients steeper than 1 in 80 unless the brake power of trains on the section is adequate to enable the trains being stopped at each of the Automatic Stop Signals.
	(h) Any signal, if proposed on Right Hand side, requires prior approval of Competent authority. Right Hand signal shall be provided with a retro reflective type of arrow to indicate the line to which it pertains to.
	<p><i>Note: (i) Till a signal is brought in to use, signal unit shall be turned away from direction of Traffic. No testing of signal aspects shall be done in the face of an approaching train, by turning signal towards direction of Traffic.</i></p> <p><i>(ii) when a signal is not in use, it shall be distinguished by two crossed bars (X) across it, each bar being not less than one metre long and 10 cm wide. (GR 3.18)</i></p> <p><i>(iii) Signals not in use shall not be lit. (GR3.18 (3))</i></p>
	(i) When signals are going to be in close proximity, they may be combined as per Para 7.1.16.
	<p><i>(i) Under approved special instructions, a colour light Distant signal may be combined with the last Stop signal of a station in rear or with an Intermediate Block signal or with a Stop signal protecting a level crossing. (Ref: GR: 3.07(7) , G.S.R. 157(E).-Dated-05-3-21)</i></p> <p><i>(ii) Where proposed IB signal location and a mid section Gate are in proximity, IB signal shall be so located, to protect LC gate also.</i></p>

2	<b>Schedule of dimension (SOD) - Considerations</b>
	(a) Minimum horizontal distance from centre of the track (Implantation) to any structure as per schedule of dimension. Please refer <a href="#">Annexure: 19-A2</a> of SEM
	(b) Each signal post shall be marked with it's Centre to centre (Implantation) distance to track/ Tracks in Black colour in white background for Normal Implantation and in Red colour with white background for reduced implantation.
	(c) If any signal post and/or any of it's components are infringing with schedule of dimensions, such post shall be painted with alternate Red & white stripes at Loco Pilot's eye level (3.65 m) and it's Centre to centre distance to adjacent Track(s) shall be marked in red colour on a white background on the signal post itself, showing an arrow towards infringing track, for easy identification.
3	<b>Precautions in RE area extract from ACTM para 16.4 to 16.5 of Appendix I</b>
	(a) If any portion of a signal post or its fittings falls within 2 meters of a 25 KV live conductor, or any it's metal part, such portion shall be protected by an iron screening solidly connected to the structure. If not, a Caution Board shall be provided on the signal post at a height of 3 meters above the rail level, to caution the staff.
	(b) Neutral section shall be located away from stop signals, level crossing. If neutral section is provided after a stop signal, the distance* between signal and neutral section shall be such that after stopping, the train shall be able to pick up enough speed to coast through the neutral section without any risk of stalling. If neutral section is provided before a stop signal, the distance* between neutral section and signal shall be such that the train shall not cross the signal in an effort to coast the neutral section.
	<i>*Note: The distance should be preferably 1600 meter away on section with gradient up to 1 in 300 and 2500 meter with higher steeper gradient up to 1 in 200, if unavoidable. If PTFE type short neutral section has been used, this distance can be reduced to at least 400 meter after the stop signal and 200 meter before the stop signal.</i>
4	Please also refer to Extracts of Para 20.5 of Appendix-1: Manual of AC Traction - Volume II (Part-II) for placement of signals in RE area, given at <a href="#">Annexure: 22-A1</a> .
5	Any other stipulation as given by Railway Board & RDSO from time to time shall also be followed.

**Extract of Schedule of Dimensions (SOD)**

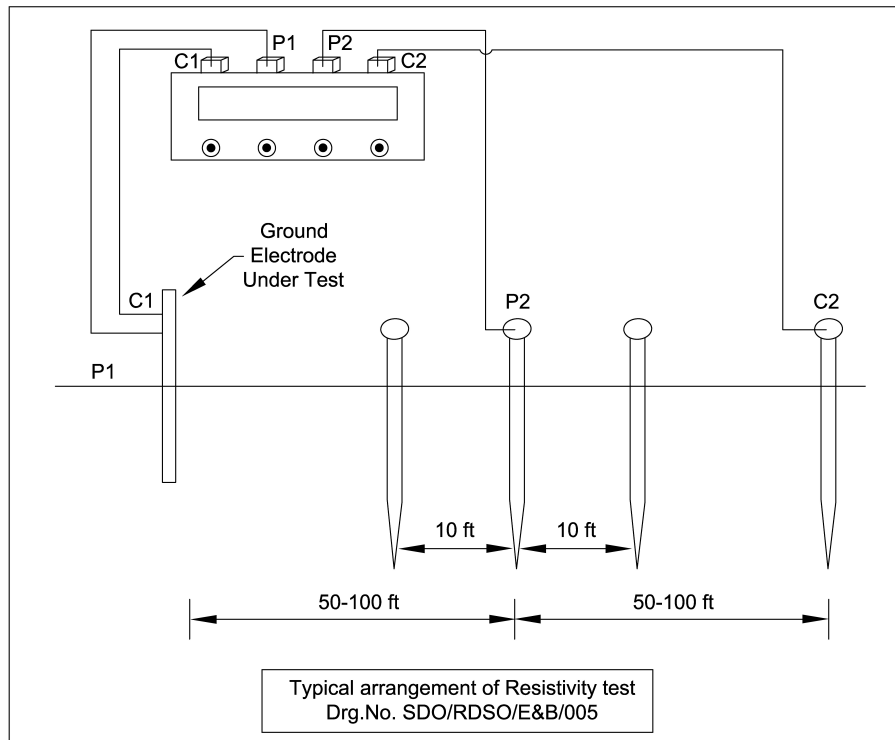
The minimum horizontal distance from centre of the track to any structure as per schedule of dimension (SOD) (addendum & corrigendum slip no (ACS) no 26 dated 10.1.2019) shall be as follows:

S. No	From Level to Level	For existing works	New works or alterations to existing works
1	From rail level to 305 mm above rail level	1675 mm	1905 mm
2	From 305 mm above rail level to 3355 mm	2135 mm	
3	From 305 mm above rail level to 1065 mm		1905 mm increasing to 2360 mm
4	From 1065 mm above rail level to 3735 mm		2360 mm
5	From 3355 mm above rail level to 4115 mm	2135 mm decreasing to 1980 mm	
6	From 3735 mm above rail level to 4420 mm		2360 mm decreasing to 2135 mm
7	From 4420 mm above rail level to 4610 mm		2135 mm decreasing to 1980 mm
8	From 4115 mm above rail level to 6250 mm	1600 mm	
9	From 4610 mm above rail level to 6250 mm		1600 mm
10	Below rail level up to formation level of the track on straight and curves up to radius of 875 m	2575 mm	2575 mm
11	Below rail level up to formation level of the track on straight and curves with radius less than 875 m	2725 mm	2725 mm

*Note: Latest Amendments of SOD as issued from time to time shall be followed.*

### Method for Finding Out the Resistance of an Earth

The typical connection diagram used for measurement of earth resistance from 'Fall of Potential' method is given below:



The earth resistance may be measured as per 'fall of potential' method using four terminal earth tester, as given below:

- (i) Connect Current probe C1 & Potential probe P1 to the earth electrode(s) under test.
- (ii) Drive a probe onto the earth 30 to 60 meter away from the earth electrode(s) under test and connect to terminal C2. In case of earthing system having multiple earth electrode like ring earth, the Current probe C2 should be in the direction which is away from the set of electrode(s) under test. This probe should be driven to a depth of 15 to 30 cm.
- (iii) Drive another probe onto the earth midway between the electrode(s) under test and probe C2. Connect this probe to terminal P2. This probe should also be driven to a depth of 15 to 30 cm.
- (iv) Measure the earth resistance. Say it is Reading 1.
- (v) Move the potential probe P2 by 3 meter farther away from the electrode(s) under test and do the earth measurement. Say it is Reading 2.
- (vi) Move the potential probe P2 by 3 meter (from midway) towards the earth electrode(s) under test as shown in figure above and do the third measurement of earth resistance. Say it is Reading 3.
- (vii) If all the three reading are within a few percent of their average, then average of the three readings may be taken as the earth resistance of electrode(s) under test.

*Note: In case there is a significant variation of three measurements from their average, then location of test probe C2 may be shifted to a farther distance and test may be repeated.*

## Chapter 20: Automatic Block Signalling

### Section 1: Automatic Signalling - General

#### 20.1.1 Automatic Block System on Double Line/Single Line: General

- (a) Automatic Block is a system in which the movement of trains is controlled by Stop Signals which are operated automatically by the passage of trains past the Signals.
- (b) The automatic Stop Signal which governs entry of Train into an Automatic Signalling section is a multiple aspect colour light signal which is not dependent upon manual operation but is controlled automatically by the passage of a train into, through and out of the Automatic Signalling section which the Signal governs.
- (c) The line between two adjacent crossing stations shall be divided into a series of Signalling sections and entry into each signalling section shall be controlled by a Manual Stop Signal or an Automatic Stop Signal or a Semi-Automatic Stop Signal which must assume 'ON' position on entry of a train into the section and be maintained in that position until the train has passed clear of the next Automatic Stop Signal in advance and also for an adequate distance beyond it.
- (d) No automatic signal shall assume 'OFF' position unless the Line is clear not only up to the next Stop Signal in advance but also for an adequate distance beyond it. Except under approved special instructions, this adequate distance shall not be less than;
  - (i) 120 metres, if next Stop signal in advance is an automatic signal.
  - (ii) 180 metres, if \*next Stop signal in advance is a Manual stop signal or Semi-automatic signal.

(\*Note: if such signal is a Home signal or LC gate signal)
- (e) Signals shall be so spaced as to meet the operational requirements of the section. At the same time the distance between signals shall not be so high as to cause serious repercussions during failures or so small as to provide inadequate braking distance. If the distance between the Caution and Stop Aspects in the case of three aspect signalling or Attention and Stop Aspects in the case of four aspect signalling, is less than the Emergency braking distance of a train, the speed of that train shall be so regulated as to bring the Emergency braking distance within the above mentioned signal spacing.
- (f) The Signal that governs entry into the Block section shall be Manual or Semi-Automatic Stop Signal, which are explained below.

#### 20.1.2 Manual Stop Signals and Semi-Automatic Stop Signals

- (a) **Manual Stop Signals:** Fixed Signals which require manual control each time they are taken 'OFF' are called Manual Stop Signals. Manual stop signals shall be manually operated multiple aspect colour light signals which shall assume 'ON' position automatically on the occupation of the section ahead but shall assume 'OFF' position only when on clearance of the relevant section and they are operated manually.

(b) **Semi-Automatic Stop Signals:** A fixed signal having both manual and track circuit controls and which is capable of being operated either as an Automatic Stop Signal or a Manual Stop Signal, is called a Semi-Automatic Stop Signal i.e they are capable of being operated either as Automatic Stop Signals or as Manual Stop Signals as per need.

- (i) The Semi-Automatic Stop Signal when working as an Automatic Stop Signal shall conform to an Automatic Stop Signal in all matters relating to its functioning including its normal aspect.
- (ii) Similarly, a Semi-Automatic Stop Signal when working as a Manual Stop Signal shall conform to Manual Stop Signals in all matters including its normal aspect.

A control may be provided to make a Semi-Automatic Stop Signal to work either as an Automatic Stop Signal or as a Manual Stop Signal as required.

### 20.1.3 Special Requirements of Automatic Block System on Single Line:

In case of single line, Line clear shall be obtained and Direction of Traffic shall be established as per GR 9.03 (Extract given below)

*GR 9.03. Essentials of the Automatic Block System on single line.—*

*(1) Where trains on a single line are worked on the Automatic Block System,---*

- (a) The line shall be provided with continuous track circuiting or axle counters,*
- (b) The direction of traffic shall be established only after Line Clear has been obtained from the block station in advance,*
- (c) A train shall be started from one block station to another only after the direction of traffic has been established,*
- (d) It shall not be possible to obtain Line Clear unless the line is clear, at the block station from which Line Clear is obtained, not only up to the first Stop signal but also for an adequate distance beyond it,*
- (e) The line between two adjacent block stations may, where required, be divided into two or more automatic block signaling sections by provision of Stop signals,*
- (f) After the direction of traffic has been established, movement of trains into, through and out of each automatic block signaling section shall be controlled by the concerned Automatic Stop signal and the said Automatic Stop signal shall not assume 'off' position unless the line is clear up to the next Automatic Stop signal:*

*Provided further that where the next Stop signal is a Manual Stop signal, the line is clear for an adequate distance beyond it, and*

- (g) All Stop signals against the direction of traffic shall be at 'on'.*

*(2) Unless otherwise directed by approved special instructions, the adequate distance referred to in clauses (d) and (f) of sub-rule (1) shall not be less than 180 metres.*

#### **20.1.4 Establishing Direction of Traffic for Automatic Stop Signals on Single Line**

- (a) A Control shall be provided to establish direction of traffic and to ensure that conflicting signals cannot be taken off and a suitable indicator provided to indicate the direction established. It shall not be possible to change the direction unless the entire line between two crossing stations and the overlap in the direction to be established are Clear. The mechanism of the control shall, in addition, be suitably approach locked.
- (b) Automatic Stop Signals shall operate in the direction of traffic established. Those Automatic Stop Signals which are against the direction of traffic must exhibit 'ON' position.

#### **20.1.5 Train Detection (Track Circuits/Axle Counter) for Automatic Signalling**

- (a) The line shall be provided with track circuits or Axle Counters over its entire length and may be divided into a series of Automatic Signalling Track Sections. The Track Circuit for the overlap must be separated from the Track Circuits for the remaining portion of each signalling section. In case of Axle Counters, track section may be extended from foot of the next signal in advance up to an adequate distance beyond it.
- (b) DC Track circuits are not to be provided in block section, in future working due to maintenance issues.
- (c) Track circuits/Axle Counter shall also be provided on all passenger running lines as well as other reception lines between passenger lines including their connections to the main lines at all stations on the Automatic Section including stations at either end of the section. There shall be no dead section between the Track Circuits/Track sections of the station and the Track Circuits/Track sections of the Automatic Section.
- (d) The design of the Axle Counters between two adjacent stations, shall be such that, individual track sections in each direction shall have resetting facility from dispatching end station master in case of failure of equipment, with co-operation of receiving end station master for verification of last vehicle.
- (e) Redundancy may be provided in Track circuits/Axle Counters in the Automatic Section to improve availability.
- (f) Media diversity shall preferably be provided for Axle Counters.
- (g) Track indicator for Automatic Signalling on Single Line: An indicator shall be provided at each station to indicate whether the block section is occupied or clear.

#### **20.1.6 Markers**

- (a) Each Automatic Stop Signal shall be identified by its number and provided with a Marker consisting of a white disc with letter 'A' in black.
- (b) A Semi-Automatic Stop Signal shall be provided with a Marker which shall show a white illuminated letter 'A' against a black background when the signal works as an Automatic Stop Signal.



- (c) Such a Signal interlocked with a level-crossing shall be provided with a yellow disc with letters 'G' in black and an 'A' marker light. The 'A' marker shall be lit only when the gates are closed and locked against road traffic.
- (d) A Semi-Automatic Stop Signal shall be provided with a Marker which shall show a white illuminated letter 'A' against a black background when the signal works as an Automatic Stop Signal.
  - (i) Such a Signal interlocked with a level-crossing shall be provided with an enamelled yellow disc with letters 'G' in black and an 'A' marker light. The 'A' marker shall be lit only when the gates are closed and locked against road traffic.
  - (ii) When a Semi-Automatic Stop signal is required to protect a level crossing gate as also points, the signal may be provided with an illuminated 'AG' marker in addition to the illuminated 'A' marker.
- (e) The illuminated markers of a Semi-Automatic Stop Signal shall preferably be repeated at the place of operation of the Signal along with the aspects of the Signal.

#### **20.1.7 Restrictions in Graded Sections**

- (a) Automatic Signalling shall not be provided on sections with heavy and continuous falling gradients steeper than 1 in 80 unless the brake power of trains on the section is adequate to enable the trains being stopped at each of the Automatic Stop Signal.
- (b) The suitability of Automatic Signalling on heavy and continuous rising gradients shall be decided in consultation with the concerned Departments duly taking into account the ability of a train to start after it has been stopped at an Automatic Stop Signal.
- (c) Points and Crossings in Automatic Block Sections: Emergency Crossovers and Siding Points shall be secured and approach locked and detected by Signals reading over the Points.

### **Section 2: Installation of Automatic Signalling**

**20.2.1** The installation and wiring shall be carried out as per approved plan and Circuit Diagrams.

The circuits and equipment shall be so installed as to cause minimum failures while ensuring maximum safety.

#### **20.2.2 Circuit Features for Auto Signals**

- (a) The aspects of an automatic signal shall be controlled by the main signal in advance through lamp proving relays/object controller, in addition to the controlling relays.
- (b) All fail-safe circuits shall work on continuously energized principle such that any open circuit in wiring, relay contacts, etc. or loss of power supplies shall not cause an unsafe condition.

- (c) An automatic signal on a double line/single line shall require all tracks to be clear up to the next signal and an adequate distance beyond, before it can display 'OFF' position as per [Para 20.1.1 \(d\)](#). In case of Single Line, Direction of traffic, shall also be established.
- (d) LED signals of approved type by RDSO shall be used.
- (e) All external circuits shall be provided with double cutting arrangements.
- (f) The circuits shall be so designed that, if the lamp of the aspect displayed fails, the signal shall immediately assume the next restrictive aspect. Also if a signal which must display red aspect does not do so for any reason whatsoever, the signal in rear shall display a red aspect.
- (g) The circuit for illuminated 'A' marker of a Semi Automatic Signal shall be such that the 'A' marker lights up only when the signal is working as an automatic signal.
- (h) The circuit for illuminated 'AG' marker where provided shall be such that the 'AG' marker lights up only when the conditions for 'A' Marker to light up are satisfied except for the level crossing gate which may either be open to road traffic or may have failed.
- (i) The illumination of the 'A' marker shall prove the correct setting and locking of the points as required and ensures the back-locking of the route. Level crossing gates, if any, on the route shall be proved closed and locked to the road traffic.
- (j) The relevant information of Automatic Signalling gears in section should be available/visible at station like Signals Aspects, track status information, Axle Counter reset information and gate information.

**20.2.3 Level Crossings in Auto Section:** Please refer to [Chapter 14, section 1](#) of SEM for working of LC gates, approach locking and audible warning to LC gate man.

#### 20.2.4 Installations - Misc

- |  |
|--|
| (a) Track circuits: Provisions contained in <a href="#">Chapter 17</a> of SEM shall be adhered to.                             |
| (b) Power Supply: Provisions contained in <a href="#">Chapter 16</a> of SEM shall be adhered to.                               |
| (c) Installation in 25 KV AC electrified areas: Provisions contained in <a href="#">Chapter 22</a> of SEM shall be adhered to. |
| (d) Installation of Cables: Provisions contained in <a href="#">Chapter 15</a> of SEM shall be adhered to.                     |
| (e) Extant guidelines on Installation, Testing & Commissioning shall be adhered to.  |

*Note: An example of Automatic signalling scheme using optical fibre cable(OFC), Multi Section Digital Axle Counter (MSDAC) and Object Controllers (of Electronic Interlocking) is given at [Annexure: 20-A1](#) for information.*

### **Section 3: Maintenance of Automatic Signalling Section**

20.3.1 LED signal lamps shall be replaced in case of failure/after completion of codal life.

20.3.2 Marker light shall be replaced on age cum condition basis.

20.3.3 The following shall be tested by the SSE/JE (Signal) at least once in a year:

- (a) Track Circuit control on signal and aspect control by signals in advance;
- (b) Automatic Cutting-in of the next restrictive aspect when the LED aspect of the main signal fails;
- (c) Interlocking equipments and circuits for level crossings and points;
- (d) The circuits that establish the direction of traffic in Single Line and prevent clearing of conflicting signals on sections provided with Automatic block Signalling on Single Line;
- (e) Axle Counter resetting circuits, if provided.

20.3.4 All failures reported by the Loco Pilots/Motor man shall be promptly attended.

#### **20.3.5 Track Circuits/Axle Counter Maintenance**

- (a) Adequate precautions should be taken after every track renewal work to ensure proper working of track circuits/Axle counters.
- (b) Provisions contained in [Chapter 17 of SEM](#) shall be adhered to.

20.3.6 Power Supply: Provisions contained in [Chapter 16 of SEM](#) shall be adhered to.

20.3.7 Cables: Provisions contained in [Chapter 15 of SEM](#) shall be adhered to.

### **Section 4: Modified Semi-Automatic Signalling Working**

20.4.1 (a) Under special instructions, one of the automatic stop signals between two stations in the automatic block signalling territory on Double Line may be made as modified semi-automatic stop signal in each direction. During abnormal conditions like fog, bad weather impairing visibility, Modified Semi-Automatic Signal may be worked by extinguishing 'A' marker in the manner prescribed under special instructions and this section shall also ensure that the 'A' Marker of the Advanced Starter Signal of the station in rear and Home signal of the station in advance shall also be extinguished. (Provisions as per para 9.01 of GR shall be ensured.)

- (b) Interlocking will be such that during mid-section Modified automatic signal working with 'A' marker extinguished, not more than two trains, one on either side of this modified stop signal, will be ensured by the signalling system between two stations in any given direction at any given point of time. The mid-section modified semi-automatic stop signal shall when 'OFF' depict the aspect (Green or Double Yellow etc.) based on the aspects and number of Automatic signals (including any other signal) between this signal and the Home signal of the receiving station.

- (c) Such Gate signal, which has been converted as mid-section modified Semi-Automatic Signal, is provided with 'A' & 'AG' markers. During modified Automatic Signalling working, these markers will be extinguished.
- (d) During normal conditions, mid-section modified semi-automatic stop signal shall work as normal automatic stop signal.
- (e) The mid-section Modified automatic signal shall be painted with alternate blue and white strips in between.
- (f) The relevant indications whether the signal is in normal automatic mode or modified semi-automatic mode shall be available to the station masters at both the ends.



*Note: This chapter has under mentioned Annexure*

S.No.	Annexure No.	Description
1	<a href="#">20-A1</a>	Automatic Signalling Scheme with OFC, MSDAC & OC



*Note: This chapter has under mentioned Drawings in [Appendix II](#)*

S.No.	Drawing No.	Description
1	<a href="#">20-D1</a>	Automatic Signalling Scheme with OFC, MSDAC & OC (Sheets-3)

## Automatic Signalling Scheme with OFC, MSDAC & OC

### Brief context

The automatic signaling is implemented usually with DC track circuit, AFTC, Universal Axle Counter (UAC), Single Section Digital Axle Counter (SSDAC). Any Failure of auto signals will have cascading effect on Trains.

In order to have much better availability, Optical Fibre Cables (OFC) along with Electronic Interlocking/Object Controllers and Multi Section Digital Axle Counters (MSDACs), with dual detection may also be used for Automatic Block Signalling (ABS)

### I. Introduction

The scheme is explained for a typical block section consisting of three Automatic Block sections. The scheme consists of two components. One is controlling of aspects of Automatic signals based on the clearance of tracks ahead and other is Train/track detection for block section.

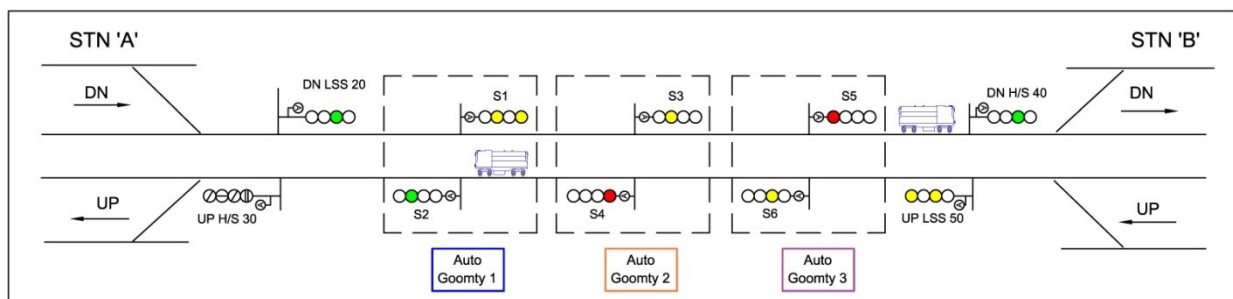
- (a) Signal aspects are controlled using Object Controllers, placed at controlling Auto section Goomties.
- (b) Continuous Train/track detection is achieved through MSDAC (Dual detection).

For Installing the above two equipment along with necessary power supply, Auto section Goomties are provided in the block section, with each Goomty catering for one UP & one DOWN Automatic Signal.

### II. Description of the Scheme

#### A. Auto Goomties

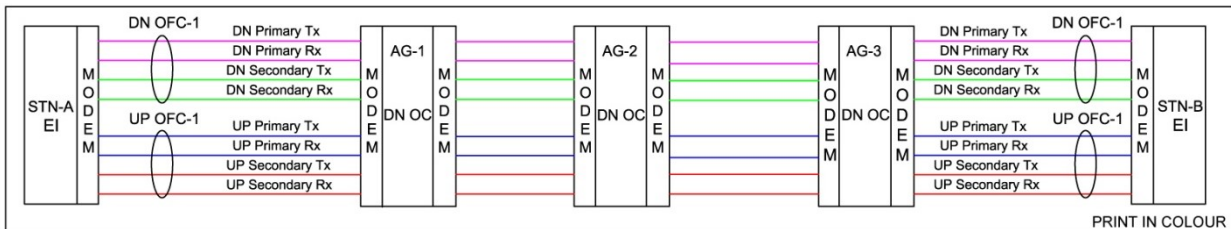
UP and DOWN Auto signals are planned in such a manner that, they are near to a Auto goomty to drive them. An Auto Goomty (AG) (Relay hut) , works as RBG room for controlling these UP and DOWN Auto signals as shown below.



**Fig 1. Auto Goomties for controlling One Up & One Dn signal**

## B. Electronic Interlocking (EI) and OCs

Both stations 'A' and 'B' on either end of the block section are provided with Electronic Interlocking System. The Automatic Signals of either direction are controlled by the EI of Sending station, through the OCs provided in the AGs. Two OCs are provided in each AG, for controlling either direction Automatic Signals. This arrangement will ensure that if any OC has failed, only one direction traffic will get affected. OC for DOWN direction is connected to EI of station A, similarly OC for UP direction is connected to EI of station B. The communication media between AG and Station is through OFC and not through any copper cable. Two numbers of 24 fibre OFCs are provided on UP and DOWN directions for path diversity.



**Fig 2. Interconnection between OCs and EIs over OFC**

The communication arrangement between OCs and Central Interlocking Units (CIUs) in Station A – Station B Automatic section is given below.

1. The DOWN direction Automatic Signals from Station A – Station B are controlled by CIU of Station A with OC placed at Goomties at each location of signal.
2. Thus a, total 4 OCs are connected to Station A CIU corresponding to G-3, 4, 5 and one OC is placed at Station B to gather the information of Station B's Down Home signal, in order to control the aspect of its rear automatic signal. (HYR, HHYR, DYR).
3. Channel A of OC No 24 at Station B is connected to Station A CIU over 4 fibers on UP direction 24 core fiber (Fiber 9, 10, 11 & 12). These fibers are patched in each and every location of goomties to have continuity of communication.
4. The architecture of EI provides for 8 number of ports and each port can be connected with 4 OCs except in case of VDUs where only one VDU can be connected to one port. The configuration of connection of these 4 OCs to CIU is given in Drawings.
5. The channel-A of 4 OCs is connected to M-0 port of CIU using 4 conductors of fiber, where primary of one OC is connected to secondary of another OC in cascading way. Similarly Channel-B of 4 OCs is connected to Channel B of M-0 Port using 4 fiber conductors.
6. Using this connection configuration, the Down direction OCs of 4 & 5 are cascaded and their Channel-A is connected to channel A of M-5 port on Up direction 24 fiber using its 5, 6, 7 & 8 conductors. Similarly Channel-B is connected to channel B of M-5 port on DN direction 24 fiber using its 5, 6, 7 & 8 conductors. Hence the path redundancy is achieved by connecting channel-A on UP direction 24 fiber and Channel-B on DN direction 24 fiber. This arrangement is preferred keeping in view on the limitation of fibers.
7. In brief, the OC at G - 3 is connected to M-4 port, OCs at G – 4 & 5 are connected to M-5 port and OC at Station B is connected to M-6 ports of CIU at Station A.

8. Bidirectional RS 485 to OFC converter is used as interface between dark fiber and CIU as shown below.



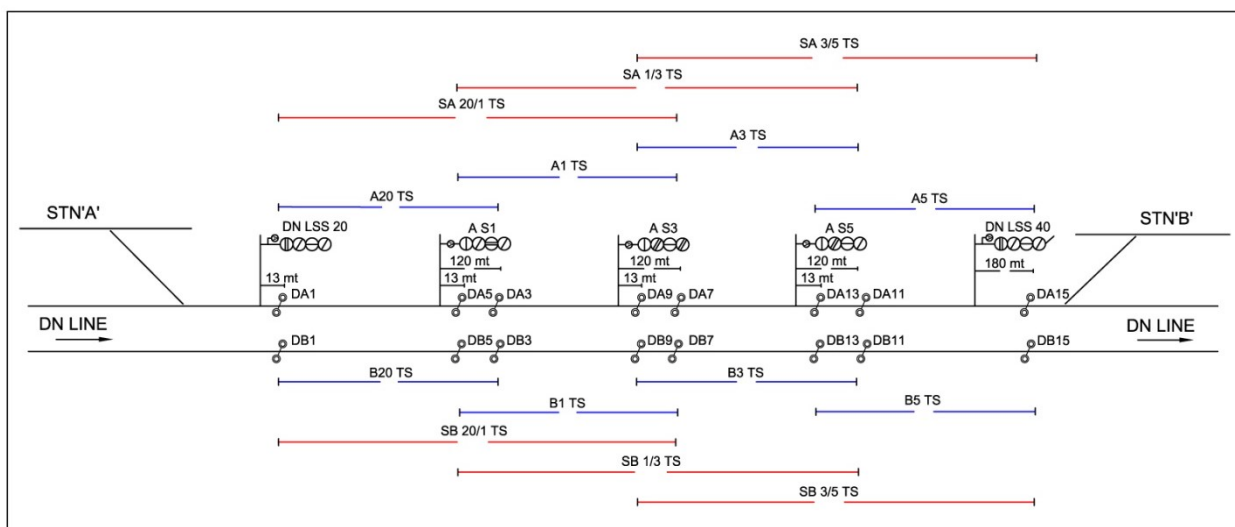
Each OFC converter has one primary (Tx, Rx) and one secondary (Tx, Rx). Two converters are required to connect one OC (Ch-A and Ch-B) to one port at CIU end. Similarly two more converters are required at OC end.

9. Similarly, the allocation of fibers in Station B – Station A Up direction may be seen in drawings.

### C. MSDACs with Dual Detection

The necessary requirement of Automatic block section is continuous track detection between adjacent block stations. MSDACs with dual detection (M&R), with one Detection Point (DP) on each rails of track are used for redundancy and auto resetting facility. However, both DPs will function simultaneously in Hot-standby mode, so that failure of any one of the DPs will not affect the track vacancy detection.

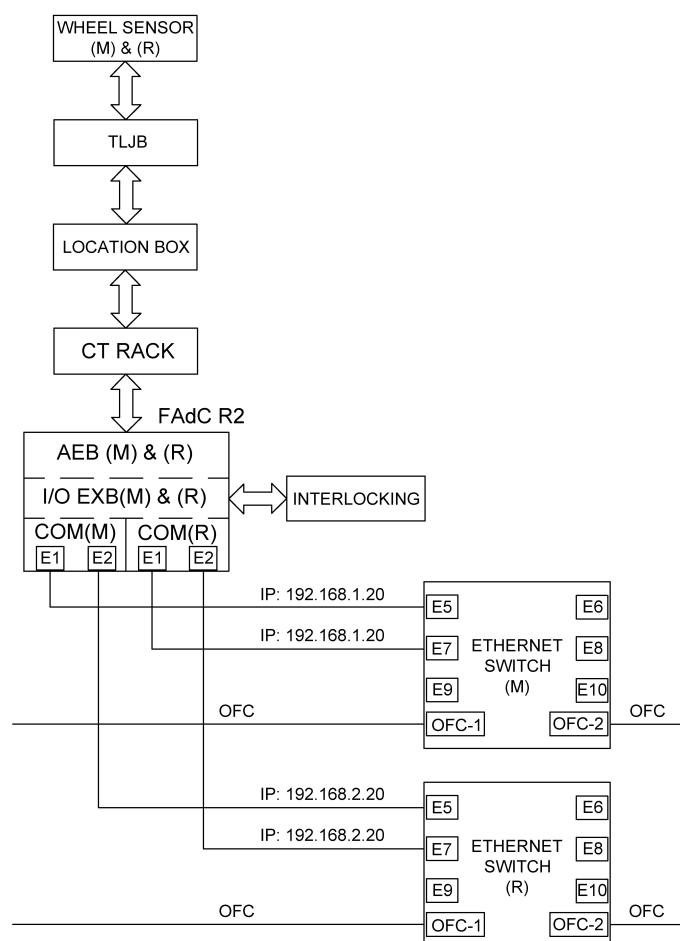
In order to minimize the number of track sections, no separate track section has been made for overlap portion of auto-sections. A single track section includes route as well as overlap of a signal. Supervisory track sections have been formed using the DPs of track sections for automatically resetting the track sections. Each supervisory track section covers two (02) track sections. Supervisory track sections have overlapping boundaries.



**Fig 3. Track Sections and Supervisory track sections**

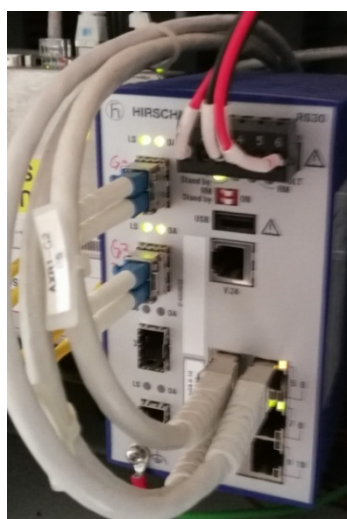


Two evaluators (EVs) (M&R) are provided in each AG as well as adjacent stations. The main DPS of UP and DOWN direction are connected to EV(M) and redundant(R) DP of UP and DOWN direction are connected to EV(R). The MSDACs used in the present scheme have one dedicated COM-AdC board with ethernet port to communicate with adjacent EVs. The evaluated information from COM-AdC is transferred through its ethernet port to dedicated OFC, via an unmanaged ethernet switch as shown in Fig.4. The COM-AdCs of both M & R EVs are hot linked and any failure of one of the board does not hamper the track detection.



**Fig 4. Interconnection of EV with OFC via COM**

The ethernet switch used in Fig.4 is as shown below





The MSDAC information through ethernet interface (Main & Redundant) is connected to the ethernet switch which transfers the same onto dark fiber. Two such switches are used at each location one each for UP and DOWN direction fibers.

The Vital Relays (ACPRs) of each track section are picked up at the sending end of track section (either in AG or station). The status of vital relays is read by the OCs, and transmitted to Central Interlocking Unit for logic processing, and the status of aspects is again sent to corresponding OCs for driving the Automatic Signals.

#### **D. Reset features of MSDAC**

The reset arrangement is proposed at three levels using Track Sections and Supervisory Track Sections, two of which are automatic reset arrangements and one is manual reset.

##### **(i) L -I : Automatic reset with redundant track section:**

Once the train has cleared both the track sections, and any one of the track sections is in failure state, the track section, which is in clear condition will reset the one in fail condition. The track section, which is under reset is kept in preparatory mode and the clear track section information is used to clear the signal.

##### **(ii) L-II : Automatic reset with Supervisory track section:**

When a supervisory track section is clear, all the track sections falling completely within the jurisdiction of that supervisory track section can be assumed to be clear. If any track section fails and it's corresponding supervisory track section is clear, it will automatically reset the failed track section.

In case of automatic resetting with supervisory track section, the reset track sections will be kept under preparatory mode, and the corresponding signal will continue to be in 'ON' aspect, until a train with low speed enters and exits the track section with equal count at the boundaries of track section.

##### **(iii) L -III : Manual Reset with Line verification:**

In case of failure of Level -1 and Level -2 reset, manual resetting has to be carried out, which resets all the track sections in the section under consideration. One reset box at train sending station along with its corresponding Line verification (LV) box at other station is used to manually reset all the track sections between both the stations of a particular direction of movement. This reset can be done only when Station Masters of both the stations have ascertained that all the track sections between the stations are clear of trains in that particular direction. This will reset and set all the DPs in preparatory mode. The clearance of train in each section with balancing of count will make the track section clear and bring to its normal mode of working.

#### **E. Power Supply Arrangement**

Each AG is provided with a Mini IPS, for which the input supply of 230 V AC is from UP AT and DN AT at each location. The necessary power supplies for EI OCs and MSDAC are derived from the Mini IPS. MSDAC works on a voltage range of 19-72 V DC. Hence 24 V DC supply with suitable current capacity from Mini IPS serves the purpose. In stations, the necessary power supplies are derived from the Major IPS.

## **F. Cable requirement**

Signaling Cable: In the stations, Home & Advance starter signals are directly fed from the EI/Relay room with standard signaling cable, with aspect repeating relays at signal locations. Automatic Signals at AG are directly fed using a 12 x 1.5 Sq.mm signaling cable from AG, without any repeater relay at site, as the distance is not more than 200 meter.

**Quad Cable:** MSDAC evaluator to each DP requires 1 quad of 4 conductor. A separate 6 quad cable is used for each DP of dual detection (main + Stand-by) from the nearest Half location box provided for Signal cable termination at signal location. From AG to Half location box one 6 quad each is used for UP & DN directions.

### ***Disclaimer:***

*(1) The scheme given above, was adopted in 2018 for Automatic Signalling work in Vijayawada – Gunadala – Mustabada section of Vijayawada division of SCRly, is only for Technical information of signal Engineers and does not indicate endorsement of any particular make of MSDAC or EI/OC.*

*(2) Scheme will have to be suitably modified as per Technical requirements/Facilities in particular make of MSDAC & other equipments being used.*

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Refer to Drawings [20-D1 in Appendix II](#)

## Chapter 21: Relay & Electronic Interlocking

### Section 1: Design Criteria of Signalling Circuits

#### 21.1.1 Circuits - General

- (a) The Detailed designs for circuits of interlocking may be required for;
  - (i) Route Setting Type i.e. on the basis of Entry/Exit principle.
  - (ii) Non-route Setting Type i.e. Route is set with individual operation of points for existing installations or alterations.
- (b) The designs shall be suitable for RE as per stipulations in [Chapter 22 of SEM](#) on "Requirements of signalling in 25 KV AC electrified areas".
- (c) The designs shall be in accordance with the approved signalling plans, Control Table, Control Panel diagram, Relay contact analysis and relay rack arrangements.
- (d) The designs shall be suitable for the specific type equipment to be installed such as Make of Electronic Interlocking (Distributed or Central), MSDAC, SSDAC, UFSBI, Block Working built into Electronic Interlocking etc and the type of Interfacing & features, they provide. Use of dual OFC in Distributed type of Electronic Interlocking, are desirable as they reduce extent of copper cables & provide an alternate path in case of Failures.
- (e) The drawings & designs shall be made in accordance with Typical templates, RDSO's Standard circuits/templates, guidelines, Board guidelines, Industry's best practices & principles of Reliability, Availability, Maintenance & Safety in mind.

#### 21.1.2 Control Panels-General

- (a) The display of the layout on the front of the Control Panel referred to as the illuminated diagram shall be well proportioned. Where additional facilities are likely to be provided, domino type panel shall, preferably, be used. The areas covered by each track circuit shall be clearly distinguished by use of different colours.
- (b) The operating members, namely route switches/buttons, point switches etc., referred to in the following clauses shall normally be provided on the illuminated diagram itself in Geographical order. A separate illuminated diagram for indication and a separate 'console' containing all the operating members may also be provided.
- (c) At Non-route setting type installations, the route may be set with individual operation of points.
- (d) The Route setting shall be on "Entry/Exit" principle for installations of Route Setting type. Each route shall be controlled by means of two push buttons-one at the entrance and the other at the exit of the route.

- (e) In Non-route setting type installations, after setting of the route by individual operation of points is completed, signal can be cleared by an individual push button in conjunction with a group button or by an individual switch controlling each signal or a common switch for conflicting signals which are not required at the same time, or one push button at the entrance and other at the exit end.
- (f) Individual push button in conjunction with a common push button or two/three position switches shall be provided for individual operation of points.
- (g) Where a route has more than one overlap, it shall be possible to select and set the desired overlap beyond the exit signal of the route.
- (h) Where the route has alternate approach routes, it shall be possible to select and set the desired route with desired overlap.
- (i) The switches/buttons shall have distinctive colours so that they can be readily distinguished, such as running signal red, shunt signal yellow, calling on signal red with white dot & exit button white. The alternate overlap white with black dot, alternate route Grey, point black, slot green, crank handle blue and point group button black with red dot etc.

#### 21.1.3 The control panel shall be provided with:

- (a) Arrangement for individual operation of points.
- (b) For emergency operation of points (where provided, during point zone track circuit failures), each individual operation shall be recorded on a counter.
- (c) Necessary slotting facilities for adjoining cabins, ground-frames, level crossings and crank handles etc.
- (d) Arrangement so that slot shall be controlled by operation of two buttons or a switch similar to route setting principle for individual line. For cancellation of slot, a group slot cancellation button to be operated along with entrance/exit button shall be provided. Each such cancellation shall withdraw the slot but the route controlled by the slot shall be kept held for a predetermined time delay or till route locking if any, is effective. Each slot cancellation shall be recorded in a counter.
- (e) When SM's key is taken out, it shall not be possible to change the last operated position of any signalling gear from control panel. However, facility shall be provided to put back the signal to 'ON' position without altering the route. It shall be ensured that no command gets executed automatically on reinsertion of SM's key.
- (f) An indication panel shall be provided in major yards, giving position of the yard and important indications for maintenance staff.

#### 21.1.4 Indications on Control Panel

The control panel shall be provided with the following indications.

**(a) Point Indications**

- (i) The position of points shall be indicated either by white/yellow or green lights near each individual point switch and by white strip light on the point zone and by white strip light on the point zone in case of push button. During operation of the points, light/strip light for the intended position shall flash till points are correctly set and locked.
- (ii) The point locked indication in route shall be given by illumination of a small white light near the point or points switch/button which shall be extinguished when point is free.

**(b) Route Indications**

- (i) Route indication lamps shall be provided to indicate setting and locking of the route. Indication that route is set and locked shall be given by a set of white lights (not less than two) on each track section. When any route is not set, route indicator lamps shall be extinguished.
- (ii) The complete route over which the movement is to take place shall be lit with a row of white lights when the route is correctly set and locked.
- (iii) As the train moves over the route, the portion of the route occupied shall change to red and after the train has cleared the particular track, it should change back to white lights until the sectional route/entire route is released, when the white light is extinguished.

**(c) Signal Indications**

- (i) Indication that a stop signal is at 'ON' shall be given by a red light and a permissive signal is at 'ON' shall be given by a yellow light on the corresponding signal symbols on the control panel.
- (ii) Indication that stop/permissive signal is 'OFF' shall be given normally by a green, yellow or double yellow light as signal is seen in the field, on the corresponding signal symbol on the control panel. In case of signal 'OFF' aspect failed to lit at site, the corresponding signal aspect indication on the control panel shall be indicated with flashing. However, in case of a domino panel where indication of all aspects is not provided, any 'OFF' aspect can be shown by green along with the following flashing indications for conditions as enumerated below:
  - Failure of green; green flashes red\* blank;
  - Failure of yellow; green flashes, red lit;
  - Failure of double yellow, both green and red\* flash; &
  - Failure of red\*, green not lit (blank), red\* flashing.

\*To be read as yellow for a permissive signal.

- (iii) Signal indication for the 'ON' aspect of a shunt signal on the same post as the running signal, is not required. In the case of shunt signal on independent post, the 'ON' indication shall be given by a white light strip or two miniature white lights in a horizontal position on the corresponding shunt signal symbol on the control panel.

- (iv) Signal indication for 'OFF' aspect of a shunt signal shall be given by a slanting white light strip or two miniature slanting white lights. Such indication of a shunt signal located on the same post as a running signal, shall be given below the running signal indication.
- (v) A white light for 'A'/AG' marker indication should be lit up on the control panel below the symbol of the signal when set for automatic working.
- (vi) Indication that "Calling on" signal is 'OFF' shall be given by a white light below the running signal indication of corresponding signal symbol.
- (vii) Starter Indicator's indication shall be provided by a white strip light which should be lit when repeater of the signal has displayed 'OFF' aspect. This indication should be provided by a white strip over the running signal symbol on the control panel.

**(d) Track Circuit Indications**

- (i) Indication that the track circuit is occupied shall be given by a row of red lights (not less than two) on the each track circuit portion.
- (ii) When the track is not occupied, the red lights shall be extinguished.

**(e) Power Supply Indications**

- (i) An indication to indicate the availability of the supply from the Mains/Diesel Generator/Catenary 1 or 2 should be suitably indicated, if such indications are not provided in Change over Panel in SM room.

**(f) Other Indications**

- (i) Approach track circuits shall be indicated on illuminated diagram. In continuous track circuit territory, the approach track circuits will cover all the track circuits in rear of the first stop signal up to the next signal in rear or up to the track circuit specified in the Control Table for approach locking. An approach track circuit controlling calling on signal shall be indicated separately with a distinct mark.
- (ii) Advance approach warning of trains if required shall be indicated on the control panel in the form of flashing lights or other type of indication and audible bell warning to attract attention of Station Master. These visual and audible warnings shall stop as soon as the approach track circuits are occupied or signals are taken 'OFF' for the train. It shall be possible to silence the audible warning by pressing a push button. This cancellation shall not apply to train approaching subsequently for which the push button must be pressed again.
- (iii) **Signal Lamp Failure alarm:** Failure of lighting of a signal aspect/route aspect at site shall light a red indication on the control panel and give an audible warning for the same. Such indication may cover a group of signals. A common audible warning can also be provided for a group of signals. It shall be possible to silence the audible warning by pressing a push button. Such cancellation of audible warning shall not apply to subsequent failures for which the push button must be pressed again.

- (iv) Indication shall be provided on the control panel distinguishing between locked and free condition of crank handle as below -
  - When CH key is in & locked - Yellow Steady
  - When CH key released from control panel but CH key is not extracted/When CH key is inserted back but CH control is not taken back from control panel - Red Flashing.
  - When CH key released and CH key extracted - Red Steady
  - When Emergency CH key release control given from control panel with 120 Seconds timer in progress - Yellow Flashing
- (v) The respective signal lock indication (white light) shall start flashing when an emergency route cancellation is initiated, in an approach locked condition of the route. This indication will extinguish after a lapse of two minutes and cancellation of the route.
- (vi) If push buttons are used on control panel, a buzzer to indicate that push button/push buttons has/have been left pressed may be provided.
- (vii) Suitable indications for slots shall be provided
- (viii) Gate control shall be provided on the control panel as below-
  - When gate is closed & locked - Yellow Steady
  - When gate slot released from control panel to open but gate is not open/When gate is closed but gate slot is not taken back from control panel - Yellow Flashing
  - When gate is open - Red Steady
- (ix) The control panel indication lamps shall be operated by not more than 24V miniature type bulbs or light emitting diodes.
- (x) Return wires from indication lamps and relays shall be suitably bifurcated so that excessive current does not damage them. Any break in return wire shall not fail the indication/relay or give a wrong indication or pick-up a wrong relay.
- (xi) When an approved electronic flasher relay other than Mercury type is provided, a flashing white indication shall be provided at appropriate corner of the control panel to indicate to the operator the satisfactory working of electronic flasher relay.

#### **21.1.5 Interlocking and Circuit Requirements: General**

- (a) Before designing the detailed circuits, Control Table showing approach locking, back locking, overlap release, isolation, interlocking, dependence of signal aspect, grouping of crank handles and the condition for release of crank handles, route release, gate release etc. shall be drawn up and approved by the competent authority. Provisions of GR & SR shall be observed.
- (b) Signal circuits shall be so designed that the signal shall not change to a lesser restrictive aspect than intended one and route shall not be released because of fluctuations in power supply voltage or when the supply resume following its failure.

- (c) Design of signal circuits and equipment shall be suitable for 25 KV AC electrified areas as per provisions of [Chapter 22](#) of SEM on "Requirements of signalling in 25 KV AC electrified areas".
- (d) Common return shall not be provided in vital circuits.
- (e) Where relays other than 24 V, 1000 ohm relay with metal to carbon contacts are used, the circuits shall be so designed that not more than 45 such contacts are used in series in a circuit.
- (f) The proving of back contacts of metal to metal relays should be done in the circuitry.
- (g) All new installations shall be of route setting type interlocking.

#### **21.1.6 Route Setting Type**

- (a) The route setting and clearance of signal shall be with the following conditions:
  - (i) SM's key is In
  - (ii) The interlocking is free
- (b) The points are correctly set and locked in the route including overlap and isolation (if any) to desired position.
- (c) The crank handle keys for all the motor operated points in the route, overlap and isolation are locked and their control is not released, shall be proved in Signal Clearance only. The keys for all the key-locked points in the route, overlap and isolation are locked and their control is not released.
- (d) All interlocked level crossing gates are closed and locked against the road traffic in the route and overlap, if any, shall be proved in Signal Clearance only to allow gate closing in the last.
- (e) Slot if any, from other agency has been received.
- (f) The track circuits in the route up to the next signal/dead end, overlap and isolation and Fouling, if any, are clear.
- (g) Stop signal ahead is not blank
- (h) The interlocking between conflicting routes shall be achieved through route interlocking electric circuits at route initiation stage.
- (i) Approach locking or dead approach locking shall be provided for all manual stop signals. Approach locking shall be continuously effective from the predetermined point on approach of the signal.
- (j) Controls on level crossings, ground frames, cabins, sidings etc., shall be suitably interlocked.



- (k) For clearing Calling On signals, proving of track circuits in the route and overlap are not required. Calling On signal shall detect all the points including interlocked level crossings in the route, which the main signal above it detects, except points in the overlap. Stop signal ahead is not blank is not needed.
- (l) For clearing of shunt signals, proving of berthing track circuits, points & LC gates in overlap, stop signal ahead is not blank is not needed.
- (m) A white indication for block control on the last stop signal should be provided on control panel, where-
  - (i) Section ahead is worked on Absolute Block System and control panel and block instrument are placed at different locations.
  - (ii) Block working is by means of axle counter or track circuit.

**21.1.7 Non Route setting Type:** (For existing installations & Alterations only. No new Installations of Non-Route setting type to be provided).

The route setting and clearance of signal shall be with the following conditions:

- (a) The points in the selected route and if required in overlap and isolation are operated to required position by individual operation of switches or push buttons in conjunction with group push button.
- (b) Operation of entrance exit buttons/switches or one control switch clears the signal if;
  - (i) SM's key is In
  - (ii) The interlocking is free
- (c) The points including hand operated points in the route including overlap and isolation if any, are set, locked and detected.
- (d) Other conditions are same as [para 21.1.6 \(d\) to 21.1.6 \(m\)](#) above

**21.1.8 Route Release Circuits**

- (a) Complete route release including overlap shall be effective only after the signal governing the route is put back to 'ON' and corresponding route switch/button has been operated to normalize the route. Automatic route release by the passage of train and complete release of route through sequential route release shall be provided.
- (b) Where a route has got number of route sections, the circuit shall be so designed that the route section does not release only by picking up of the concerned track relay. Same is released only after the next track circuit is also dropped and picked up, except in case when the last track is a berthing track. In cases where the route is controlled by single track circuit, the route release shall be controlled after predetermined time delay.

- (c) The route release circuit shall be so designed that it will release only when at least two track circuits drop and pick-up in sequence.
- (d) In installations provided with route setting system, sectional route release shall be provided if nos. of routes are more than 100. In such cases sub-route section already released shall permit setting up of other routes, if interlocking otherwise permits.
- (e) In case of installations provided with non-route setting system, sectional route release shall be provided if nos. of routes are more than 100. The complete route release shall be effective only after the signal governing the route is put back to 'ON' and corresponding route switch/push button has been operated to normalize the route. However, where sequence proving relays are provided to prove the authorized passage of a train, automatic route release shall be provided.
- (f) It shall be possible to release a route in emergency after suitable time delay as per Table-1, with the approach track occupied, provided the train has not passed the signal during the time interval.
- (g) It shall be possible to release a route in emergency after a suitable time delay as per Table-1, where approach track circuits have not been provided and after the signal has been put back to danger provided the train has not passed the signal during this time interval.
- (h) When the route is released by the passage of train, the overlap points shall be released only after the lapse of suitable time delay as per Table-1 after clearance of last point track circuit of the route i.e. the train is on berthing track. (However, in major yard this timing of route release can be reduced as per Table-1 with the approval of PCSTE). On cancellation, the overlap points shall be released simultaneously along with the main route.
- (i) Facility of emergency route/sub-route cancellation shall be provided and it shall be possible to release the route/sub-route with suitable time delay as per Table-1. Cancellation shall be operated after physical verification of the line by traffic representative. Every such cancellation shall be recorded on a non-resettable counter and in a register to be maintained by traffic representative.

#### **21.1.9 Signal Control Circuits**

- (a) It shall not be possible for a signal to assume 'OFF' aspect in installations provided with route setting facility unless the route switches/buttons have been operated and relevant route has been correctly set and locked and relevant track circuits are clear. In installation provided with non-route setting facility, the signal shall not assume 'OFF' aspect unless the route is set and locked, relevant track circuits are clear and signal switch/button has been operated. In case self-restoring type of push buttons are used, signal shall not assume 'OFF' aspect unless concerned push buttons are pressed simultaneously for 3 seconds and released.
- (b) Circuits shall be so designed that the failure of any part of a circuit affecting the control of the signal shall cause the signal to display a most restrictive aspect.

- (c) The circuit shall be so designed that in case of failure of lighting of a Main signal aspect at site, the more restrictive aspect is lit automatically and in case of failure of lighting of ON aspect, it shall not be possible to clear the signal in rear.
- (d) Fouling protection, approach locking, indication locking, route locking, siding control key locking, crank handle locking and track locking shall be incorporated in the relevant control circuits.
- (e) Each aspect light of a signal may be proved where necessary and the aspect indication shall be provided.
- (f) Wherever required, necessary control on the level crossing, ground frames, cabins, siding control key, crank handles etc. shall be provided.
- (g) The correspondence of the point control relays and point indication relays may be proved in signal circuits before the signal displays an 'OFF' aspect.

#### **21.1.10 Locking of Advanced Starter and Starter Signal at Junction Stations**

- (a) Starter released by Advance starter is not required at way side stations having single & double line block working, where track circuiting have been completed.
- (b) Starter released by Advance starter is required at all diverging ends of junction stations, stations having twin single line block working and also at stations where track circuiting has not been provided between starter and Advance Starter.
- (c) All signals shall be automatically replaced to 'ON' by the passage of a train past the signal. However, starter signals shall be automatically replaced to 'ON' by the passage of a train (after a specified time delay, where required as per Table-1).

#### **21.1.11 Level Crossing Gates circuits**

- (a) It shall not be possible for a main signal to assume 'OFF' position unless all interlocked level crossing gates in its route and overlap are closed and locked against the road traffic.
- (b) It shall not be possible to open any such interlocked gate at a station until the concerned signal is replaced to 'ON' position and the route up to the gate is released or it is proved by suitable circuit arrangement that train has cleared the gate.
- (c) Mid section Gate signals shall be provided with Dead approach locking with Time delay as per Table-1.
  - (i) Back locking for Gate signals in automatic signalling territory shall be provided.
  - (ii) Back Locking may also be provided, if the distance of gate of a signal to LC gate is more than 180 meters, by two track circuits (where required) based on risk assessment.

### **21.1.12 Point Control Circuits**

- (a) The points once set shall remain in the last operated position until these are operated by different route setting or by individual operation of points, except when stipulated otherwise. However, isolation points of catch siding, slip siding may operate automatically after the passage of train to their isolation position where sectional route release is provided.
- (b) Moreover, soon after CH/NX control is released, points shall not be operated by route setting operation. However, the points can be operated individually from the control panel/Control Terminal till such time the CH/NX key is not inserted in point machine.
- (c) Operation of points shall be possible only when the interlocking is free and relevant point track circuit is clear. Emergency operations, where provided when point zone track circuit fails, it shall be possible to operate the concerned point provided interlocking is free by releasing an emergency control. Each such operation shall be recorded on a counter.
- (d) Interlocking between points shall be provided only to the minimum extent necessary.
- (e) Point control circuits shall be so designed that a cross connection or a short circuit cannot operate a point or give a false indication of the same.
- (f) Hand operated points shall be equipped with circuit controllers that are operated by the switches when closed. Keys controlling such switches shall be electrically locked by the approach track back locking track circuit so that it's not possible to work them in the face of an approaching train.
- (g) Means shall be provided to cut off the motor feed in case of obstruction to the point movement after a predetermined time lag, based on the type of point machine used.
- (h) The point operating control circuits shall have track circuit control, overload protection and cross protection.

### **21.1.13 Crank Handle & Siding Control Keys**

- (a) Crank handle/point NX key provided for manual operation of the points worked by electric point machine must be interlocked with signals.
- (b) The crank handles shall be provided to facilitate operation of points in case of failure of point machines. For this purpose, if necessary, the points in the yard may be divided into convenient groups and to distinguish particular groups, crank handles with different wards shall be used. The crank handles shall, however, normally be locked. It shall be possible to release them for use in point machine by releasing a control from the control panel. With the crank handle released, it shall not be possible to clear the signal for the concerned routes. The interlocking of crank handle can also be achieved by using NX key of different wards.

- (c) It must not be possible to release the crank handle/point NX key unless the signals have been put back to 'ON' position and concerned route is released. However, if the route remains locked due to what so ever reason, it shall be possible to release the crank handle/point NX key after a time delay of 120 seconds from the time the signals have been put back to 'ON' position. Each such CH/NX keys release operation shall be recorded on non-resettable counter.
- (d) In major yard where number of points are more, these points should be grouped in different zones maintaining the yard flexibility. The crank handle/point NX key for each group of point machines should be so arranged that they cannot be interchanged.
- (e) Siding control key for manual operation of siding points, taking off from running lines, shall be so interlocked that it may not be possible to clear the signal leading over to that line when the key is released for operating siding points for shunting purposes.
- (f) It must not be possible to release the crank handle/point NX key unless the signals have been put back to 'ON' position and concerned route is released. However, in case of failure of Interlocking or for any other emergency case (E.I/both Control Terminal& Control Panel/both Control Terminals fails) an 'Extreme Emergency Key' and self restoring 'Extreme Emergency Button' shall be provided. Turning of key along with pressing of 'Extreme Emergency Button', shall restore all signals to 'ON' aspect and after a time delay as per Table-1, all CH/NX Keys shall be free and it shall be possible to release the CH/NX key. To normalize this emergency operation, ASM shall restore back the 'Extreme Emergency Key'. Each such 'Extreme Emergency key' release operation shall be recorded on a non-resettable counter.

#### **21.1.14 Cross Protection features**

- (a) For purely internal circuits including vital circuits, double cutting or cross protection may not be provided, unless specifically required.
- (b) All external circuits shall be suitably protected from cross connections and rendered immune to false operation by induced voltages in RE areas.

#### **21.1.15 Control Panel/Control Terminal [Video Display Unit (VDU)]**

- (a) Stipulations given in above paras shall apply also apply to Control Panel for Electronic Interlocking Installations. These Control Panels shall not be used in future E.I installations.
- (b) Control Terminal/multiple Control Terminals shall be of appropriate size to display layout of the Yard in well-proportioned dimensions and shall display all functions clearly distinguishable. Normally Control Terminal/multiple Control Terminals shall be provided in redundant mode.
- (c) Video Display indications on Control Terminal shall conform to Control Panel indications and UFSBI Block panel as Block working built into Electronic Interlocking (EI) as covered in Section above or other approved type.

- (d) Operation of Signals, Points and other Controls such as Gate, Crank handle, Siding, Slot, Block Working etc. shall be carried out through appropriate dropdown menus or other approved means.
- (e) Control Terminal shall have suitable protection facility against unauthorized operation which may be provided by physical 'SM Key' in a separate box and key contacts are taken to pick up two separate 'SM Key' relays in relay room for redundancy purpose. These relay contacts are taken as input through two different input cards preferable in different OC's and 'SM Key IN' bit shall be made by their parallel proving inside E.I.
- (f) All Emergency operations shall be two-step process protected against unintended operations.
- (g) Control Terminal shall have provision for Signal, Point and Line Block Collars equivalent of Control Panel in the form of individual 'Block' & 'Un-Block' feature which shall remain effective even during changeover from one Control Terminal to other Control Terminal. 'All Un Block' option shall be provided while E.I starts up to un-block all signals, points & lines after a time delay of at least 120 seconds. SM's key shall be required for unblocking of a function whereas no SM's key required for blocking. There should not be any automatic unblocking of functions. Blocking of a function shall be indicated on Control Terminal by different mark or colour over the concerned function.
- (h) Where Control Panel and Control Terminal are provided, it shall be possible to switchover the controls from Control Panel to Control Terminal and vice-versa, and where two Control Terminals are provided, it shall be possible to switch the controls from one Control Terminal to other Control Terminal through suitable means by either manual switch or password.
- (i) Indication that E.I system is healthy shall be displayed on the Control Panel using a blinking green LED or blinking green indicator on Control Terminal.
- (j) Operation of points shall be possible only, when the interlocking is free and relevant point track circuit is clear. Emergency operations provided when point zone track circuit fails and after line verification from site by traffic personnel, it shall be possible to operate the concerned point by inserting an emergency key in a separate box provided interlocking is free. Each such operation shall be recorded on a non-resettable counter.
- (k) Each 'Normal' or 'Reverse' operation of point shall be controlled through two output relays derived from two output bits should be from different output cards of E.I.
- (l) Last controlled position of points shall be available by using latch relay in point control circuits.
- (m) Mid stroke point reversal preventing feature shall be provided to prevent starting of operation when the point is under operation or tried for other position during mid stroke.

- (n) Maintenance Terminal of Electronic Interlocking system shall be provided for the Signal Technician.
- (o) Block Working built into EI shall be provided for line clear purpose. It shall be possible to take a line clear when block section is clear upto first stop signal including Block overlap. Indication of Block built into VDU and indication of TCF, TGT, TOL, Bell, Block clear, SNK, SNOEK shall be as per drawing no. RDSO/S/32019.

#### **21.1.16 Precautions for design of circuits using Electronic devices**

The following fail-safe principles shall be incorporated in the design of the equipment.

- (a) Component failure shall be self-detecting by way of causing a signal to display a most restrictive aspect as far as practicable.
- (b) All fail-safe circuits shall work on continuous energisation principle such that open circuits in wiring, relay contacts, etc., or loss of power supplies shall not cause unsafe conditions.
- (c) Due consideration shall be given to the effects of faults in fail-safe electronic equipment to allow open or short circuit or earthing conditions and variation in component values due to ageing, replacement of faulty component with new components of specified tolerance, etc. Safety shall not be impaired as a result of multi-terminal devices failing-either open circuit, short circuit or with partial short circuit between any pair of terminals or earthing.
- (d) The physical construction of fail-safe equipment shall be designed to eliminate the possibility of external objects causing short circuits between combinations of terminals in vital circuits. This may be achieved for example, by adequate separation of terminals, and by the fitting of protective shrouds where necessary.
- (e) Stipulated guidelines shall be followed in the design, Installation, Testing, Commissioning & Maintenance of Electronic Equipments/Systems.

#### **21.1.17 Train Detection (Track Circuits & Axle Counters)**

- (a) Provisions of SEM [Chapter 17](#) on Train Detection (Track Circuits & Axle Counters) shall be followed.
- (b) DC track relays shall be centralized in location/relay room only by using separate cables of adequate cross section.
- (c) Track circuiting of the entire station section including all lines where direct reception is provided shall be done.
- (d) Type of Axle Counter – SSDAC, HA-SSDAC, MSDAC and Location of Track section Proving Relays and Type of Interface - whether Signal Cable or Quad cable or OFC shall be considered.

### 21.1.18 Signalling Cables.

- (a) Provisions of [Chapter 15](#) of SEM on Cables shall be followed.
- (b) At least two cores of cable shall be provided between two ends of the yard to cater for telephone communication for maintenance purposes in non RE areas. Where the yard is extending over a large area, the location boxes may be grouped and one socket may be provided in one of the location boxes in the group so that telephone communication is conveniently available for co-ordination with the cabin during maintenance or rectification of failures of various ground equipments. Where such groups are situated in different directions from the cabin, a separate pair of conductors shall be used for each direction connected to the cabin. In RE area, provision shall be made for telephone communication through a telecommunication cable if already available or a separate telecom cable shall be laid for the purpose.
- (c) Earth leakage detectors of approved type may be provided to detect any leakage to earth in cable conductors.

### 21.1.19 Signals in Outdoor

- (a) The main signals shall be of multi unit colour light type. Shunt signals shall be of position light type. LED signals of approved type shall be used.
- (b) Route indicators shall be either of the direction type or multi lamp unit type or of Stencil type conforming to approved design.
- (c) 'A' & 'AG' marker lights for semi-automatic signals shall be of approved type.

### 21.1.20 Point Machines - Operation

- a) The point operating control circuits shall have track circuit control, overload protection and cross protection.
- b) Crank handles with different wards shall be used. The slots in the point machines provided to take the crank handles would also be suitably made to take only the crank handle applicable to the group. The crank handles shall, however, normally be locked. It shall be possible to release them for use in point machine by releasing a control from the control panel. With the crank handle released, it shall not be possible to clear the signal for the concerned routes. The interlocking of crank handle can also be achieved by using NX key of different wards.

Notes:- (i) For more details of Installation of Outdoor signalling Equipment, Refer to [Chapter 19](#).

(ii) In case of alterations to existing installations, Detailed documentation for alterations, duration of Non-Interlocking/Disconnection & sequence of working shall be made carefully and concerned staff to be briefed.

### 21.1.21 Various Timers in Signalling circuits shall be as given below in Table-1.



Para no:21.1.21			
Timers in Various circuits – Table-1			
S.No	Description	Delay in seconds	Conditions/Remarks
1	Main Stop Signal (Route cancellation)-Home, Starter etc	120	1) Before movement, if back lock track circuits are clear. Sub routes (if any) should also get released with main route. 2) After movement, either back lock track circuits are clear or after physical verification by SM, if any back lock track circuit has failed.
2	Sub Route (Emergency Cancellation)	120	1) Where a route is divided into sub routes and such facility is operationally required. 2) On physical verification of the route by SM if any back Lock track circuits is showing occupation.
3	Crank handle (CH) emergency key release time	120	Points are locked due to failure in any route/sub route. Cancellation timer to start after cancellation buttons are operated duly putting back to ON position those signals which were taken OFF.
4	Shunt Signal (Route cancellation)	120	1) Before movement, if back lock track circuits clear. Sub routes (if any) should also get released with main route. 2) After movement, either back lock track circuits are clear or after physical verification by SM, if any back lock circuit has failed.
5	Calling On Signal (Route cancellation/Release)	120	1) Proving all back lock track circuits are clear (if they are functional). 2) Emergency cancellation of calling route (without proving any back lock track) can be provided, on physical verification of the full route by SM.
6	Signal Overlap (release)	120	Timer to start automatically , on clearance of last back track circuit of Home Signal route and on occupation of berthing track circuit (or as soon as Train has passed beyond signal overlap track circuits in which case timer gets bypassed).
7	-do-	60	For big yards with the approval of PCSTE. On clearance of last back track circuit of Home Signal route and on occupation of berthing track circuit.
8	Calling On Signal below Home (Initiation)	60	Calling on track circuit is occupied.
9	Calling On Signal below the starter (Initiation)	0	SM to ensure that train has come to a stop, before taking Off Calling-on.

Para no:21.1.21			
Timers in Various circuits – Table-1			
S.No	Description	Delay in seconds	Conditions/Remarks
10	Opening of LC gate (Gate signal at 180 m from LC)	60	1) Timer shall start on putting back the Gate signal. 2) If two track circuits are provided to prove that train has passed beyond LC gate, such sequential proving is adequate to open LC gate immediately with out waiting for completion of 60 seconds.
11	Opening of LC gate (Gate signal at more than 180 m from LC)	120	1) Timer shall start on putting back the Gate signal. 2) If two track circuits are provided to prove that train has passed beyond, LC gate, such sequential proving is adequate to open LC gate without waiting for completion of 120 seconds.
12	Opening LC Gate (Traffic Gate)	120	When route/sub route is locked, LC gate opening control can be given after 120 sec time delay by applying cancellation, duly putting back the signals taken OFF.
13	Opening of LC gate in automatic section	120	When approach track circuits of an automatic signal protecting LC gate have failed.
14	Crank handle/LC gate key Extraction	120	To extract keys when Electronic Interlocking/VDU has failed.
15	Point failure alarm	15	Alarm to SM that point has failed to operate.
16	Point Operation timer	10	Point contactor relay to de-energise and cut off power to Point Machine to protect it.
17	Signal blank buzzer	10	Alarm to SM if any signal goes blank by proving that all ECRs are de-energised
18	Panel Button struck up alarm (Button type panels)	10	Alarm to SM, whenever any button is struck up in button type panels
19	HR Relay de-energisation	5	Slow to drop for HR relay of starter where starter is placed at 3 meters from controlling Track Circuit glued joint/Detection Point, to avoid confusion to Loco pilot
20	Holding HR relay energised	3	To prevent signal bobbing, in case of intermittent failures of Track circuit's/Point detection due to loose packing.
21	HR control timer de-energisation	5	For HR control timer de-energisation, if read back is not received from Concerned signal as per command given by Electronic Interlocking
22	Power failure Alarm	5	Alarm to SM, if all power supplies fail
Note: Above timers where not yet existing, may be provided for new works and major alterations.			

## Section 2: Installation & Testing of Relays

### 21.2.1 Relays – General Requirements:

- (a) Approved type of Plug-in Line relays of Neutral/Polar Biased/Magnetic latch/Interlocked type rated at 24/48/60 V DC shall normally be used. Approved type of LED Lamp proving relays shall be used for LED signal lamps.
- (b) Approved type of Relays shall be used in RE & Non-RE areas. Various types of relays used in signaling are given in [Annexure: 21-A1](#).
- (c) Time element relays of approved type shall be used. Where approved electronic time element relays are used, these shall be two in number and their contacts shall be in series in the concerned time release circuits.
- (d) The relays, including track relays, located in the track side location boxes, shall be plug-in type.
- (e) All plug-in relays and relay groups shall be provided with coding pin arrangement to prevent the wrong relays/relay group being accidentally plugged-in during replacement. All relays, relay groups shall be sealed.
- (f) As far as possible, all relays shall be housed in the relay room of the controlling cabin to achieve maximum centralization.
- (g) Sequential proving of front and back contact shall be ensured where metal to metal contact relays are provided.
- (h) Removal or replacement of plug-in relays/relay groups from the relay racks during operation shall not cause any unsafe conditions in the circuits.
- (i) Where feasible all relays except track relays, shall have 10% of working contacts as spare subject to a minimum of one front and one back to facilitate addition and alteration to the circuits at a later date. Extra space (minimum 10%) to accommodate repeater relays shall be provided in the relay rack to cater for future expansion.
- (j) Where magnetic latch relays are used, the circuit shall be so designed so as to prevent undue dropping of the relay due to back EMF generated by other relays.
- (k) Wiring of 'Q' type relays shall be done through flexible multi strand wire preferably and contacts to be paralleled as feasible.
- (l) Mercury wet contact type relay shall be used for flasher circuits, alternatively, a solid state flasher may be used. If solid state flasher is used, flashing indication on operating panel should be provided for indicating healthy condition of flasher.
- (m) Relays shall not be stored in the vicinity of damp or chemically polluted environment.
- (n) Sealing screws of the relays shall be intact.
- (o) Care shall be exercised in transporting the relays from the place of storage to the work site so that the relays do not get damaged.

### 21.2.2 Fixing in Relay Room

As far as practicable, the relay room is not located in the vicinity of chemical factory, loco shed or engine ash pits etc. In case it becomes unavoidable, necessary precautions shall be taken so that relays are least affected by the chemical fumes, dust etc. and are provided with dust free environment. Relay room shall be provided with double locks and door opening shall be monitored through Datalogger.

- (a) Where Relays cannot be located in the Cabin, they shall be housed in location box of approved type which are properly secured.
- (b) In 'Q' style relay the code pins configurations for plug in relay shall not be changed by drilling additional holes on plug board to avoid fixing of a wrong relay which may lead to unsafe condition. In Siemen's K-50 relays, the Code pins position on base plate should not be changed and to be retained as fixed by the manufacturer.
- (c) All relay clips shall be checked for proper locking in the base when plugged in. Extreme care shall be exercised while removing the clips from the jacks of the plug-in type relay.
- (d) In all installations, a relay index board shall be provided for locating relays easily.
- (e) Relays involving external circuits shall have cross protection and double cutting. Signal control relays shall preferably be provided with double cutting.
- (f) A contact analysis chart shall be prepared duly showing the contacts used circuit-wise with reference and spare contacts available, wire count for each contact and relay position in the rack.
- (g) Number of contacts in a circuit shall not exceed 45 Nos. due to voltage drop consideration. The voltage across R1 & R2 of a relay shall not be less than 22 V.
- (h) Where available, spare contacts shall be paralalled with working contacts.

### 21.2.3 Sealing of Plug-in Relays

- (a) In case of metal to carbon contact type relays, sealing shall be done at Manufacturer's premises before dispatch and if the seals have to be broken due to any defect noticed, resealing must be done at the workshops.
- (b) In case of metal to metal contact type relays, sealing of the cover shall be done by not below the rank of JE (Signal) at site. Whenever seals have to be broken at site for maintenance purposes, the same shall be done by an official not below the rank of JE(Signal).
- (c) Line Relays shall be energized at the rated voltage specified in the specification.

#### **21.2.4 Maintenance of Relays**

- (a) Cleaning shall be done regularly so that dust is not deposited on the relay. There is no loose connection on the terminals, plug in relays is fitted tightly & the sealing is intact. Metal contacts are not blackened due to arcing. There is no pitting of carbon contacts. No foreign materials or water vapor which can cause fungus formation, are inside the relay. There is no rusting or sulphation on the parts. Relays are not due for P.O.H., wherever applicable.
- (b) During routine inspection and maintenance, if high contact resistance is observed on any contact of a relay, spare contact to be used or the relay should be replaced.

#### **21.2.5 Periodical Inspection of Relays**

Sectional SSE/JE (signal) shall visually inspect the relays, with particular attention to those used in vital circuits. During visual inspection, relay shall be taken out of service if any of the defects are noticed in respect of;

- (a) Movement of armature and contact carriage
- (b) Wiping of contacts
- (c) Arcing of contacts
- (d) Pitting or charring of contacts
- (e) Dust accumulation on contacts
- (f) Electro-plating
- (g) Corrosion, rusting of components
- (h) Crack or breakage in components
- (i) Presence of fungus and ants inside the relay casing
- (j) Charring of cover near contacts in the case of plug-in-type relays
- (k) Corrosion of Label
- (l) Absence or tampering of seal
- (m) Effectiveness of relay retaining clip to be checked in case of Q style Plug-in type relays
- (n) Any other abnormal condition

#### **21.2.6 Replacement of Relays:**

Metal to carbon contact miniature plug-in type relays should not be overhauled. These relays except track relays should not be used after completion of the codal life of 25 to 30 years or after their failure. Plug in type track relays have to be replaced on completion of 12 years or earlier if warranted by the actual condition of the relay and/or its usage.

## Section 3: Installation of Relay Interlocking

### 21.3.1 Wiring and Relay Racks

- (a) The wiring used in various equipment shall comply with the requirements laid down in IRS specification No. S 23.
- (b) All wiring in the cabin and locations shall be done in a neat manner so that the wiring does not in any way prevent the proper functioning over working parts and is easily accessible for maintenance.
- (c) All wiring in the cabin and location shall be terminated on approved type terminal blocks/tag blocks unless otherwise specially permitted.
- (d) At all locations and cabins, cable/entry arrangements of adequate size, conveniently located for ease of approach to terminals and other equipment so arranged as to protect the wires from damage, shall be provided. Such cable/entry arrangements shall be plugged and sealed with suitable compound after the wiring is completed.
- (e) The internal wiring of relay rack in locations and cabin shall be generally carried out with plain annealed copper conductors; PVC insulated unarmoured flame retarding type of 1100 V grade unless otherwise specially permitted. The size of the conductors may be as follows:

	Type	Size
(a)	Single Core size	1 mm
(b)	Multi core each core of size	1 mm
(c)	Multi core each core of size	0.6 mm
(d)	Flexible insulated wire size	16/0.20 mm
(e)	Flexible multi strand wire size	3/0.75 mm

- (f) Rack to rack wiring shall be generally carried out with multi core cable having plain annealed copper single core conductor of size 1/0.6 mm or multi-strand 16/0.2 mm as per approved specification for indoor cables.
- (g) Following practice shall be adopted for internal wiring. The connecting wires shall be terminated on eyelets/lugs/receptacles unless otherwise specially permitted.
  - (i) All connections to plug-in non-proved type relays flexible wire of 16/0.20 mm shall be used.
  - (ii) All connections to proved typed relays shall be done with 0.6/1 mm single strand multi core cable.
  - (iii) For all connections from cable terminations to tag blocks and indicators etc. shall be done with the help of 1 mm single strand wires.
  - (iv) For all connections to circuit breakers, lever locks etc. single strand wire of 1.5/1.6 sq. mm size shall be used.

- (h) Relay to Relay wiring on the same rack should be as far as possible direct without intermediaries like tag block/terminals.
- (i) Identification Marker for identifying the terminals and tags shall be provided to each terminal to identify the circuits for which it is used.
- (j) Relay racks shall have sufficient capacity to take additional equipment to the extent of 15% of equipment provided to permit additions and alterations.
- (k) Charts showing the position of relays on relay racks and contact analysis of relays indicating the spare and used contacts shall be prepared and kept in the relay room.
- (l) For future expansion, provision shall be made to accommodate additional relays, relay groups & racks in the relay room.

### **21.3.2 Fuses, Terminals and Terminal Links**

- (a) Cartridge type fuses shall preferably be of Non deteriorating type. Where screw cap cartridge type fuses are used, these shall be of different colour codes for different current rating and these shall be non - interchangeable.
- (b) Fuses shall be so grouped that blowing of a fuse has minimum repercussion on train operation.
- (c) The fuses when blown off, shall preferably give a visual indication.
- (d) Each group of circuits shall be carefully protected by fuses in the cabins and in location to facilitate easy fault localization.
- (e) Fuses shall be so arranged that they can be easily replaced without causing interference or unsafe conditions to other circuits.
- (f) Cartridge fuse links shall be approved type.
- (g) The terminal block and tag blocks shall be of approved type unless otherwise specially permitted.
- (h) The terminal boards provided at the locations and other places shall be provided with suitable links to facilitate isolation of the two sides of the circuits which are connected through the terminal links.
- (i) For vital circuit fuse auto change over system of approved type to be provided.

### **21.3.3 Power Supply Arrangements**

The power supply systems for Signalling Installations shall be as per details given in [Chapter 16](#) on "Power Supply Arrangement systems for Signalling Installations".

### **21.3.4 General Arrangements**

- (a) Air conditioning may be provided for every signalling interlocking (PI/RR) installation with more than 100 routes. For E.I installations air conditioning may be provided irrespective of number of routes to improve reliability.

- (b) For other signalling installations, with less than 100 routes, air-conditioning may be provided for those installations which are
  - (i) prone to dust (coal dust, stone dust, iron ore etc.) or
  - (ii) in the vicinity of chemical/fertilizer/other industrial factories releasing harmful fumes or
  - (iii) in areas with extreme temperature with the agreement of PCSTE and PCEE.
- (c) AC equipments shall be provided and maintained by Electrical department. Such ACs shall be connected with the local power supply. The switch to operate AC shall be outside the relay room.
- (d) 'Automatic Fire Detection and Alarm System' may be provided at all stations irrespective of number of routes.
- (e) 'Automatic Fire Suppression System' along with "Automatic Fire Detection And Alarm System" may be provided at stations with more than 400 routes.

*Note: In case provision of "Automatic fire suppression system" along with "Automatic Fire Detection And Alarm System" is considered desirable by Zonal Railways at critical stations and important junction stations even below 400 routes, same may be provided with the approval of competent authority (i.e. PCSTE).*

- (f) Firefighting equipment shall also be kept in the power supply equipment room.
- (g) Suitable standard earthing shall be provided for all control panel, power supply, switch board, transformers, inverters etc.
- (h) At all Relay Interlocking Installations, Data Logger shall be provided.
- (i) Communication between the SM's panel room, relay room, equipment room and locations shall be provided.

**21.3.5 Lightning & surge protection, Earthing:** Shall be done as per Section 5 of this chapter.

#### **21.3.6 Testing & Commissioning of Relay Interlocking:**

- (a) Once the indoor wiring works are completed before conducting the system Integrity testing, simulation test shall be conducted by simulating field gears such as Track circuits, Signals & Points on a simulation panel and errors removed. This will ensure the correctness of indoor wiring before connecting to outdoor gears.
- (b) Testing of wiring & Commissioning shall be done as per [Para 19.8.5 to 19.8.12](#).
- (c) Recommended check list of items for commissioning is given at [Annexure: 21-A2](#). This list may be suitably modified as needed.



## **Section 4: Electronic Interlocking (EI)**

### **21.4.1 Essential Requirements of Electronic Interlocking**

- (a) Electronic Interlocking System shall be approved type and shall conform to latest approved specification.
- (b) Electronic Interlocking System shall have the highest level of safety integrity as stipulated.
- (c) Electronic Interlocking System shall be suitable for working on Electrified and Non-Electrified sections.
- (d) Electronic Interlocking System Installation shall be of Route setting type using Dropdown menu Or Entry/Exit control with a facility for individual operation of points.
- (e) Signalling and interlocking arrangements for the Yard shall be in accordance with the approved Signal Interlocking plan (SIP) and Control Table.
- (f) Electronic interlocking system shall be capable of working with Control Panel or/and Control Terminal.
- (g) Electronic Interlocking system shall have adequate built-in redundancy as per approved specification.
- (h) Provisions given in Sections 1, 2 given above are generally applicable for Electronic Interlocking also.

### **21.4.2 Control Terminal (Video Display Unit (VDU))**

- (a) Same requirements given in [Para 21.1.1](#), [21.1.2](#) shall apply for existing Control Panels (where provided) for Electronic Interlocking (E.I) installations. Control Panels shall not be used in future Electronic Interlocking installations.
- (b) Control Terminal/multiple Control Terminals shall be of appropriate size to display layout of the Yard in well-proportioned dimensions and shall display all functions clearly distinguishable. Normally Control Terminal/multiple Control Terminals shall be provided in redundant mode.
- (c) Video Display indications on Control Terminal shall conform to Control Panel indications as covered in [Para 21.1.4](#) or other approved type.
- (d) Operation of Signals, Points and other Controls such as Gate, Crank handle, Siding, Slot etc., shall be carried out through appropriate dropdown menus or other approved means.
- (e) Control Terminal shall have suitable protection facility against unauthorized operation which may be provided by physical 'SM Key' in a separate box and key contacts are taken to pick up two separate 'SM Key' relays in relay room for redundancy purpose. These relay contacts are taken as input through two different input cards preferable in different OC's and 'SM Key IN' bit shall be made by their parallel proving inside E.I.

- (f) All Emergency operations shall be two-step process protected against unintended operations.
- (g) Only non-resettable counters shall be provided while working with Control Panel or Control Terminal.
- (h) Control Terminal shall have provision for Signal, Point and Line Block Collars equivalent of Control Panel in the form of individual 'Block' & 'Un-Block' feature which shall remain effective even during changeover from one Control Terminal to other Control Terminal. 'All Un Block' option shall be provided while E.I starts up to un-block all signals, points & lines after a time delay of at least 120 seconds. SM's key shall be required for unblocking of a function whereas no SM's key required for blocking. There should not be any automatic unblocking of functions. Blocking of a function shall be indicated on Control Terminal by different mark or colour over the concerned function.
- (i) Where Control Panel and Control Terminal are provided, it shall be possible to switchover the controls from Control Panel to Control Terminal and vice-versa, and where two Control Terminals are provided, it shall be possible to switch the controls from one Control Terminal to other Control Terminal through suitable means by either manual switch or password.
- (j) Indication that E.I system is healthy shall be displayed on the Control Panel using a blinking green LED or blinking green indicator on Control Terminal.
- (k) Operation of points shall be possible only, when the interlocking is free and relevant point track circuit is clear. Emergency operations provided when point zone track circuit fails and after line verification from site by traffic personnel, it shall be possible to operate the concerned point by inserting an emergency key in a separate box provided interlocking is free. Each such operation shall be recorded on a non-resettable counter.
- (l) Each 'Normal' or 'Reverse' operation of point shall be controlled through two output relays derived from two output bits should be from different output cards of E.I.
- (m) Last controlled position of points shall be available by using latch relay in point control circuits.
- (n) Mid stroke point reversal preventing feature shall be provided to prevent starting of operation when the point is under operation or tried for other position during mid stroke.
- (o) When embedded block working in Electronic Interlocking is used, all indications like TGT, TCF, LC etc required for block working shall also be displayed

#### **21.4.3 Interface with Electronic Interlocking**

- (a) Interface between Control Panel, Video Display Unit and Electronic Interlocking system shall be of approved type.
- (b) Interface of Points, Signals, Track Circuits and Controls such as Crank Handle, LC Gate, Siding, Slot etc., with Electronic Interlocking System shall be through Relays of approved type or through any Electronic Modules of approved type conforming to approved specification. Interface with E.I of adjacent station, Digital axle counter shall be of approved type.

- (c) Interface between external data logging equipment and Electronic Interlocking system shall conform to approved specification.
- (d) Electronic Interlocking System shall be capable of being controlled and monitored from a either centralized location or distributed locations as per requirement at site.
- (e) It shall be possible to network the Electronic Interlocking Systems for diagnostic function to a centralized location.
- (f) Electronic Interlocking system may be capable of being networked with other systems for the purpose of centralized control and monitoring.

#### 21.4.4 Interlocking & Circuit Requirements

- (a) Interlocking application logic (site specific data) requirements for the E.I system shall be as per interlocking principles stipulated for Relay Interlocking and Standard Circuits for Electronic Interlocking.
- (b) It shall be possible to modify application logic for yard remodeling or change in interlocking using approved type of user interface.

*(Note: For Standardised Typical Circuits of Electronic Interlocking, may refer to*

[http://10.100.2.19/signal/policy/uniform\\_circuit\\_diagram/Report%20SS%20155%202019%20\(std%20ckts%20of%20EI\)%20Booklet%20print.pdf](http://10.100.2.19/signal/policy/uniform_circuit_diagram/Report%20SS%20155%202019%20(std%20ckts%20of%20EI)%20Booklet%20print.pdf)

#### 21.4.5 Powering up of Electronic Interlocking

- (a) Electronic Interlocking system shall drive all the relevant signals to the most restrictive aspects whenever internal failure of any nature arises or when Electronic Interlocking system is powered up or during shutdown.
- (b) After powering up of Electronic Interlocking the system shall block all signals and other operations. After verification of safety functions by Electronic Interlocking system, this blocking shall be released after a delay of at least 120 seconds.

#### 21.4.6 Configuration of Electronic Interlocking

- a) Electronic Interlocking system shall have hot-standby arrangement and changeover from one system to other systems shall not interrupt status of signalling.
- b) Electronic Interlocking system shall be of either **Centralised or Distributed type** as per approved specification and as per policy directives.
- c) In case of Distributed configurations, redundancy with route diversity in OFC communication media and power supply system shall be provided for linking the subsystems.
- d) Electronic Interlocking system in any configuration shall have time synchronisation.

#### **21.4.7 Version Control of Softwares of Electronic Interlocking**

- (a) Version of the Generic System software and hardware shall be approved and controlled by authority competent to approve the Electronic Interlocking system and its specifications.
- (b) Version and checksum of the Application logic (station specific logic) shall be unique for the installation and shall be approved by the authority competent to approve the circuit diagrams. Corresponding Checksum shall be recorded and controlled by the same authority.
- (c) Version number and Checksum shall change whenever any modifications are carried out to the Application logic (site specific logic).
- (d) A proper record of Checksums shall be maintained at Station, Divisional Headquarters and Zonal Headquarters as a part of completion circuit diagrams.

### **Section 5: Installation & Testing of Electronic Interlocking**

#### **21.5.1 Installation of Electronic Interlocking**

- (a) Installation of Electronic Interlocking system shall be done as per approved guidelines and technical advisory notes issued from time to time.
- (b) Application logic (site specific logic) shall be verified for safety and functionality by carrying out exhaustive safety and functionality tests by officers authorized by PCSTE.
- (c) Only approved application logic with specified checksum shall be used in the E.I system and this data and checksum shall be version controlled and preserved by the Railways.
- (d) Electronic Interlocking is required to be provided in dust proof cabinets of approved type having transparent front door.
- (e) Interface Relays, where provided, shall be of approved type and contacts should be paralleled as far as possible for better reliability.
- (f) Wherever possible, the spare input/outputs shall also be wired from E.I cards up to Wago terminals for ease of carrying out future alterations.
- (g) The input and output cables of E.I shall be twisted to minimize EMI & EMC effect.
- (h) Electronic Interlocking system shall be installed closer to Operator Room, preferably adjacent room. Track crossing should be avoided between main E.I system and operator room.
- (i) The Electronic Interlocking room shall be provided with tiles or similar arrangements on floor and walls to avoid periodic painting of walls and resultant dust.

- (j) FRP or insulated ladders arrangement shall be used to carry wires from rack to rack or from other equipment.
- (k) All entries to Electronic Interlocking room shall be suitably sealed to prevent entry of rodents, lizards, insects etc.
- (l) Electrostatic Floor Pads and Hand bands shall be provided near electronic equipment to prevent damages to electronic equipment due to electrostatic discharges.
- (m) The room where Electronic Interlocking is installed shall be provided with Air-conditioning.
- (n) The building/room where E.I is installed shall be protected by External Lightning protection arrangement at the top of building. In case there is any other metallic earthed structure is available nearby which protects the E.I building, then separate Class A at top of E.I room is not required. The guidelines in National Building Code of India (2016 or latest) shall be followed for calculations.
- (o) Surge and lightning protection devices of appropriate class and rating shall be provided for the regulated power lines before extending them to Electronic Equipment Room. All equipment in Electronic Equipment Room shall derive power from these regulated and protected power lines (clean), but not from electrical service lines (dirty) used for room lighting air-conditioning or fans.
- (p) Clean and dirty wiring shall be clearly segregated and routed in different enclosures/ladders, and where this is not feasible, a minimum distance of 150 mm between clean and dirty wiring shall be maintained.
- (q) If clean and dirty wiring need to cross at any place, then wiring should be arranged at perpendicular to each other.
- (r) Indicative type surge protection devices of appropriate class and rating shall be installed for all copper based external interface ports (power, communication, maintenance terminal, control panel interface etc).
- (s) The connectivity between E.I and sub-systems like Control Terminal, Control Panel, and Object Controller shall be planned with OFC cable to avoid damage due to surge and lightning. The OFC shall be provided in redundant manner to avoid failure due to cut/damage in one location/path.

### **21.5.2 Testing Of Electronic Interlocking**

- (a) For Electronic Interlocking, the integrity of interlocking inside E.I designed for a specific station can be tested at factory which is termed as Factory Acceptance Test (FAT). This interlocking when installed at site and interface wiring is connected then the test carried out as laid down for relay interlocking, it is termed as Site Acceptance Test (SAT).

(b) **Tests to be performed during FAT:** FAT testing is performed with the computer simulation. Only the testing of interlocking on Application Software with reduced time as per SIP and RCC is performed during this stage. Interface with I/O card, intercommunication is not checked as E.I hardware is not used in FAT. Hence, the following test are to be usually done during FAT (Computer Simulation), besides any other tests as required-

- (i) Control Table (including Negative Testing).
- (ii) Cross Table (Also known as Square sheet testing).

(c) **Tests to be performed in SAT (for new installations):** In SAT, similar testing is being performed at site with E.I hardware and simulation panel in first stage. The correspondence & Interface testing are also performed after interface with field gears.

Any other test may also be conducted as required.

- (i) Logic and interlocking testing:
  - Control Table (including Negative Testing).
  - Cross Table (Square sheet).
- (ii) Interface and Equipment functional Test:
  - Intercommunication test between sub-racks,
  - Correspondence test

(d) **Tests to be performed in SAT (for alteration works):-**

- (a) When the existing ports (I/O and communication) are not disturbed, the following tests, besides FAT, and any other tests as required, are to be done;
  - (i) Logic and interlocking testing Control Table to the extent as decided by the Zonal Railway.
  - (ii) Interface and Equipment functional Test:
    - Correspondence test (new additions)
    - Intercommunication test between sub-racks (if any new addition)
- (b) When the existing ports (I/O and communication) are disturbed, the following tests, besides FAT, and any other tests as required, are to be done;
  - (i) I/O port correspondence check between Application logic and Interface circuits.
  - (ii) Logic and interlocking testing Control Table to the extent as decided by the Zonal Railway.
  - (iii) Interface and Equipment functional Test:
    - Correspondence test (new additions)
    - Intercommunication test between sub-racks (if any new addition)

*Note: (i) FAT should preferably be conducted at factory premises. However, FAT can also be done at railway premises at central location but not at the site. For this, the setup should be made by all the Zonal Railways.*

*(ii) FAT & SAT should be done by separate officials where ever feasible.*

### **21.5.3 Power Supply for Electronic Interlocking**

- (a) Adequate redundancy in power supply arrangements for E.I systems including Control Terminals shall be provided as per approved specifications and guidelines.
- (b) Wires connecting equipment shall be of adequate size so that there is not more than 0.5% loss in voltage.
- (c) The power supply for fan shall be fed with separate external supply, which should be completely isolated from Electronic interlocking supply and same shall be provided with fuse.

**21.5.4 Lightning & surge protection, Earthing:** Shall be done as per [Section 7](#) of this chapter

### **21.5.5 Testing & Commissioning of Electronic Interlocking:**

Wiring, Testing & Commissioning shall be done as per [Para 19.8.5 to 19.8.12](#).

Recommended check list of items for commissioning is given at [Annexure: 21-A2](#). This list may be suitably modified as needed.

## **Section 6: Maintenance of Interlocking**

### **21.6.1 Periodicity of Tests (for existing installations-Relay interlocking/Electronic Interlocking)**

All the tests indicated in this chapter shall be conducted at the time of new installation or making any alteration to the existing installations.

- (a) In a working installation, the following periodical tests shall be done:
  - (i) Physical inspection once in a year or earlier as feasible.
  - (ii) System integrity test as per [para 19.8.8](#) once in five year or earlier if interlocking is altered.
  - (iii) Insulation tests on Cables as per [Chapter 15 of SEM](#).
  - (iv) Test of individual equipment in accordance with specifications and instructions applicable for each apparatus as stipulated in current Chapter.
- (b) It will be personal responsibility of SSE/JE (Signal) to test all Electrical signalling circuits of relay interlocking up to 20 routes.
- (c) It will be personal responsibility of ASTE/DSTE concerned to test all electrical signalling circuits of relay interlocking with more than 20 routes.

### 21.6.2 Specific tests for Electronic interlocking

- (a) Maintenance of Electronic Interlocking system shall be done as per approved system maintenance manuals. A general maintenance schedule for Electronic interlocking is provided for guidance at [Annexure: 21-MS3 in Appendix I](#).

*Note: At stations having dense traffic and high speed, the Railways may prescribe more frequent inspections, if considered necessary.*

- (b) Maintenance Terminal of Electronic Interlocking system shall be provided in the Signal Technician Duty room.
- (c) Latest E.I station database files (application logic, Control Terminal database, etc.) shall be kept updated in centralized server as specified.
- (d) Periodic testing of redundant systems shall be carried out. Checksums shall be verified during periodic inspections.
- (e) Additional References for Electronic Interlocking.
  - (i) Relevant International Standards (or equivalent standards) with latest revisions are also applicable to development and implementation of safety related railway signalling systems and projects including Electronic Interlocking. IEC stands for “International Electro technical Commission” and CENELEC stands for “European Committee for Electro technical Standardization”.
  - (ii) RDSO Specifications and Technical Advisory Notes (TAN) with latest amendments are applicable for design, installation, testing and maintenance of Electronic System.

## Section 7: Lightning & Surge Protection for Signalling Equipments

**21.7.1 Lightning-General:** Lightning and surge protection shall be provided to protect Electrical & electronic signalling equipments from lightning & surges.

- (a) S&T equipment shall be protected as per National Building Code 2016 (NBC 2016) and IEC 62305. S&T equipment, including those given below, are to be grounded and protected from lightning surges. Code of Practices, Technical Advisory Notes, Guidelines issued by RDSO on the subject shall be taken into consideration.
  - (i) Electronic Interlocking Installations including Object Controllers.
  - (ii) BPAC Systems, Axle Counter Systems, Integrated Power Supply Systems.
- (b) Equi-potential bonding to be provided for all the equipment for effective lightning and surge protection in Signal Equipment Rooms.
- (c) External Lightning Protection and Class/Type I, II & III devices are to be provided at



- (i) External Lightning Protection on Top of Buildings housing S&T equipment.
- (ii) Class B/Type-I devices at the Input of Power Supply Equipment.
- (iii) Class C/Type-II devices at Output of Power Supply Equipment.
- (iv) Class D/Type-III devices at Indoor and Field Equipment.

#### **21.7.2 Earthing for Electronic Interlocking**

- (a) Earthing shall be provided as per approved specifications, drawings and code of practice.
- (b) To the extent possible, perimeter earth shall be provided around the Electronic Interlocking room.
- (c) Earth value shall be less than one ohm and shall be measured annually during dry season.
- (d) Copper tape (Bonding ring conductor) as per drawing mounted on insulated stand-off is provided to cover the maximum area in the Relay room and the connection to equipment shall be made at the nearest point.
- (e) Earth wire from Surge protection device to main earth terminal inside the room should be as straight and short as possible to provide a low impedance path for discharge of surge energies.
- (f) Earthing wires from electronic interlocking subsystems to main earth terminal shall be of distinctive color. Green or Green Yellow (GNYE) color is recommended for quick identification of a loose or disconnected earth wire.
- (g) All earth wires shall be as straight as possible and shall never be coiled. All Earth wires should be made of copper of adequate current carrying capacity and should never be less than 4 Sq.mm cross section.



*Note: This Chapter has under mentioned Annexures*

<b>S.No</b>	<b>AnnexureNo.</b>	<b>Description</b>
1	<a href="#">21-A1</a>	Relays for Railway Signalling
2	<a href="#">21-A2</a>	Pre Commissioning Check List



*Note: This Chapter has under mentioned Maintenance Schedules in Appendix I*

1	<a href="#">21-MS1</a>	Maintenance Schedule of Control Panel
2	<a href="#">21-MS2</a>	Maintenance Schedule of Relays & Relay Room
3	<a href="#">21-MS3</a>	Maintenance Schedule of Electronic Interlocking



*Note: This chapter has under mentioned Drawings in Appendix II*

<b>S. No</b>	<b>Drawing No</b>	<b>Description</b>
1	<a href="#">21-D1</a>	S&T Building Plan up to 4 Road Stations
2	<a href="#">21-D2</a>	S&T Building Plan for 5 to 8 Road Station
3	<a href="#">21-D3</a>	S&T building plan for End Goomties (EI)
4	<a href="#">21-D4</a>	ASM Room Layout Plan
5	<a href="#">21-D5</a>	SM Table with Dual VDUs
6	<a href="#">21-D6</a>	Contact Configuration (8F/8B) & (12F/4B)
7	<a href="#">21-D7</a>	Contact Analysis Format (8F/8B), Contact Analysis with Posting of Contacts (12F/4B) (2 Sheets)
8	<a href="#">21-D8</a>	Bonding & Earthing Connections for Signalling Equipments (RDSO Drg)

## Relays for Railway Signalling

### 1.0 Relays in General

- (a) **Relay Working Principle:** A relay is an electromagnetic device, which is used for closing or opening of an electrical circuit. The relay may be classified as Shelf type and Plug-In Type. Plug-in-type relays which are plugged in to prewired terminal boards. It works on electromagnetic principle. Each relay has a base electromagnet, armature, contact spring, contacts, transparent cover, and handle. It works on a low current. A non-magnetic residual pin is fixed on the inner face of armature, in all relay except magnetic latch relays. When current is applied through the coil, it sets up a magnetic flux through the bar magnet, core, L shape heel piece and armature.

### 2.0 Metal to Carbon Line Relay - Non- AC Immunized Relays

- (a) **QN1 Style Relay:** This is used as internal relay for all control and detection circuit except in external circuits of AC RE area. It's specification No-B.R.S. No: 930A. Though it is immune to 300 Volt AC 50Hz but only in emergencies can be used in RE area with protection against AC Interface
- (b) **QS3 Style Relay:** It is sensitive line relay. It works on a low current. It works on 12 V DC. It's Specification is B.R.S. 930A.
- (c) **QB3 relay is biased neutral line Relay:** It works on 12 V DC and has a contact configuration of 4F/2B. it is a biased relay. Its Biasing stands good up to 240 Volt DC. This is confirming to BRS Specification No.930A.
- (d) **QNN1 Style Relay:** This comprises two neutral line relays whose contacts and magnets are mounted side by side with a common heel piece on a base. These two relays operate independently to each other and also have equal number of front and back contacts. It is based on BR specification 960.

### 3.0 Metal- Carbon - AC Immunised Q- style line relays

- (a) **AC Immunised DC neutral line Relay:** The relay design shall be inherently such that the immunisation is achieved intrinsically without use of any external means. The relay shall not make any of its front contacts when 1000 V (r. m. s) of 50 Hz AC is applied at any instant to the terminals of relay coils. The relay shall not break any of its back contacts when 300 V (r. m. s) of 50 Hz AC is applied at any instant to the terminals of relay coils. This is confirming to IRS Specification No. S60 –78. Usage: these relays are used as interface relays in Electronic Interlocking systems.
- (b) **QNA1 Relay:** The immunisation is achieved by provision of a copper slug on the core at its armature end. In all other respects, it is similar to QN1. Its Specification is BR specification no. 931A. Usage: These relays are used as external relays.
- (c) **QBA1 Relay:** This is a DC biased AC immune neutral line relay. A copper slug is provided on the core for immunisation and a permanent magnet is provided on the core for Biasing. It does not operate if 20 times of the rated voltage is applied in reverse direction. It's specification is BR Specification No. 932 A.

- (d) **QBCA1 Relay:** This is similar to QBA1 relay but having two heavy-duty front contacts. It can carry 30A inductive current at 110 V through its front contact. The back contact can carry 3A continuous and 2A switching current like any other relay. Its Specification is BR specification no. 943. Usage: These relays are used as Point contactor relays.
- (e) **QSPA1 relay:** Only this relay is permitted to be used as the repeater for immunised 'Q' series track relays (QBAT & QTA2), due to its slow to pickup character. Provision of a copper slug between the core and the heel piece behind and a magnetic shunt between the core and the armature at the front contact make this relay slow to pickup. Features of QSPA1 relay are: (i) Slow to pick up by 540 /600 milli seconds.(ii) Less slow to release by 140/200 milli seconds and immune to AC. This made to BR specification no. 933A.
- (f) **QL1 relay:** This is a magnetically latched DC line relay. This relay remains in full operated condition though the feed to the relay is cut off. This relay has two coils namely operate coil (R) and release coil (N) and a permanent magnet. This made to BR specification no. 935A. Usage : these relays are used as latch relays in block instruments etc.

#### 4.0 Track Relays

Track relays shall always be of metal to carbon contact type & normally be of plug in type, unless otherwise specially permitted. In non electrified area, the following relays shall be used: 9 ohm DC non-AC immunized (plug-in type). In electrified area, the following relays shall be used: 9 ohm DC neutral, AC immunized. 9 ohm DC biased, AC immunized. Double element motor type relay, operating on 83 & one third Hz in AC traction area and 50 Hz in DC traction area shall be used. Vane type relays may continue in use till replacement. Relays for track circuit provided with coded, pulsed, electronic (audio frequency or high frequency track circuit), shall be of an approved type of track/line relay or as recommended by manufacturer.

- (a) **QT2:** The construction of this relay is similar to that of a Q - Series line relay except that its contact load is reduced drastically. The relay is more sensitive and workable on a low voltage. QT2 relay has only one core and 2F - 1B contacts. The back contact is used for cross protection for TPR circuit. This has a single coil unlike the shelf type relay, which has two coils with open ends. Usage: it is used as track relay in Non-RE area.
- (b) **QTA2:** Copper slug is provided on the core to achieve AC immunity. It's pick up voltage is 1.4v and pick up current is 140 ma approximately. QTA2 relays are available in 9 Ohms coil resistance with 2F/1B contact configuration. This relay requires more D.C. operating power and it take more time to pick up and drop due to the copper slug. New Installations: This can be used Upto 450 meters track Circuit Lengths in RE Areas with Choke at both ends. ii. Existing installations: This can be used Upto 450 meters track Circuit Lengths in RE Areas with Choke at the Relay end with high traction return current of 1000 Amps and up to 350 meters track circuit length without choke at the Relay end with low traction return current of 600 amps. Usage: used as track relay in RE area.

- (c) **QBAT:** Its pick up voltage is 1.75 V and pick up current is 175 ma approximately. This is achieved by the provision of a biasing permanent magnet on its core along with its copper slug. It has only one core and 2F-2B contacts. This can be used Upto 750 meters track Circuit Lengths with choke in RE Areas. This is made to RDSO specification. No. 84/88. Usage: it is used as track relay in RE area.

## 5.0 Timer Relays

- (a) **Types & Usage of Timer Relays:** These relays are used in the signaling circuits to release interlocking after certain period of time to ensure safety. Following types of Time Element Relays are in use (i) DC Thermal type (ii) Siemens Motorised Clock Work time relay (iii) Motor type (iv) Electronic type
- (b) **DC Thermal Type Element Relay (QJ1):** This type of relay employs heat operated contact associated with an ordinary DC Neutral Relay. It has a heating element (H) and a neutral line relay (R) which together energise an external line relay after a pre-set time delay. One of such type is “QJ1” type relay. Features of this relay are: (i) Rated Voltage 24 V DC or 50 V DC (ii) Heat coil resistance 40 to 42 Ohms (iii) Max. Heating power 15 Watt at rated supply Voltage. The Maximum numbers of operations should be restricted to 100/day otherwise characteristics of the heating element may change. An increase of 10% in applied voltage may result in a time decrease of up to 10%.An decrease of 10% in applied voltage may result in a time decrease of up to 20%.Usage: these relays are used to count time delay in Signalling Circuits
- (c) **Electronic Timer Relays:** Fail safe Electronic Timer Relays are being used to achieve time delay either by charge, discharge method or counting by clock pulse or integrated circuits. Usage: These relays are used to count time delay

## 6.0 Metal to Metal Relays

- (a) **K-50 Relays:** K-50 relays are available only in group units of different sizes. Depending upon the unit size, these groups are broadly classified as: (i) Mini group (ii) Minor Group (iii) Major group. The capacities of various groups are as follows (i) Mini Group: 2 Neutral control relays, 2 Interlocked relay or ECR with power conversion unit. (ii) Minor Group: 15 Neutral (with one interlocked relay replacing two neutral relays, one contactor relay replacing four neutral relays, or one resistor or condenser fixed in place of one neutral relay in some units.(iii) Major Group (used only in RRI): Up to 30 relays space with combination of Neutral and interlocked relays, One contactor relay replacing four neutral relays space one resistor and condenser fixed in placed of one neutral relay in same group
- (b) **Group relays in Siemens interlocking:** (a) 2-Aspect Signal Group (b) 3-Aspect Signal Group (c) Shunt Signal Group (d) Universal Route Group in PI, RRI (e) Point Group for PI (f) Point Group for RRI (g) Point Chain Group for RRI
- (c) **Non AC immunised Neutral Relays:** These relays are available in 4F/4B, 5F/3B & 6F/2B contact configurations. The ohmic values of these relays are 1260 ohms for 4F/4B, 1260 ohms for 5F/3B and 1840 ohms for 6F/2B

- (d) **Interlocked Relays:** These relays are available in 4F/4B, 5F/3B & 6F/2B contact configurations. The ohmic values of these relays are 615 ohms for all contact configuration
- (e) **AC immunised relay (Both Top & bottom Relays):** These relays are available in 5F/3B contact configuration only. The ohmic values of the relay is 1840 ohms only.
- (f) **AC immunised relay (Top AC immunised & bottom Non AC immunised Relay):** These relays are available in 5F/3B contact configuration only. The ohmic values of the top relay is 1840 ohms and bottom relay is 1260 ohms only.

## 7.0 Metal to Metal Relays - Misc Relays

- (a) **Double Coil Relays:** These relays are commonly used as Z1WR1, Z1NWR, Z1RWR, WKR3, Z1WR, WLR in point control circuit. These relays are available in 5F/3B contact configuration only. The ohmic values of the top relay is 1340 ohms and bottom relay is 1590 ohms only.
- (b) **Universal ECR:** These relays are available in 3F/3B contact configuration only. The ohmic values of the relay is 83.1 ohms only. It is used as lamp proving relay.
- (c) **WKR1:** These relays are available in 5F/3B contact configurations. The ohmic values of these relays are 1840 ohms only. It is a part of Point minor group and Point Major group. It is used for point detection.
- (d) **WKR2:** These relays are available in 5F/3B contact configurations. The ohmic values of these relays are 1840 ohms only. It is a part of Point minor group and Point Major group. It is used for point detection.
- (e) **WJR:** These relays are available in 2F/2B contact configurations. The ohmic values of these relays are 1840 ohms only. It is a part of Point minor group and Point Major group. It is used to provide 10 sec time duration for point operation.
- (f) **WR (Heavy Duty contactor Relay):** These relays are available in 2F/2B contact configurations. The ohmic values of these relays are 60 ohms only. It is a part of Point minor group and Point Major group. It is used for point motor operation
- (g) **Siemens Motorised Clockwork Timer:** This relay works on 11 OV A.C. +/- 10%. It has a time range of 1 to 5 minutes. The time can be adjusted. Its resetting is automatic. A synchronous motor drives and switches over contacts after the lapse of preset time. If the energising circuit is prematurely interrupted, the mechanism returns to its normal position before actuating the contacts. Usage: These relays are used to count time delay.

## 8.0 ECR Relays

- (a) Relays of an approved type shall be used.
- (b) Plug-in type Line relays of Neutral/Polar Biased/Magnetic latch/Interlocked type rated at 24/48/60 V DC shall normally be used. Suitable type of LED Lamp proving relays (QECX-61) are used for signal LED lamps to meet with parameters to suit various LED lamps.
- (c) Universal Plug-in-type, Tractive armature AC lamp proving - Metal to carbon contact Relay, as per RDSO specification STS/E/Relays/AC Lit LED Signal/09-2002 (Amdt1) & BRS- 941A shall only to be used for 110V AC LED Lamp units.
- (d) The important parameters of LED lamp proving relays:
  - (i) ECR pickup current = 108 mA/AC, 50Hz.
  - (ii) ECR Drop away current = 72 mA/AC, 50Hz.
  - (iii) This ECR withstands for a continuous current of 250 mA/AC 50Hz.
  - (iv) Contact configuration: 4F-4B identically in A to D rows.
  - (v) Voltage drop across R1 and R2 is less than 10V @ 125 mA/AC (normal working current).

**Pre-commissioning Check List**

S.No.	Description	Yes/No/NA
<b>1</b>	<b>Documentation:</b> Availability of documents at site	
	a) Approved copy of Engineering Scale Plan (ESP).	
	b) Approved copy of Signal Interlocking Plan (SIP).	
	c) Signed copy of SWR with SWRD as per approved SIP.	
	d) Approved Track Bonding Plan& Track circuit Bonding plan.	
	e) Approved As Made Cable Route Plan with Protection details.	
	f) Approved Cable Core Plan with Termination details of locations.	
<b>2</b>	<b>Statutory Approvals/Sanctions:</b>	
	a) PCOM approval for RH signals.	
	b) PCOM approval for Terminal Yard.	
	c) Condonation for Infringing Signals and other signaling equipment.	
	d) CRS/PCSTE Sanction	
	e) PCSTE and PCOM approval for Non Interlocked working (Rly.Board's letter No.2012/Sig/SF/2 (Policy) dtd. 09.04.2012).	
	f) Technical System Application Approval (TSAA) of EI Installation.	
	g) Approved copy of Application Logic and Interface Diagrams.	
<b>3</b>	<b>Test Records:</b>	
	a) FAT Certificate duly signed by all concerned including OEM.	
	b) SAT Certificate duly signed by concerned officers. Simulation testing certification in case of Relay interlocking installations.	
	c) TOC Testing copy duly signed and stamped on all pages by concerned supervisors & officers.	
	d) Cross Table (Square Sheet) Testing Sheets duly signed on all pages by concerned supervisors & officers.	
	e) Final CRC check sum jointly noted by OEM's representative, concerned supervisors and displayed.	
	f) Satisfactory installation certificate of EI from OEM Engineers.	
	g) Data Logger validation certificate with certified Bit chart.	
	h) Signal Sighting Committee report duly signed by TI, LI & SSE (Signal) for all new or Shifted signals as per <a href="#">Annexure: 19-A1</a> .	
	i) Jointly tested and updated Cable Insulation Measurement register with all details of cables like Drum No. Name of Manufacture, Month/year of manufacture, length of cable, circuit etc., as per Chapter 15.	



S.No.	Description	Yes/No/NA
	j) Implantation Register of all signals jointly recorded with SSE/P/Way.	
<b>4</b>	<b>Pre-commissioning Check Lists for Equipments:</b>	
	a) Electronic Interlocking.	
	b) DataLogger.	
	c) Integrated Power supply System.	
	d) SSDAC/HASSDAC/MSDAC.	
	e) UFSBI and Block Panel.	
	f) LED Signal units.	
	Ensure that all items are complied with appropriate remarks and signed on all pages by concerned supervisors and OEMs representative, verified by field ADSTE/DSTE and countersigned by Dy.CSTE/Sr.DSTE).	
<b>5</b>	<b>Installation &amp; Maintenance Manuals for</b>	
	a) Electronic Interlocking.	
	b) DataLogger.	
	c) Integrated Power Supply system (IPS), Solar Panels (if any).	
	d) SSDAC/HASSDAC/MSDAC.	
	e) UFSBI and Block panel.	
	f) Earth Leakage Detector (ELD).	
<b>6</b>	<b>Maintenance Registers for</b>	
	a) Signaling Assets History Book.	
	b) Point Machines.	
	c) Track Circuits.	
	d) Axle Counters.	
	e) Signals.	
	f) IPS.	
	g) Batteries including Initial Charging.	
	h) Earth Resistance.	
	i) Joint Point & Crossing Inspection Register for newly laid points.	
	j) Signal Failure Register	
<b>7</b>	<b>Painting &amp; Labeling:</b>	
	a) Description writing of CT rack, Relays, Power supply distribution board, IPS, Batteries, Location boxes etc.	

S.No.	Description	Yes/No/NA
	b) Display of Date of installation on all batteries, Operating Panel, Block instruments, IPS etc.	
	c) All indoor & outdoor equipments are painted as per scheme and all earthing pits are labeled with Earthing value.	
<b>8</b>	<b>Datalogger Related:</b>	
	a) Wiring of all vital/non vital input/output hard wired relays of EI, Block instruments, potential free contacts of ELD and it's monitoring through Datalogger.	
	b) PC, Printer, UPS, Computer table & Chair provided with data logger.	
	c) Networking of Datalogger with DLMC.	
<b>9</b>	<b>Power Supplies:</b>	
	a) Availability of all means of Power Supply. UP AT, DN AT, SEB & Generator as per norms.	
	b) Status of incoming voltage at Change Over Panel.	
	c) Redundant power supply cable between auto change over panel and IPS and wired through proper change over arrangement.	
	d) Monitoring of all external AC & DC supplies through ELD.	
	e) Both DG sets in working condition.	
	f) Exhaust fans are provided in Battery & IPS Rooms.	
<b>10</b>	<b>Miscellaneous items:</b>	
	a) Availability of cable route markers at site.	
	b) Boulder Pitching around Locations, Fencing of Location Clusters wherever required.	
	c) Indication of health of cable as per ELD.	
	d) Earthing of all equipment and metallic structures as per RDSO/HQ latest guidelines. Protective screens and its Earthing on signals falling in danger zone.	
	e) Insulation of Wire/Rod run at LC Gates.	
	f) Antistatic/Rubber mats in front and back sides of all EI and IPS racks/Cabinets.	
	g) Insulated Tool Kits as per approved list of PCSTE.	
	h) Earthing and surge protective devices as per RDSO spec.	
	i) Right hand signals shall be provided with retro-reflective red color arrow.	
	j) Automatic Fire alarm system/fire extinguishers.	
	k) Air-conditioning & Fans as per applicable Norms.	

S.No.	Description	Yes/No/NA
	l) Double locking arrangement for Relay Room and Block Instruments.	
	m) Availability of approved application logic in maintenance terminal PC and CD/Pen Drive/ External hard disk containing the final program.	
	n) Availability of Spare modules and Cards of EI system with appropriate storage facility.	
	o) All works are done to suit RE.	

*Note: The above list is only indicative, given as a guideline but not exhaustive. All items may not be applicable at all stations. Each Zonal Railway may modify/supplement as per individual needs of section/Station/Type of equipment.*

Signature	Signature	Signature
Name & Designation of Supervisor	Name & Designation of Officer (1)	Name & Designation of Officer (2)
Date .....	Date .....	Date .....

## **Chapter 22: Requirements of Signalling in 25 KV AC Electrified Area**

### **Section 1: General**

#### **22.1.1 Objectives**

- (a) To ensure that signalling equipment continues to function normally in the presence of traction current.
- (b) To ensure that interference from the traction system cannot, under any circumstances, cause the Signalling system to exhibit false indications, or in any other way imperil the safe operation of trains. This objective must be achieved even if the traction or Signalling system is in a faulty or anomalous condition.
- (c) To safeguard equipment and staff from electric shock.

#### **22.1.2 Factors Affecting Signalling in AC Electrified Area**

- (a) Visibility of signals due to OHE structure.
- (b) Electrical clearances of signals due to live OHE close by.
- (c) Traction return current.
- (d) Electrostatic induction and Electro-magnetic Induction.

**22.1.3** Visibility of Signals shall be taken care of by the proper implantation of OHE structures during the design stage of OHE. Where electrical clearances are not possible to maintain, suitable protective shields for signal structures shall be provided. Lay Out Plan for OHE shall be based on approved Signalling Plan.

*Note: (i) Protective wire-mesh screen of approved design and size shall be provided wherever clearance of more than 2 meter for any part of the signal from live OHE conductor is not possible to get.*

*(ii) OHE bonds (Structural, longitudinal and cross bonds) to be provided by electrical department in the yard and in the block section wherever required for proper functioning of field S&T equipment. These bonds should be properly fastened with the structure/mast/rails and must be insulated for portion passing under positive rail of track circuit.*

**22.1.4** The electrostatic induction is practically eliminated by transferring a circuit into underground cables protected by a metal sheath. The Electro-magnetic Induction causes various currents and voltages to develop in conductors parallel to the track. These include the rails, traction return conductors where provided, cable sheath, any other conductors in the vicinity, and signalling and telecommunication circuits. The voltages that occur in the conductors appear as potential gradients. In addition, there are potential differences between various points along the conductors and the adjacent Earths. The value of this induced voltage depends on various factors, such as-

- (a) Length of parallelism between the cable conductors and the electrified track.
- (b) Soil conductivity.
- (c) Screening efficiency of the cable sheath where existing.
- (d) Return current through the rails and return conductor where provided.
- (e) Mutual inductance between catenary and the cable conductors.
- (f) Separation between catenary and cable.
- (g) Current carried by the catenary etc.

## Section 2: Signal Structures in RE area

22.2.1 Colour light signals only shall be used in electrified areas.

22.2.2 On electrified sections, the masts, insulators, wires and supports obstruct the visibility of Signals. In addition, the Signals have to be so erected that they maintain a minimum clearance from the live parts of the O.H.E. The instructions in this section shall be strictly followed in so far as the electrical clearance is concerned. These instructions may be taken as a rough guide in determining the location of signals, which would afford the best visibility to the Loco Pilots of approaching trains. However, the actual visibility shall in all cases, be checked by a Signal Sighting Committee and action to improve the visibility taken on the recommendations of the Committee.

22.2.3 The location of signals and the protection required shall be worked out from the following signal clearance diagram for Broad gauge.

<a href="#">Drg. No 22-D1</a>	For Tangent tracks & tracks with super elevation less than 60 mm.
<a href="#">Drg. No 22-D2</a>	For Curved tracks with super elevation 60 mm to 140 mm.
<a href="#">Drg. No 22-D3</a>	For Curved tracks with super elevation 140 mm to 185 mm.

22.2.4 In these diagrams the un-shaded portion shown above the standard moving dimensions is the area into which a signal posts or any of its fittings shall, under no circumstances, be allowed to infringe. The shaded envelope around this is the area into which a signal or its fittings shall not normally be allowed to infringe. If due to unavoidable reasons, a portion of the signal post or its fittings has to infringe into this shaded area, special protective measures as detailed in [para 22.2.6](#) shall be taken. The dotted outline in [Drg. Nos. 22-D1, 22-D2, 22-D3](#) for Broad Gauge is applicable when there are two sets of Catenary and Contact wires parallel to each other in the same span, viz. insulated and un-insulated overlap locations. It is to be noted that these diagrams are not applicable to (i) anchor spans, (ii) turnouts, (iii) 3 meters on either side of masts, and (iv) in loco sheds and inspection pits. The diagrams are also not applicable when there is a feeder line running along with masts or where booster transformers and return conductors are provided.

22.2.5 The normal height of the contact wire is 5.60 meters at supports. The normal height of the catenary at its highest point is 7.05 meters. In tunnels as well as underneath bridges, where clearances are limited, the contact wire may be as low as 4.58 meters for Broad Gauge and the catenary is also lowered suitably or terminated at the face of Bridges or Tunnels. The clearance diagrams have, however, been drawn to suit the extreme positions of the catenary and the contact wire. In addition, the diagrams make allowances for the stagger as well as displacement of wires by wind.

#### 22.2.6 Clearances for Safety

In the matter of electrical clearances, the fundamental rule to be observed is that no one is allowed, under normal conditions, to approach closer than 2 meters from the extreme positions of the live parts of the O.H.E. The following protective measures shall, therefore, be adopted.

- (a) If any portion of a signal post or its fittings where signalling staff have to work, falls within 2 meters of a 25 KV live conductor, or any metal part electrically connected to this conductor such portion shall as far as practicable be protected by an iron screening of approved design solidly connected to the structural work.
- (b) If for any reason it is not practicable to provide the protective iron screening as mentioned above, a Caution Board of approved design shall be provided on the signal post at a height of 3 meters above the rail level, to caution the signal staff.

*Note: Technical personnel shall exercise particular care to protect themselves while working on signal posts not provided with protective screens. If there is any likelihood of any part of their tools or equipment coming within 2 meter of live equipment, they shall take a power block as detailed in Chapter VI of the Manual of AC Traction-Volume II (Part-I). The same precautions are also required in the vicinity of return conductors, which should be treated as live.*

- (c) The SSE/JE (Signal) shall explain these instructions to the staff working under them and ensure that they are correctly complied with.

22.2.7 [Drg. Nos. 22-D4](#) and [22-D5](#) illustrate the location of signals on the left-hand side and right hand side of Broad Gauge track and the figures indicate the minimum heights and distances of Signal from the track to avoid electrical infringements.

## 22.2.8 Location of Neutral Section (Reference: Para No. 16.4 to 16.5 of ACTM, Appendix I)

Para No. 16.4	Neutral section shall be located away from stop signals, level crossing and shall be on tangent track and on level to the possible extent.
Para No. 16.4.1	If neutral section is provided after a stop signal, the distance* between signal and neutral section shall be such that after stopping, the train shall be able to pick up enough speed to coast the neutral section without any risk of stalling.
Para No. 16.4.2	If neutral section is provided before a stop signal, the distance* between neutral section and signal shall be such that the train shall not cross the signal in an effort to coast the neutral section.

*\*Note: The distance should be preferably 1600 meter away on section with gradient up to 1 in 300 and 2500 meter with higher steeper gradient up to 1 in 200, if unavoidable.*

*The PTFE type short neutral section shall be located on level tangent track at least 400 m after the stop signal and 200 m before the stop signal. Where, however, modifications require to comply with these guide lines are difficult or entail heavy investment, the Chief Electrical Engineer of the Railway may direct any other arrangement to be followed consistent with safety and reliability, and for location on graded section according to para 16.4.1 and 16.4.2. (Para No. 16.4.5 of ACTM).*

## Section 3: Erection of Signals in RE Area

### 22.3.1 Location of Signals in RE Area

Normally, all signals should be located on the left side of the track for which it refers. In exceptional cases the signals may be located on the right side. To ensure adequate visibility of signals the OHE masts should be implanted as per the ACTM. In case it is not possible, offset brackets may be used for signal units without affecting the schedule of dimensions. Further the following steps should be taken to achieve adequate visibility.

- (a) In case the traction mast is located in front of the signal post, the distance between the traction mast and signal post should not be less than 30 meters. In addition, it should be ensured that no traction mast is located in advance of the signal post at a distance less than 10 meters.
- (b) PCSTEs and PCEEs of the zonal railways shall give dispensation for reduction in the distance of placing mast in front of the signal from 30 meters to 10 meters on straight track after ensuring staggering for proper visibility of signal as per provisions of ACTM and SEM.
- (c) The signal post should be sufficiently high so as to be seen clearly.
- (d) On tangent tracks it is desirable that the signal should be located within the OHE structure, i.e. the implantation of the signal from the track centre shall be less than the implantation of the OHE mast from the track centre. The setting of OHE masts in the vicinity of the colour light signals shall be as per para 20.5 of Appendix-I of the AC Traction Manual, Vol-II (Part-II). Relevant extracts as in [Annexure:22-A1](#).

- (e) On curved track or in areas, where other obstructions such as buildings, trees etc. exist, the site should be individually examined by the 'signal sighting committee' for deciding the most appropriate location of the signal.

22.3.2 No portion of a post or fittings of a colour light signal shall infringe with the schedule of dimensions from the centre line of the nearest track.

#### 22.3.3 Signals without Junction Indicators Outside Tracks

- (a) Distance of OHE masts shall be in accordance with [Drg. No.22-D6](#).
- (b) The signal units shall be so fixed that the height of the centre line of the red signal shall be approximately 3.65 meters above rail level. No part of Signal without a route indicator shall normally be higher than 5.2 meters above rail level.

#### 22.3.4 Signals without Junction Indicators between Tracks

- (a) If signals are located between tracks no OHE structures shall be provided in the same track space for at least 600 meters in rear of the signals.
- (b) Portal drop arms shall not normally be located at least for a distance of 600 meters before the signal in track space where signals are located.
- (c) If a portal drop arm has to be unavoidably located in rear of signal itself, the signal shall be mounted on an offset bracket. In addition special study shall be made in each case to see whether the portal drop arm should also be offset from the centre line of the track space in the direction opposite to the offset of the signal. This special study shall be made for at least three portal drop arms in rear of the signal and shall also cover the possibility of shortening the portal drop arm.

#### 22.3.5 Signals with Junction Indicators Outside Tracks

Signals with Junction Indicators outside tracks Setting distances of OHE masts shall be in accordance with [Drg.No.22-D7](#).

#### 22.3.6 Signals with Junction Indicators between Tracks

- (a) Precautions and parameters for location of portal drop arms shall be as specified under [Para 22.3.4](#).
- (b) For details of drawings, illustrating the above principles for Colour Light Signals, refer to [Drg.No.22-D7](#).

22.3.7 The visibility of the signal shall be checked by day as well as by night by the Official in charge (Signal) of the section after each phase of the O.H.E work, i.e. erection of masts, provision of brackets, wiring, etc. If at any stage the official feels that the visibility is not adequate, he shall impose suitable speed restrictions and take such steps as are required to improve the visibility.

*Note: For Details on Cable laying in RE Area, please Refer to [Chapter 15 of SEM](#).*

22.3.8 For Clearances for Signals for High Rise OHE (for Running Double Stack Container & Three Tier Car) , Please see [Annexure: 22-A3](#) and [Drg.No.22-D7](#)



## Section 4: Signaling Circuits in RE area

- 22.4.1 As a rule, no aerial circuits shall be retained in the electrified zone. In every case, the length of parallelism and the distance of Block Wires from the nearest electrified track shall be checked to ensure that the maximum induced voltage does not exceed 60 volts limits prescribed by CCITT.
- 22.4.2 Barring block-instrument circuits, no other earth-return circuit shall be permitted in A.C electrified territory. Block instruments, however, shall be suitably protected by a filter of approved design as explained in [Chapter 18 of SEM](#).
- 22.4.3 The following electrical signalling equipment are not safe to withstand AC induced voltage. The coils of this equipment can only be used inside a cabin or a location box or internal circuits only. The coils of these equipment shall be worked from a separate battery/DC-DC Converter and this battery/DC-DC Converter shall not be connected to any external circuits going outside the cabin/location box.
- (a) Luminous Indicators.
  - (b) Telephone type relays.
  - (c) Electrical Lever Locks.
  - (d) Door Coil of IRS Block Instrument.
  - (e) 250 Ohm D.C. neutral Line Relay.
  - (f) Rotary Key Transmitter.
  - (g) D.C. Neutral Polar Relays.
- 22.4.4 All Batteries and the wiring in the equipment, location box or cabin shall be well insulated from the ground. PVC insulated wires to an approved specification (IRS-S-76) shall be used for wiring in location boxes and cabins.
- 22.4.5 Separate Batteries/DC-DC Converters shall be provided for external and internal circuits.
- 22.4.6 When more than one cable is laid between two locations or cabins, it shall be ensured that as far as possible, all wires pertaining to any individual circuit are within the same cable.
- 22.4.7 Polarized Relays using permanent magnet shall not be used in any external circuit in 25 KV AC electrified areas as the permanent magnet in the relay tends to lose its magnetic properties due to continuous application of induced voltages. Competent authority shall authorise any exception in specific cases.
- 22.4.8 The relays, which release an interlocking, shall be slow acting so that the interlocking is not released inadvertently by voltage variations of short duration. Time delay may be of the order of 0.6 to 0.8 seconds.
- 22.4.9 All external circuits in AC. electrified area shall work with double cutting.

## Section 5: Outdoor Signalling Circuits in RE area

### 22.5.1 Maximum Length of Parallelism

- (a) The length of any signalling line circuit must be limited to ensure that the induced voltage from the traction system does not exceed 400 Volts under normal conditions. If necessary, line circuits must be sectionalized. Where line circuits leave line side enclosures or buildings in different directions, this could give rise to a continuous circuit of such length that the limits of induced voltage above could be exceeded. In such cases a sectionalized power supply unit should be provided for each direction.
- (b) The induced voltage in the underground-Unscreened cable shall be reckoned as 116 Volts/km on single line and 95 Volts/km on Double Line under normal conditions when the catenary current of 800 amperes for single line and 1000 amperes for double line.
- (c) When such circuits are terminated on relays/equipment their immunity shall not be less than 400 V AC. Length of feed cable terminated on relay shall be suitably reduced depending upon its AC immunity.
- (d) The length of DC Circuits on Line Relays with unscreened cable shall be restricted to-

Type of Relay	AC immunity level in volts	Maximum permissible length on*	
		Single Line	Double Line
QNA1/QNNA1/QNA1K	1000	2.1 km	2.8 km
K50 B1	170	1.0 km	1.2 km
K50 B1-A2	450	2.1 km	2.8 km
K50	130	750 meters	900 meters
AC Immunized neutral relay (IHC Make)	750	2.1 km	2.8 km
* Maximum permissible induced voltage is restricted to 400 V for human safety and factor of safety 1.5 has been considered.			

## Section 6: Signal Feed Circuitry in RE area

### 22.6.1 Feeding Distance

Signal feed system shall be of the 110 V 50 Hz type or any approved type.

- 22.6.2 The distance between the signal control relays and the signal must not exceed the prescribed limits in electrified zone, measured along the line of way. This will ensure that the voltage induced in the circuit will be inadequate to illuminate the lamps, even under the most adverse circumstances and with one or more earth faults present.

22.6.3 Maximum permitted length of direct feed of signal shall be as per Table given below.

Type of Cable	110 Volts feed system	
	Single Track	Double Track
Unscreened	180 m	220 m

22.6.4 When a signal is located at a distance greater than that specified in [para 22.6.3](#) the signal shall be fed locally by controlling relays located at the location. Such signals may also be remotely fed from the cabin by using a controlling relay at the location. Typical circuit is given in [Drg. No. 22-D9](#).

22.6.5 It shall be ensured that the power transformer for feeding circuits as per [para 22.6.2](#) shall be different from the transformer feeding longer circuits.

### Section 7: Point Operation & Detection in RE area

22.7.1 Point can be operated electrically or mechanically by rodding. Mechanical operation of point will require special measures for the protection of operating staff. Electric operation shall have restriction on maximum length between point control relays and point machine depending upon their immunity level.

#### 22.7.2 Electric Operation of Point

- Point detection and point detection repeat circuits shall use ac-immunized relay.
- The maximum permissible length for various types of commonly used Point Machines is as under:

Type of Machine	AC immunity level in volts	Maximum permissible parallelism in meters between Point Contactor and Point Motor	
		Single line	Double line
As per IRS S-24	160	910	1100
	400	2200	2800
Factor of safety is 1.5			

- 3 phase point machine is inherently immune to induced voltage and therefore can be used for operating point to any length subject to its own operating limitation.

### 22.7.3 Rod Runs in RE Areas

The point rods in A.C electrified areas are subject to a certain amount of induced voltage. In addition since the rods are in contact with the rails at some point or other, the rail voltage, which can be quite high in case of faults, is transmitted through them to the lever frame. Insulators shall, therefore, be provided on the rodding as per instructions in [para 22.7.4](#) for protecting the Operating & Maintenance Staff from the effects of these voltages.

### 22.7.4 Insulated Rod Joints for RE

- (a) The insulated rod joints shall be as per approved drawings.
- (b) Each rod shall be provided with an insulator in the lead out as close to the cabin as possible. While providing this insulator, it shall be ensured that there is no possibility of a contact between the insulated portion of one rod and the un-insulated portion of another rod or signal wires, the rail or O.H.E mast.
- (c) An additional insulator shall be provided between the last adjustable crank and the point or the lock bar. The purpose of this insulator is to prevent the rail voltage being passed on to the main run of rods.
- (d) If the distance between the two insulators at either end is greater than 300 meters, additional insulators shall be provided on each rod, so that the distance between two consecutive insulators on the same rod is not greater than 300 meters.
- (e) Each Point, Trap indicator and lock bar operated by rodding shall be electrically isolated from the track.
- (f) All insulators in a run shall be provided between the same two sets of rollers and guides, so that there is no possibility of the insulated portion of one rod coming into contact with the un-insulated portion of another rod.
- (g) The clearance between the insulator and the adjacent rod roller shall be adequate to permit normal movement of the rod.
- (h) When a rod crosses the track, the top of the rod shall not be less than 40 mm from the bottom of the rail. When steel or C.I sleepers are used, the distance between the rod and the sleeper shall be also not less than 40 mm. Similarly, the distance between any O.H.E mast and the point rods shall not be less than 40 mm.
- (i) The operating rod of locally worked points on all electrified lines and of similar points taking off from the non-electrified track adjacent to the last electrified line shall also be provided with an insulator so that the point lever or point box is insulated from the rail.
- (j) When the Engineering department provides the point lever or point box, Engineering department shall provide the insulator on the operating rod.

- 22.7.5 (a) Please refer to [SEM Chapter 16](#) for details of Power supply arrangements.
- (b) Please refer to [SEM Chapter 17](#) for details of Track Circuits, AFTC in RE area, Axle counter.
- (c) Please refer to [SEM Chapter 18, section 2](#) for details of Block working in RE area.
- (d) Please refer to [SEM Chapter 19, section 11](#) for details of Earthing.

## **Section 8: Rules for Protection of Staff working on Signal & Telecommunication Installation**

### **22.8.1 Protection for Staff**

Railway personnel working on Signal & Telecommunication equipment on sections provided with 25 KV A.C traction are required to take suitable precautions on account of the following:-

- (a) Proximity to live conductors.
- (b) Presence of returns currents in the rails.
- (c) Induction in all metallic bodies situated near the overhead equipment.

**22.8.2 Proximity of a Live Conductor:** Any contact direct or indirect, with the 25 KV conductors is dangerous and shall be strictly avoided.

### **22.8.3 Pressure of Return Current in Rail**

The flow of return current in the rails will give rise to a potential difference.

- (a) Between adjacent rails at an insulated joint of a track circuit or at an ordinary joint in case the fish plates and bonding are broken.
- (b) Between the ends of a fractured rail at the fracture.
- (c) Between an insulated rail and the non-insulated rail used for the traction return current.
- (d) Between the rail and the surrounding mass of earth.

**22.8.4** Wherever staff has to work on installations, which are in direct or indirect contact with the rails, they shall:

- (a) Insulated tools must be used in accordance with approved instructions.
- (b) Observe provisions of Section 'J' of permanent way manual (extract given at [Annexure: 22-A2](#)).

### **22.8.5 Induction in Metallic Bodies Situated Close to OHE**

Induced voltage may appear in Signalling and Telecommunication Circuits when the length of parallelism to the track is appreciable. Even if there is no induced voltage in a circuit at the time of starting a work, precautionary measures listed below shall be taken, as induced voltages may develop at any time on account of an increase in current in the traction lines. It is also to be noted that in the case of equipment or circuits, which are earthed, a contact, which may normally be without danger, may give rise to an electric shock in the case of a break in the circuit or in the earth connections. Consequently, when staff have to work on Signal and Telecommunication Circuits on 25 KV AC electrified lines, they shall take the following precautionary measures:

- (a) They shall as a general rule, wear rubber gloves and use tools with insulated handles.
- (b) When the work to be done is of such a nature that rubber gloves cannot be used conveniently, special precautions shall be taken by splitting the circuits into sections or earthing them. In special cases, both the steps shall be taken simultaneously. If these protective measures cannot be applied, staff must insulate themselves from the ground by using rubber mats, etc.
- (c) The cable conductors pertaining to the block instruments are likely to develop heavy induced voltages and every time the staff handles the terminals of Block Circuits, they must rigidly observe the provisions of paragraphs (a) and (b) above. These cable terminals shall be painted "RED" to remind the Maintenance staff of the danger. The Maintenance SSE/JE (Signal) shall explain the meaning of this painting to the maintenance staff and ensure that they correctly understand it.

**22.8.6** Before any work is undertaken on Signalling/Telecommunication cables, the staff shall take the following precautionary measures:

- (a) Reduce the length of the circuit as much as possible.
- (b) Use Rubber gloves as far as possible or alternatively use insulated rubber mats.
- (c) Before cutting the armour or the metal sheath of the cable or the wires in the cables, an electrical connection of low resistance shall be established between the two parts of the armour, the Sheathing and wires that are to be separated by cutting.

**22.8.7** Staff who have to work on electrical circuits shall be equipped with insulated tools such as box spanners, pliers, screw-drivers, etc. They shall, in addition, be supplied with rubber mats and rubber gloves. In regard to staff who have to work on equipment directly connected to the rails, tools with insulated handles may be supplied as far as possible and as far as practicable. A plastic sleeve on the handle will be sufficient in most cases.

**22.8.8** Staff shall make themselves familiar with the instructions for treatment of persons suffering from electric shocks. Instruction Boards in English and in the regional languages describing the methods to be adopted for treatment of electric shock shall be clearly displayed in all SSEs/JEs (Signal)' offices.

### 22.8.9 Breakage of Catenary/Contact Wire

In the event of break of catenary/contact wire of the overhead electrical equipment, the following precautions shall be taken for the safe working of the signalling equipment:

- (a) The Train Controller, on receipt of an advice of a break in Traction Overhead Lines or confirmation of such an advice from the Traction Power Controller, shall immediately advise by the quickest possible means, to all the staff responsible for the maintenance and operation of the signalling equipment of the section where the catenary/contact wire has broken.
- (b) The staff responsible for the operation of the Signalling equipment of the section shall immediately check whether the block and other signalling equipment are working normally. If an abnormal working of any equipment is noticed, its working shall be immediately suspended and necessary action under the Rules shall be-taken.
- (c) On receipt of this intimation, the staff responsible for the maintenance of Signalling system of the section shall immediately proceed to the site and test all circuits and allied equipment paying particular attention to the external signalling gear to ensure that no damage to it has taken place. An authorised representative of the Signal Department not below the rank of SSE (Signal) shall submit Certificate that everything is working all right and send it to his superiors along with a detailed test report as soon as possible.

### 22.8.10 2.2 KV Charging as an Anti-Theft Measure

- (a) Guidelines for anti-theft charging pertaining to S&T works as prescribed in Appendix VII of ACTM Vol-II Part II shall be followed.
- (b) Besides, any specific works pertaining to specific section, the following S&T work shall be completed before issue of certificate for 2.2 KV charging.
  - (i) Replacement of existing DC track relays and DC line relays by AC immunized relays.
  - (ii) Provisions of wire mesh screen on the working platform of existing signals in case the requisite electrical working clearance of 2 meters is not available. No portion of signal post or its fittings shall be less than 700 mm from the live conductor.
  - (iii) Supply of insulated tools to maintenance staff.
  - (iv) Conversions of all overhead track crossings of BSNL and Railway into cables and removal of overhead wires thereof.
  - (v) Certificate of clearance from DOT regarding 2.2 KV anti-theft energisation.

22.8.11 An approved checklist of the works to be completed as per provisions of this chapter shall be issued by Principal Chief Signal and Telecom Engineer to the field offices. Compliance of this checklist shall be insured by the nominated officers responsible for issue of certificate before OHE is charged at 25 KV.

*Note: Please refer to concerned chapters for specific requirements for any particular Type of equipment.*



*Note : This Chapter has under mentioned Annexures*

<b>S.No</b>	<b>Annexure No</b>	<b>Description</b>
1	<a href="#">22-A1</a>	Visibility of Signals in RE Area (Extracts of Para 20.5 of Appendix-1: Manual of AC Traction)
2	<a href="#">22-A2</a>	Maintenance in Electrified areas (Extract of part 'J' of Permanent Way Manual)
3	<a href="#">22-A3</a>	Clearances for Signals for High Rise OHE (for Running Double Stack Container & Three Tier Car) Vol. II (Part-II)



*This Chapter has under mentioned Drawings in [Appendix II](#)*

<b>S. No</b>	<b>Drawing No</b>	<b>Description</b>
1	<a href="#">22-D1</a>	Signal Clearance Diagram to Suit 25 KV AC Traction for Tangent Tracks and Curved Tracks with S.E.60.
2	<a href="#">22-D2</a>	Signal Clearance Diagram to Suit 25 KV AC Traction for Curved Tracks with 60 to 140 S.E.
3	<a href="#">22-D3</a>	Signal Clearance Diagram to Suit 25 KV AC Traction for Curved Tracks with 140 to 185 S.E.
4	<a href="#">22-D4</a>	Colour Light Signal Left Hand or Right Hand Broad Gauge (Tangent Track).
5	<a href="#">22-D5</a>	Colour Light Signal with Junction Route Indicator Left Hand or Right Hand Broad Gauge (Tangent Track).
6	<a href="#">22-D6</a>	Distance in Rear from the Signal in Meters (Sheets 2).
7	<a href="#">22-D7</a>	Distance in Rear from the Signal in Meters for High Rise OHE (Sheets 2).
8	<a href="#">22-D8</a>	Implantation of OHE Structures with respect to Colour Light Signal.
9	<a href="#">22-D9</a>	Signalling Feed Arrangement with Cut-In Relays.



## Visibility of Signals in RE Area

**(Extracts of Para 20.5 of Appendix-1: Manual of AC Traction - Volume II (Part-II))**

**20.5 Masts near Signals:** The visibility of signal should be kept in mind while deciding the setting up masts in their vicinity. The following principles should be observed for deciding the setting of masts near signals.

**20.5.1** Colour light signals located outside all tracks.

**(a) Colour Light Signals without Route Indicators:**

- (i) Where no approach signal is provided: The minimum settings of mast before should be 3.25, 3.10, 3.05, 2.90 and 2.75 m for distance up to 80m, beyond and up to 110m, beyond and up to 190 m, beyond and up to 270 m and beyond and up to 400m respectively.
- (ii) Where approach signal is provided and for signals other than distant signals: The minimum setting of masts before the signal should be 3.25, 3.10, 3.05, 2.90 and 2.75 m for distance up to 50 m, beyond and up to 70 m, beyond and up to 115 m, beyond and up to 160 m and beyond and up to 240 m respectively.

**(b) Colour Light Signal with Route Indicators:**

- (i) **With Horizontal Route Indicator:** The minimum setting of masts before the signal should be 3.72, 3.50, 3.25, 3.05, 2.90 and 2.75 m for distances up to 60 m, beyond and up to 125 m, beyond and up to 170 m, beyond and up to 215, beyond and up to 250 m, beyond and up to 310 m respectively.
- (ii) **With other than Horizontal Route Indicator:** The minimum setting of masts before the signal should be 3.50, 3.25, 3.05, 2.90 and 2.75 m for distance up to 70 m, beyond and up to 130 m, beyond and up to 170 m, beyond and up to 215 m and beyond and up to 280 m respectively.

*Note: 1. See Drg. No. ETI/OHE/G/00112 also. The setting may be reduced in special cases, conforming to Figs. 6 to 9 of ibid.*

*2. Setting distance may be reduced for starter signals of loop lines and yard lines.*

**20.5.2 Colour Light Signals Located Between Tracks**

**(a) Signals without Route Indicators:** No OHE mast should, as far as possible be located in the same lane as the signal for a distance of at least 600 m before a signal. Drop arms of portals should also not normally be located in the lane where signals are located at least for a distance of 600 m before the signal. Where this is not possible, for any reason, the signal should be mounted on an off-set bracket. In addition, a special study should be made in each such case in respect of three drop arms before the signal, to see whether the drop arms can be off-set from the center line of the lane in a direction opposite to the off-set of the signal or alternatively, whether it is possible to shorten the drop arms. Reduction in the signal's height may also be examined.

**(b) Signals with Route Indicators:** The principles mentioned under para 20.5.2 (a) should be observed in these case also.

*Note: 1. No. part of a colour light signal without a route indicator should, as far as possible be higher than 5.2 m above rail level. Great care should be exercised in deciding the locations of colour light signals with route indicators so that the necessary minimum clearances are available between the signals and live out of run conductors, or pantogaphs way zone.*

*2. On signal-line sections, signals (colour light as well as semaphore) should, as far as possible be located on the side of the track opposite to the OHE masts.*

**20.5.3** For semaphore signals located outside the track: The minimum settings of masts before the signal should be 3.05, 2.90 and 2.75 meters for the first, second and next three masts respectively.

*Note: For details see Drg. No. ETI/OHE/G/00112.*

## Maintenance in Electrified Areas

(Extract of part 'J' of Permanent Way Manual PART 'J')

### 282 General Instructions to Staff: -

#### 1) General Knowledge of Engineering Staff

- (a) Every Engineering official working in electrical traction area shall be in possession of a copy of rules framed for the purpose of the operation of the Traction Power Distributions System pertaining to Engineering Department and ensure that staff working under him are also acquainted with the rules. He will ensure that rules pertaining to carrying out engineering works are strictly observed.
- (b) All electrical equipment, every power line or cable shall be regarded as being 'live' at all times. No work shall be commenced adjacent to any electrical equipment except on authority issued in writing by a competent official of the Electrical Department to the effect that the equipment has been made dead and earthed.

2) **Defects in Overhead Equipment:** Defects or break downs in the overhead equipment including track and structure bonds noticed by the Engineering staff shall be reported immediately to the Traction Power Controller. When defects in the overhead equipment that are likely to cause damage to pantographs or trains are noticed, and it is not possible to convey information to Station Masters or Signal men to enable them to issue caution orders, the line shall be protected by the staff noticing such defects according to General Rule 3.62.

3) **Traction Bonds:** In electrified areas the return current fully or partially flows through the rail. To ensure a reliable electrical circuit continuity and also to ensure proper earthing in case of leakage of current, various types of traction bonds as described below are provided at suitable places and maintained by the Electrical Traction Department: -

- (a) **Longitudinal Rail Bonds:** In the case of D.C. traction system, practically the whole return current flows through the rail. Therefore, two flexible copper bonds offering minimum resistance to the flow of current are provided at each rail joint under the fishplates. Two solid lugs at the two ends of the copper bonds are inserted in holes drilled at the two rail ends between the fish bolt holes and are pressed by using a bend press to rivet them firmly to the rails. On points and crossings and at junction fishplates where continuity bonds of the above type cannot be provided due to space constraints, continuity of return current path is achieved by using mild steel straps or G.I. wire ropes.

Absence of such bonds may cause unsafe working condition and in extreme cases may damage the rail ends.

- (b) **Cross Bonds (D.C):** Cross bonds are provided between adjacent tracks at regular intervals to reduce resistance of the current to the minimum. Such cross bonds are also known as transverse bonds.

- (c) **Structure Bonds:** All structures supporting overhead equipment either in AC or D.C. track circuited areas are connected to the running rails for ensuring good earthing. Failure of insulator or leakage of current switches off the supply from the sub station so that men coming in contact with supporting structure etc., do not get electric shock. Removal or tampering of such bonds can, therefore, result in unsafe conditions. Since the structure are grouted in concrete, they are likely to become charged in case such bonds are kept disconnected. Similarly, other steel structures such as foot-over bridges, sheds, etc., in the vicinity of O.H.E lines are also connected to rails through similar structure bonds.

### **283 Special Instructions to Staff working in Traction area:**

1) **Need for Precautions:** Precautions are required to be taken on account of following:

- (a) **Proximity of a Live Conductor:** The risk of direct contact with live O.H.E is ever present while working in electrified sections such as for painting of steel work of through spans of bridges and platform cover.
- (b) **Build up of Potential due to Return Current in Rails:** The return current in the rails may cause a potential difference:
- (i) Between rail and the surrounding mass of earth;
  - (ii) Between two ends of a fractured rail;
  - (iii) Between the two rails at an insulated joint; &
  - (iv) Between earth and any other metallic mass.

2) The following precautions should, therefore, be taken while working in traction areas: -

- (a) No work shall be done within a distance of two meters from the live parts of the O.H.E without a 'permit-to-work'.
- (b) For work adjacent to overhead equipment the Engineering Inspect or shall apply to the proper authority sufficiently in advance for sanctioning the traffic and power block required. The Traction Power Controller through Traction Foreman will arrange to isolate and earth the section concerned on the date and at the time specified in consultation with the Traffic Controller. He shall then issue 'Permit-to-work' to the Engineering Inspector. On completion of the work the 'Permit-to-work' should be cancelled and Traction Power Controller advised, who will then arrange to remove the Earth and restore Power supply.
- (c) No part of a tree shall be nearer than 4 meters from the nearest live conductor. Any tree or branches likely to fall on live conductors should be cut or trimmed periodically to maintain this clearance. Authorized O.H.E staff should do cutting or trimming.
- (d) No fallen wire or wires should be touched unless power is switched off and the wire or wires suitably earthed. In case the wires drop at a level crossing, the Gatekeeper shall immediately make arrangements to stop all road traffic.
- (e) **Work on Station Roofs and Signal Gantries:** Staff working on station roofs and signal gantries and similar structures adjacent to live Overhead Equipment shall not use any measuring tapes, tools and materials when there is a possibility of their being dropped or carried by wind on to the live overhead equipment.

(f) **Earth Work:** For excavation work adjacent to tracks, the following action is taken:-

- (i) In D.C. traction areas, intimation should be given in writing sufficiently in advance to the concerned Traction Distribution Officer to enable him to depute the Traction Staff to be present in order to prevent possible damage in the traction underground feeder cables which are always located near the running lines.
- (ii) In AC traction areas, intimation should be given to the concerned officers of the Electrical General Services and also S&T Department, since all the S&T and Electrical lines are cabled on account of Electrical Induction.

In all AC and D.C. traction areas, the Traction Department provides cable markers showing location of cables. In addition, tiles and bricks protect the cables and during excavation, if workmen come across such tiles or bricks in an arranged manner, they should at once report the matter to the higher officials. Any further excavation should be carried out only in the presence of the authorized staff of Electrical Traction and or S&T Department as the case may be.

(g) The relative alignments of the centerline of the track with respect to the alignment of the contact wire must be maintained within the specified tolerances. This applies to both horizontal and vertical clearances. Slewing or lifting of track must not be done outside the agreed maintenance limits unless the position of the contact wire is altered at the same time. Adjustment of cant has a magnified effect on the horizontal displacement of the centerline of the track with respect to the alignment of the contact wire.

Horizontal clearances to structures within the limits laid down in the Schedule of Dimensions must be maintained. For slewing or alterations to track involving adjustment of contact wire (outside the agreed maintenance limits) sufficient notice should be given to the traction staff so that they arrange to adjust the overhead equipment.

(h) **Alterations to Track Bonding:** All bonds removed by the staff of the Engineering Department shall be replaced by the staff of the Engineering Department and all such removals and replacements shall be reported to the Assistant Electrical Engineer, Traction Distribution in charge, concerned without delay.

(j) **Working of Cranes:** No crane shall be worked except on the authorized 'permit-to-work'. In every case of working of a crane, arrangement should be made for the presence of authorised overhead equipment staff to ensure that all safety precautions are taken.

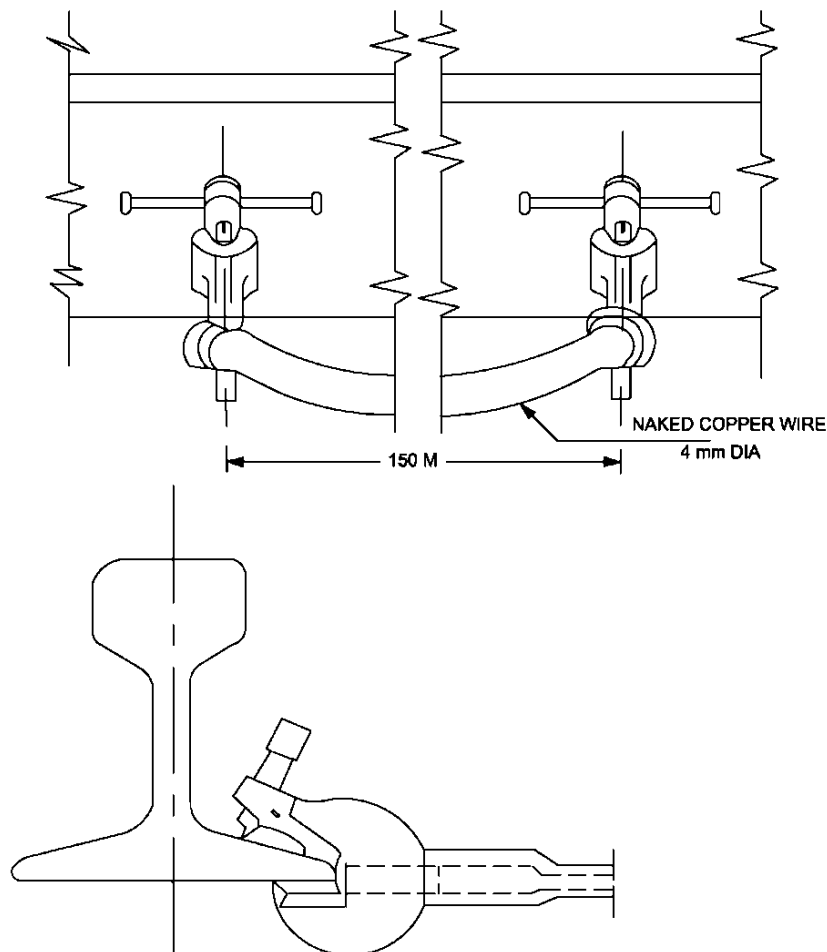
(k) **Inspection of Tunnels:** For inspection of roofs and sides of a tunnel, the overhead equipment shall be rendered 'dead'. Special insulated apparatus should be used if sounding the unlined portions to locate loose rock in the roof and sides, is required to be carried out, when the overhead equipment is 'live'.

(l) As far as possible closed wagons shall be used for material trains. In case open or hopper wagons are used, loading and unloading of such wagons in electrified tracks shall be done under the supervision of an Engineering official not below the rank of a Permanent Way Mistry, who shall personally ensure that no tool or any part of body of the worker comes within the 'danger zone', i.e. within 2 meters of OHE.

- (m) Steel tapes or metallic tapes with woven metal reinforcement should not be used in electrified tracks. Linen tapes are safer and, therefore, should be used even though they are not accurate.
- (n) The top of foundation blocks in electrified structures should be kept clear of all materials.

### 284 Maintaining Continuity of Track:

- 1) During maintenance or renewal of track, continuity of the rails serving electrified tracks shall invariably be maintained. For bridging gaps, which may be caused during removal of fish-plates or rails, temporary metallic jumpers of approved design shall be provided as under. The Electrical Department on requisition will provide the necessary jumper.
- 2) In case of rail fracture, the two ends of the fractured rail shall be first temporary connected by a temporary metallic jumper of approved design (as shown in the sketch below). In all cases of discontinuity of rails, the two parts of the rail shall not be touched with bare hands; Gloves of approved quality shall be used.
- 3) In the case of track renewals temporary connection shall be made as showed above.
- 4) In the case of defective or broken rail bond, a temporary connection shall be made as shown above.



- 5) Before fishplates are loosened or removed temporary connections shall be made as in sub section (3) above.

**285 Catch Sidings:** Normally all catch sidings except those, which are sanded, shall be kept alive. On sanded catch siding, the rails shall be kept clear of sand for a length of 21.5 meters, beyond the section insulators in the overhead lines and the switches controlling the sanded catch sidings shall be kept in the neutral position. If an electric engine or single or multiple unit train runs into the sanded length of a catch siding, it may possible be insulated from earth except through the buffers or couplings if connected to other vehicles, therefore, these sidings shall not be made alive when an electric engine or single or multiple unit train or any vehicle coupled thereto are standing in the sanded track until all staff have been moved away from positions where they are likely to make contact between the permanent way formation and any part of the locomotive or single or multiple unit train or coupled vehicles. No person shall attempt to enter, or leave or in any other way make contact between the permanent way formation and the electric engine or single or multiple unit train or any vehicles coupled thereto while one overhead equipment of the sanded length of siding is alive.

**286 Additional Precautions in AC Traction Area:** The following additional precautions are required to be taken in AC traction areas:-

- 1) Build-up of potential due to induction in metallic bodies situated close to O.H.E : - It is important to note that dangerous voltage may be induced in metallic masses such as fencing posts in the vicinity of traction conductors. To avoid possibility of shock due to such voltages, the metallic structures are bonded together and earthed.
- 2) **Unloading of Rails:** When unloading rails along tracks, care shall be taken to ensure that rails do not touch each other to form a continuous metallic mass of length greater than 300 meters.
- 3) Permanent way staff are advised to keep clear of the tracks and avoid contact with the rails when an electrically hauled train is within 250 meters.

**287 Fire in Electrified Areas:** The Permanent Way Officials noticing a fire likely to result in loss of life or cause damage to property shall take all possible steps to prevent it from spreading and to extinguish it. In case the fire is on adjacent to any electrified equipment, the permanent way official shall make no attempt to extinguish the fire but shall report the occurrence of fire to the nearest Station Master by most expeditious means.

**288 Permanent Way Tools:** Permanent Way tools (insulated and un-insulated) along with gloves shall be used in the manner as approved by the Chief Engineer of the Railway.

**289 Treatment of Persons Suffering from Electric Shock:** When persons receive electric shock, practically in every case, they can be revived with the prompt application of First Aid.

**Method of Resuscitation:** The method of resuscitation resorted to should be that known as artificial respiration.

**Continuity of Treatment:** The efforts to restore breathing must be continued regularly and with perseverance, and must not be discontinued until a Doctor has taken charge of the case.

**290 Accident to Power Lines of Outside Bodies:** The Engineering Inspector shall be in possession of the name and address of the officer-in-charge of each power line across Railway land to enable an immediate report of any defect or accident appertaining thereto being made, under advise to the Assistant Engineer/Divisional Engineer.

**Clearances for Signals for High Rise OHE  
(For Running Double Stack Container & Three Tier Car)**

(Extract of Design Handout for High Rise OHE Document No: TI/designs/OHE/2014/00001 (Rev-1) issued by Traction Installation Directorate/RDSO)

**7.5.1 COLOUR LIGHT SIGNALS LOCATED OUTSIDE ALL TRACKS**

(a) COLOUR LIGHT SIGNALS WITHOUT ROUTE INDICATORS

(i) Where no approach Signal is provided

The minimum setting distance of structure before the signal shall be 3.55, 3.40, 3.35, 3.20 & 3.05 m for distance upto 80 m, beyond & up to 110 m, beyond & upto 190 m, beyond & upto 270 m and beyond & up to 400 m respectively.

(ii) Where approach Signal is provided and for Signals other than Distant Signals

The minimum setting distance of structures before the Signal should be 3.55, 3.40, 3.25, 3.10 and 3.05 m for distance upto 50 m, beyond & upto 70 m, beyond & upto 115 m, beyond & upto 160 m and beyond & upto 240 m respectively.

(b) COLOUR LIGHT SIGNALS WITH ROUTE INDICATORS

(i) With Horizontal Route Indicator

The minimum setting distance of structure before the Signal shall be 4.02, 3.80, 3.55, 3.35, 3.20 and 3.05 m for distance upto 60 m, beyond & upto 125 m, beyond & upto 170 m, beyond & upto 215 m and beyond & upto 250 m and beyond and upto 310 m respectively.

(ii) With other than Horizontal Route Indicator

The minimum setting distance of structures before the Signals shall be 3.80, 3.55, 3.35, 3.20 and 3.05 m for distance upto 70 m, beyond & upto 130 m, beyond & upto 170 m and beyond & upto 215 m and beyond & upto 280 m respectively.

Setting distance may be reduced for Starter Signals of loop lines and yard lines. The setting distance can be reduced in special cases, conforming to Figures 6 to 9 of Revised RDSO Drawing No. ETI/OHE/G/00112, Revision 'D' or latest.



### **7.5.2 COLOUR LIGHT SIGNALS LOCATED BETWEEN TRACKS**

#### **(a) SIGNALS WITHOUT ROUTE INDICATORS**

No overhead equipment structure shall, as far as possible, be located in the same lane as Signals for a distance of atleast 600 m before a Signal.

Drop Arms of Portals shall also not normally be located in the lane where Signals are located atleast for a distance of 600 m before the Signal. Where this is not possible for any reason, the Signal shall be mounted on an Offset Bracket.

In addition, a special study shall be made in each such case, in respect of these Drop Arms before the Signal, to see whether the Drop Arms can be offset from the centre line of the lane in a direction opposite to the Arms. Reduction in the Signal height must also be examined.

#### **(b) SIGNALS WITH ROUTE INDICATORS**

The principles mentioned in the preceding paras shall be observed in this case also.

No part of a colour light Signal without a Route Indicator, shall, as far as possible, be higher than 5.2 m above rail level. Great care must be exercised in deciding the location of the colour light Signals with Route Indicators so that the necessary minimum clearances are available between the Signals and live out of run wires, or pantograph sway zone.

*Note:- For Drawing on Distance in Rear from the Signal in Meters for High Rise OHE , Please refer to [Drg .No: 22-D7](#) in Appendix II.*

# GENERAL ANNEXURES FOR INFORMATION

## **Reliability, Availability, Maintainability & Safety (RAMS)**

### **1.0 Introduction**

- 1.1 (a) In any system output depends on input. In Railways, punctuality is an output. It depends on how subsystems are available for service. Availability depends on Reliability and how good/fast the maintenance (maintainability). Hence R, A, M, S parameters are important. Punctuality is also related to equipment, failures and Reliability in the science of failures.
- (b) RAMS Assurance can help stakeholders in balancing performance requirements and Life Cycle Cost (LCC) to improve customer satisfaction along with compliance of National/International regulatory requirements. Many standards have suggested that RAMS characteristics can be visualized as the Key Performance Indicator (KPI) at System Level.
- (c) RAMS concept is relatively new to the Railways as compared to other industries such as nuclear, power, chemical, avionics, etc.
- 1.2 The key objective of a railway system is to achieve a defined level of rail traffic in a given time safely. The objective can be fulfilled by implementing RAMS principle and process as suggested by EN50126/128/129 or equivalent.
- 1.3 If there is lack of RAMS Assurance, the following may happen-
- (a) Loss of KPI
  - (b) Customers satisfaction, project credibility will be on doubt
  - (c) Global Certification may not be possible
  - (d) Development as well as operational cost will be more.

### **2.0 Terms and Definitions**

2.1 Please refer to Glossary of terms

2.2 Safety Assurance Acts & Standards:

- a) Indian Railways Act
- b) Metro Railway Act
- c) International Standards (EN50126, 50128, 50129 or equivalent)
- d) ROGS Legislation 2006 (Railway and other Guided Transport Systems)

### 3.0 Examples of RAMS Parameters for Railways

#### 3.1 Reliability Parameters:

Failure Rate	$\lambda(t)$
Mean Up Time	MUT
Mean Operating Time To Failure (for non-repairable items)	MTTF
Mean Operating Time Between Failures (for repairable items)	MTBF
Reliability	$R(t)$
Failure probability $R(t)$	$F(t)$

#### 3.2 Maintainability Parameters:

Mean Down Time	MDT
Mean Operating Time Between Maintenance	MTBM
MTBM (Corrective or Preventive)	MTBM(C), MTBM(P)
Mean Time To Maintain	MTTM
MTTM (Corrective or Preventive)	MTTM(C), MTTM(P)
Mean Time to Restore	MTTR

#### 3.3 Availability Parameters:

Availability A

Inherent  $A_i$

Operational  $A_o$

$A_i = \text{MTTF} / (\text{MTTF} + \text{MTTR})$  for non-repairable items

$A_i = \text{MTBF} / (\text{MTBF} + \text{MTTR})$  for repairable items

$A_o = \text{MUT} / (\text{MUT} + \text{MDT})$

#### 3.4 Safety Parameters:

Hazard Rate	$h(t)$
Probability of Wrong Side Failure	PWSF
Tolerable Hazard Rate	$THR$

### 3.5 Failure Rate and Mean Time Between Failures (MTBF)

Consider a batch of  $N$  items and that, at any time  $t$ , a number  $k$  to have failed. The cumulative time  $T$  is given by

Repairable Case:  $T = Nt$ , if it's assured that each failure is replaced when it occurs.

Non-Repairable Case  $T = [t_1 + t_2 + t_3 + \dots + t_k + (N - k)t]$

Where,  $t_1$  is the occurrence of first failure, etc. Failed items are not replaced.

The observed failure rate is given by

$$\text{Gama} = k/T$$

The observed MTBF of the  $N$  items

$$\text{MTBF} = T/k \text{ (for repairable items)}$$

$$\text{MTTF} = T/k \text{ (for non-repairable items)}$$

The only difference between MTBF & MTTF is that the value of  $T$  will be calculated as indicated above.

Reliability equation is as under

$$R(t) = e^{-\lambda t} \text{ (for constant } \lambda \text{)}$$

### 4.0 Safety Integrity Level (SIL)

4.1 **Functional Safety:** Functional Safety is part of the overall safety which depends on the correct functioning of a safety related system.

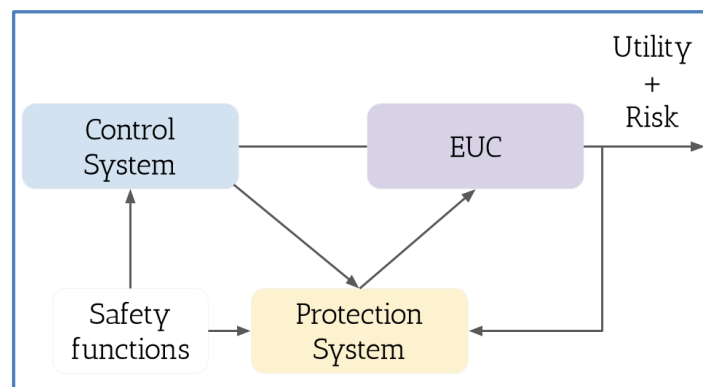
4.2 **Safety Related System:** A system is safety related if its failure can cause harm to life and property. A safety related system performs one or more safety functions.

4.3 **Safety Function:** Function which is intended to achieve or maintain a safe state of the Equipment Under Control (EUC).

4.4 **Equipment Under Control (EUC):** Equipment, Machinery, Apparatus or Plant used for manufacturing, process, transportation, medical or other activities, eg: Railway station points & signals, train, etc.

4.5 **Equipment Under Control Control System (EUCCS):** System which responds to input signals from the process and or from an operator and generates output signals causing the EUC to operate in the designed manner, eg. Interlocking system, train driver.

### 4.6 Safety System Diagram:



#### 4.7 Requirement of Safety Related System:

- a) Safety function requirements i.e., what is function supposed to do
- b) Safety integrity requirements i.e., what is the likelihood of the correct operation of the safety function

4.8 **Safety Integrity:** The ability of a safety related system is to achieve its required safety function under all stated conditions within stated operational environment and within a stated period of time. If you introduce a protection system to reduce risk you are now “Trusting” it, to do the job. Safety Integrity is a measure of that Trust.

#### 4.9 Safety Functions in Railway Signalling:- Important elements of Signalling System:

- (a) Interlocking System
- (b) Train Detection System
- (c) Point Operation
- (d) Signal
- (e) ATP and/or ATC Infrastructure

The functions performed by the above systems can be considered safety functions. SIL is associated with these safety functions and not the equipment.

#### 4.10 SIL is used for two purposes:

- a) SIL is used to give an interval for the rate of safety critical failures. Applies to random faults mostly due to intrinsic physical processes such as aging.
- b) SIL defines measures to be applied in the design and during the manufacturing process to keep systematic failures low.

#### 4.11 SIL Integrity Level (SIL) Table:

Tolerable Hazard Rate (THR)	Safety Integrity Level (SIL)
$10^{-9} \leq \text{THR} < 10^{-8}$	SIL 4
$10^{-8} \leq \text{THR} < 10^{-7}$	SIL 3
$10^{-7} \leq \text{THR} < 10^{-6}$	SIL 2
$10^{-6} \leq \text{THR} < 10^{-5}$	SIL 1

## Brief of High-Speed Rail Signalling Ahmedabad-Mumbai Route

### 1.1 General

### 1.2 Objective: Objectives of the Signaling for high speed are

The Automatic Train Control System (ATC) with the subsystems, their requirements, Interfaces with Rolling Stock, Telecom and other Infrastructure.

### 1.3 Requirement of High-Speed Train Control System: High Speed System operation requires ATC in compliance to UIC mandated requirements as well as to meet the following;

- a. Safe train operations
- b. Prevention of overspeed, derailments and collisions
- c. Fail safe train detection
- d. Interlocking enforcement
- e. Hazard protection
- f. Work Zone protection
- g. Headway requirements
- h. Quality of Service

## 2 Functional Sub-Systems of ATC: ATC comprises of the following functionalities

- a. Automatic Train Protection (ATP)
- b. Automatic Train Operation (ATO)
- c. Automatic Train Supervision (ATS)

### 2.1.1 Automatic Train Protection (ATP): This sub-system is responsible for the safety of train operations. Few of the safety features enforced by ATP are;

- a. Overspeed protection through speed control
- b. Rollback protection
- c. Maintaining inter train safe spacing
- d. Ensuring correct docking/stopping of the train
- e. Ensuring correct side door opening
- f. Train detection, etc.

### 2.1.2 Automatic Train Operation (ATO): This sub-system is responsible for the automatic operation of trains through throttle and braking control

### 2.1.3 Automatic Train Supervision (ATS): This function is responsible for centralized supervision and control of the train movements. The main functions are;

- a. Supervision
- b. Automatic and Manual Route setting
- c. Train Control and Regulation
- d. Passenger Announcements and Display System management
- e. Quality of Service, etc.

## 2.2 ATC System and sub-systems

- a. Equipment and Software on-board
- b. Equipment and Software along the track and wayside
- c. Equipment and Software in Central Control Room

- 2.2.1 Equipment and Software On-Board:** It includes processors, firmware, software and electronics, operator displays, operator panel, data radios, antennas, transponder/ballise antennas, code pickup antennas, network components, GPS receiver and antennas, tachometer and other sensors, connections between train control elements and interfaces.
- 2.2.2 Equipment and software along the track and wayside:** Vital equipment located in housings/location box/Relay huts along the Right of Way (track) including station equipment rooms, train control equipment houses and signal equipment cases and cabinets. The equipment includes track circuits, point machines, wayside signals, interlocking equipment and transponders.
- 2.2.3 Equipment and Software in Central Control Room:** ATS Servers, Man Machine Interfaces, Large Video Screen along with Controllers, Firmware and Software, Fibre Distribution Systems, etc.
- 3.1.1 Temporary Speed Restriction Function:** A temporary speed restriction function (a function to change control information indicated for Running Line outside of a Station to another control information which indicates a running speed lower than one of said control information) shall be provided.
- 3.1.2 Alarm Sound of Cab Signal:** Cab Signal shall sound an alarm in a driving cab for the following item:
- In the case of the ATC and the fallback ATC (WHERE PROVIDED ) when control by the control pattern is received and when the control pattern is updated.
- 3.1.3 Function of Interlocking:** Interlocking shall have functions set forth in the following:
- Track Lock
  - Route Lock
  - Sectional Route Lock
  - Approach Lock
  - Stick Lock
  - Signal control
- 3.2 Centralised Traffic Control System**
- 3.2.1 Function of Centralised Traffic Control System:** Centralised traffic control system shall indicate the following items and shall allow setting of a Route of a Train which enter/leave a Station or a Route of a shunting Vehicle on Running Line:
- The position of a Train (including Vehicle) on Running Line and Depot Line which has ATC route
  - Route clear situation on Running Line and Depot Line which has ATC route
  - Train number of a Train on Running Line and Depot Line which has ATC route.
- 3.3 Train Detection Devices**
- 3.3.1 Function of Train Detection Devices:** Train detection device which is used for Signalling Equipment including ATC for Safety of Train Operation shall make sure to detect a Train (including Vehicle) on the track.

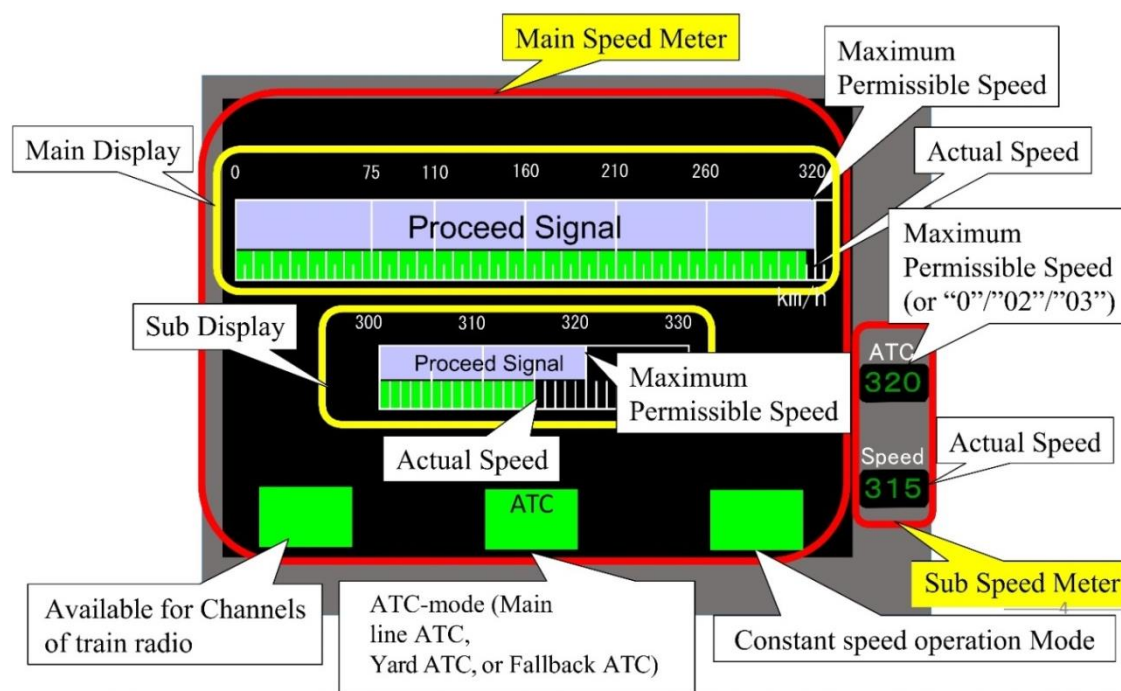


### 3.4 Maintenance and Action in the Event of Accidents, etc.

#### 3.4.1 Maintenance Type: The Maintenance types shall be as follows:

- a. Preventive Maintenance: Preventive Maintenance shall be performed to detect, in an effective method, a risk that functions of equipment are lost and to perform necessary treatment to avoid such situation. It shall cover equipment of which breakdown can directly affect train operation or seriously affect customer service.
- b. Corrective Maintenance: Corrective Maintenance shall be performed basically for the treatment after breakdown of equipment.

#### On-Board Display:



Main speed meter and sub speed meter are separated system (from the viewpoint of redundancy).

The meaning of terms in this Implementation Standard shall be defined as below:

1. "⊗ Signal" means a kind of stop signal indicated when the Train (including Vehicle) is required to stop immediately.
2. "0 Signal" means a kind of stop signal indicated when the Train (including Vehicle) is required to stop normally before the end of the Route which is indicated by ATC.
3. "02 Signal" means a kind of ⊗Signal indicated when ATC Control Information is not received, or when such ATC Control Information is received like in case PESB is pushed.
4. "03 Signal" means a kind of ⊗Signal indicated when the Train (including Vehicle) over runs the stopping limit without proper authority.
5. "Approach Lock" means a kind of lock function of interlocking system. Approach Lock shall lock the Turnouts on the set Route when the Train (including Vehicle) enters approach section.
6. "ATC Control Information" means control information transmitted to a Train (including Vehicle) within an ATC Route.

7. "ATC Route" means a portion of track where a Train (including Vehicle) can travel according to the Cab Signal displayed by ATC. There are two types of ATC Routes.
  - a) Automatic Route – It is applicable for Block Route where ATC Route control information is automatically controlled and the operator cannot intervene except for temporary speed restriction.
  - b) Semi Automatic Route – It is applicable for Station (including Rolling Stock Depot) Routes (Home Route, Departure Route, Fallback Home Route, Fallback Departure Route, Yard Route) where the ATC Route control information is automatically controlled based on Route setting by the operator.
  - c) "Automatic Train Control (hereinafter "ATC")" is as defined in "General Guidelines for Management of Implementation Standards".
8. "Automatic Train Supervision (hereinafter "ATS")" means the real time Train control supervision system which regulates performance levels, monitors and controls the Trains services and provides data to Controllers to adjust Train services to minimise the inconveniences caused by Train operation disruptions.
9. "Base Station" means the radio device to communicate with on-board radio device, as well as with Train Radio network on the ground.
10. "Block Route" is as defined in "General Guidelines for Management of Implementation Standards".
11. "Cab Signal" is as defined in "General Guidelines for Management of Implementation Standards".
12. "Cable Gas Pressure Monitoring System" means the system which supplies dry air into the cable and monitors the gas pressure in order to detect breakage or cut of the cable.
13. "Call Recording System (hereinafter "CRS")" means the system which is installed in OCC having the function of recording designated incoming/outgoing calls to/from the OCC such as through a Despatcher Telephone or Train Radio System.
14. "CCTV System for Train Operation" means the system which is installed at the platform and is used to facilitate the Station staff to monitor the areas at platform where visibility is not good enough and where the Station staff requires to have assurance in respect of opening/closing of Train doors.
15. "Centralised Information Control System (hereinafter "CIC" or "CIC System")" means the system which shall collect and monitor the information of Signalling & Telecommunication facilities and disaster information necessary for train operation etc. in real time, and also perform controlling operation for some of Signalling and Telecommunication equipment.
16. "Centralised Traffic Control (hereinafter "CTC")" is as defined in "General Guidelines for Management of Implementation Standards".
17. "Contact Detector" means a device mounted on the stock rail at the turnout to check whether tongue rail and stock rail contacts closely for safe passage of Train.
18. "Control Information Section" means a section where the control information for Cab Signal is transmitted.
19. "Controller" or "Despatcher" is as defined in "General Guidelines for Management of Implementation Standards".

20. "Corrective Maintenance" is as defined in "General Guidelines for Management of Implementation Standards".
21. "Data Transmission system (hereinafter "DTS")" means the system which is installed as communication backbone between OCC, Stations, Traction Substations, Depots and other locations and shall be highly reliable for usage of important, vital and critical system.
22. "Dead Section" means a section of track, either within a track circuit or between two track circuits, the rails of which are not part of a track circuit for detecting Trains.
23. "Departure Route" is as defined in "General Guidelines for Management of Implementation Standards".
24. "Departure Route (ATC) (hereinafter "Departure Route")" is as defined in "General Guidelines for Management of Implementation Standards".
25. "Despatcher FAX" means the system which transmits Fax simultaneously to designated groups such as Stations (including Rolling Stock Depots), train crew depots and maintenance depots.
26. "Despatcher Telephone" means the system which provides voice communication between Controllers and agencies involved in safety and/or train operation for carrying out tasks smoothly and quickly.
27. "Audio Frequency Track Circuit (hereinafter "AFTC")" means the track circuit which uses audio frequency to transmit MA to the on-board system for ATC.
28. "Direct Telephone between Adjacent Stations" means the system which ensure instant and uninterruptible voice communication between two adjacent Stations (including Rolling Stock Depots) for substitute safety operation or other operations as required.
29. "Disaster Prevention System" means the system which shall collect the information like the wind, rainfall and rail temperature and have the function of displaying the received information on the monitoring terminals and CIC Systems in OCC and at other locations as required.
30. "Interlocking" means an arrangement of Signals, Points and other appliances which are operated from a panel or lever frame and interconnected by mechanical locking, electrical locking or electronic locking so that their operation can take place in proper sequence to ensure safety.
31. "Leaky Coaxial Cable (hereinafter "LCX")" means the cable that radiates radio waves of a desired frequency along its length.
32. "Maintenance" is as defined in "General Guidelines for Management of Implementation Standards".
33. "Maintenance Work" is as defined in "General Guidelines for Management of Implementation Standards".
34. "Movement Authority (hereinafter "MA")" is as defined in "General Guidelines for Management of Implementation Standards".
35. "Passenger Station" is as defined in "General Guidelines for Management of Implementation Standards".

36. "Point Device" means various equipment including ground connections such as Point Machine and contact detector, which is used for changing, detecting and locking the setting of Turnout.
37. "Repeater" means the communications device that amplifies (analog) or regenerates (digital) the data signal in order to extend the transmission distance.
38. "Replacement" is as defined in "General Guidelines for Management of Implementation Standards".
39. "Rolling Stock Depot" is as defined in "General Guidelines for Management of Implementation Standards".
40. "Route" is as defined in "General Guidelines for Management of Implementation Standards".
41. "Route Lock" means a kind of lock function of interlocking system. Route Lock shall lock the Turnouts on the set Route until the Train (including Vehicle) pass through the Route.
42. "Safe Signal Failure" means the same as "Right Side Failure" in MSS. It means types of signal failure which will not cause danger to rail traffic and may only affect performance of train operation.
43. "Sectional Route Lock" means a kind of lock function of interlocking system. Sectional Route Lock shall lock the Turnouts on the set Route and progressively release the Turnouts as soon as the Train (including Vehicle) passes through the section.
44. "Signalling Equipment including ATC for Safety of Train Operation" means following devices to ensure safety of train operation and its management.
  - a) All the devices/equipment including displays required to facilitate stop/proceed aspect on display devices in a safe manner.
  - b) The on-board & ground devices which indicate the condition(s) of Route ahead and/or automatically decrease the speed of or stop the movement of a Train (including Vehicle) in a safe manner.

For details of on-board device, refer to "Implementation Standard for MAHSR Rolling Stock Maintenance".
  - c) The device which controls signal aspects and turnouts of stations and conducts the Train operation management from a control centre (CTC).
45. "Stick Lock" means a kind of lock function of interlocking system. Stick Lock shall lock the Turnouts on the set Route for specific time (release time).
46. "Supervisory Control and Data Acquisition System (hereinafter "SCADA")" means the system which can remotely monitor and control all traction substations, sectioning posts, sub-sectioning posts, auto-transformer post, distribution substations, disconnectors (motorised) in Depot, tunnel separation disconnector equipment, and other related facilities.
47. "Track Lock" means a kind of lock function of interlocking system. Track Lock shall lock the Turnouts when the Train (including Vehicle) is on the track circuit which includes these Turnouts.

48. "Train Protection Radio" means the system which shall be used by any staff or worker to alert the Train Operator to stop and protect a running Train in the event of an emergency.
- a) "Train Radio" or "Train Radio System" means the system for Controllers (specifically Traffic Controllers) and Train crew to communicate with each other, and exchange necessary data information between the wayside/ground devices and on-board devices.
  - b) "Transponder" means a part of ATC Device installed between rails to send information to Trains for the position correction.
  - c) "Yard Radio" or "Yard Radio System" means the system which is used for communication between Station (including Rolling Stock Depot) staff and On-board crew during shunting in yard.

## Communication Based Train Control (CBTC) in Metro Railway Systems

- 1 A centralized control is inescapable to monitor and handle any emergencies.  
With closed doors to ensure passenger safety, there is a need for opening the train doors on the correct side for the platform which has to be again failsafe to prevent wrong side opening leading to passenger injury.
- 2 In order to achieve safety with a number of trains using the same line, it is essential to provide information to the driver by some sort of “signals” about where to stop or how fast the train can go etc.
- 3 To derive the information required to convey to the driver through “signals”, some form of train detection was essential, to know where exactly the train in question is with reference to other trains or other hurdles.
- 4 To provide means for more than one train to use the same line, it became necessary to divide the line into “blocks” and ensure there is only one train in each “block”.
- 5 To control the trains and allow precedence between slow and fast trains, it became necessary to have stations with turnouts and loops.
- 6 To ensure the points and crossings of a turnout were set within safety limits for prevention of derailment, it was necessary to ‘detect’ the point by the signalling system before allowing train movement i.e it was necessary to “interlock” the signal with the points. The interlocking may be achieved through Relay based or Microprocessor based.
- 7 Centralized Traffic control by a single operator controlling a line to avoid time delay for exchange of information between Station Masters for increasing the line capacity resulted in further advances such as block working, automatic Block signalling.
- 8 The rolling stock must have automatic train protection to eliminate driver errors.
- 9 The need for high frequency of train service necessitate automation of train supervision and route setting for quick turn round in terminal stations.
- 10 In Communication Based Train Control (CBTC) signalling system, the primary train detection is purely based on failsafe communication link between the train and the control centre with the train communicating its position continuously and the control centre communicates the position to other trains for maintain the safety distance between two trains. Track circuits or axle counters if any are used only as a secondary detection in case the Metro operator desires a fall back system.
- 11 **Train Spacing and its Impact on Safety and Line Capacity (Headway):**  
  
Considering the need for higher order of safety, as well due to the presence of halts at frequent intervals of even less than a KM length, Primarily the train detection is done by communication, based on the train location, the movement of authority is to be updated which is known as a moving block, which include a safety envelope behind and in front of a train, always moving along with the train.

## 12 Cab Signalling and Need for Track to Train Communication:

CBTC uses Cab signalling in which the signal aspects were made available right inside the driver's cab by way of displays. Information to be displayed had to be provided from track side to the equipment on-board the train. The information exchange between track to train is done through

- (a) by fixing coils on the track as well as underneath the cab and transferring information by magnetic induction.
- (b) By fixed Beacons or Balises mounted between rails transmitting the information electro magnetically through low frequency modulations to be picked up by antenna mounted below the engine of the trains.

or

- (c) By the provision of Coded AFTC.

- (i) The rolling stock must have on-board electronic/computing equipment for cab signalling equipped with Automatic Train Protection (ATP) for eliminating accidents due to SPAD.

- (ii) Automatic Train Control Systems (ATC) for Metro Rail networks:

- (iii) The rolling stock must have on-board electronic/computing equipment for cab signalling equipped with Automatic Train Protection (ATP)

## 13 CBTC mainly comprises

- (a) Automatic Train Protection (ATP) comprises of the sub-systems which provide the basic safety by way of fail-safe detection of dangerous conditions and controlling and stopping the train when required independent of any action by the driver when the train is being driven manually. ATP also ensures similar fail safe protection even when train is being driven automatically.
- (b) Automatic Train Operation (ATO) which comprises of sub-systems which can enable automatic operation of the train without any intervention by the driver except for closing of the train doors. ATO obtains the safety instructions from ATP and other operational information from the ATS system automatically and runs the train as required.
- (c) Automatic Train Supervision (ATS) which comprises of various sub-systems which are used to regulate and control the operations of all the trains in the network by monitoring the positions of trains all over the network at every instant and implementing the pre defined operator commands for automatic route setting at interlocking and automatic turn backs at the terminal station etc.
- (d) ATS works with the driver if the train is manually driven to keep him informed about when to leave a station. In case of ATO operation, the ATS will work with ATO and control the movements of all trains in the network. The Traffic Controller can manually intervene and take over the functions any time as required, due to any emergencies or disruptions in the network.

Communication-based train control (CBTC) is a railway signaling system that makes use of the telecommunication between the train and track side equipment for the traffic management and infrastructure control. By means of the CBTC systems, the exact position of a train is known more accurately than with the traditional signaling systems. This results in a more efficient and safe way to manage the railway traffic. Metros (and other railway systems) are able to improve headway while maintaining or even improving safety.

IEEE 1474 standard defines CBTC as a "continuous, automatic train control system utilizing high-resolution train location determination, independent from track circuits; continuous, high-capacity, bidirectional train-to-wayside data communication; and trainborne and wayside processors capable of implementing automatic train protection (ATP) functions, as well as optional automatic train operation (ATO) and automatic train supervision (ATS) functions".

#### **CBTC applicability:**

- Mainly suitable for urban railway lines (either light or heavy) and APMs (Automated people mover)
- Also deplorable on commuter lines/suburban lines.
- For main lines, a similar system of ERTMS (Level-3) exists, though it is not yet fully defined.

#### **CBTC systems in India**

<b>Metro</b>	<b>Make</b>
Kochi Metro	Alstom
Hyderabad Metro	Thales
Lucknow Metro	Alstom
Delhi Metro Line-7	Bombardier
Delhi Metro Line-8	Nippon
Noida Metro (operated by DMRC)	Ansaldo
Nagpur Metro	Siemens
Ahmedabad Metro	Nippon

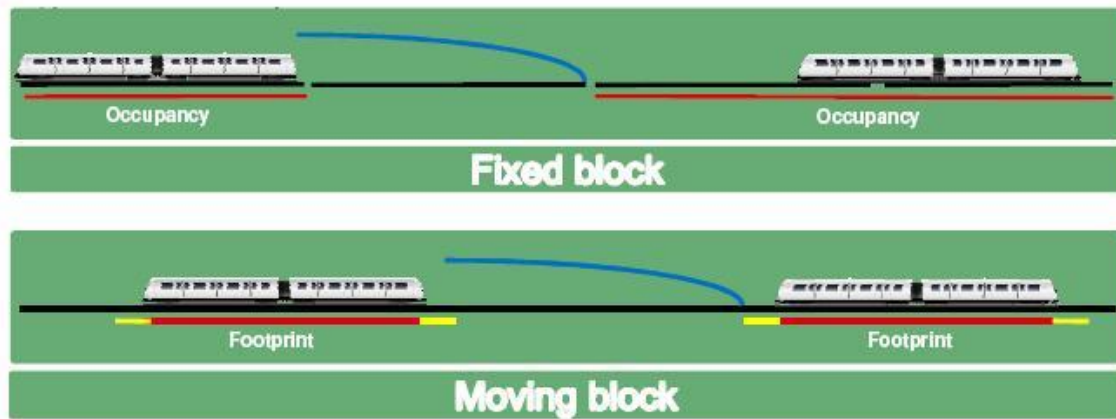
#### **CBTC Functions:**

- The trains continuously calculate and communicate their status via radio to the wayside equipment distributed along the line.
- This status includes, among other parameters, the exact position, speed, travel direction and braking distance.
- This information allows calculation of the area potentially occupied by the train on the track.
- It also enables the wayside equipment to define the points on the line that must never be passed by the other trains on the same track.



- These points are communicated to make the trains automatically and continuously adjust their speed while maintaining the safety and comfort (jerk) requirements.
- So, the trains continuously receive information regarding the distance to the preceding train and are then able to adjust their safety distance accordingly.

### Moving Block principle



First, let us understand the conventional Fixed Block system as depicted in the first figure.





- The figure shows the total occupancy of the leading train by including the whole blocks which the train is located on.
- This is due to the fact that it is impossible for the system to know exactly where the train actually is within these blocks.
- Therefore, the fixed block system only allows the following train to move up to the last unoccupied block's border.

Now, the Moving block is a significant refinement over the Fixed Block system.

- The train position and its braking curve is continuously calculated by the trains.
- Train then communicates its train position via radio to the wayside equipment.
- Thus, the wayside equipment is able to establish protected areas, each one called Limit of Movement Authority (LMA), up to the nearest obstacle (in the figure the tail of the train in front).
- Movement Authority (MA) is the permission for a train to move to a specific location within the constraints of the infrastructure and with supervision of speed.
- Occupancy calculated in these systems must include a safety margin for location uncertainty.
  - It is depicted by the yellow lines in front and rear of the trains.
  - It is called footprint.
  - This safety margin depends on the accuracy of the odometry system in the train.

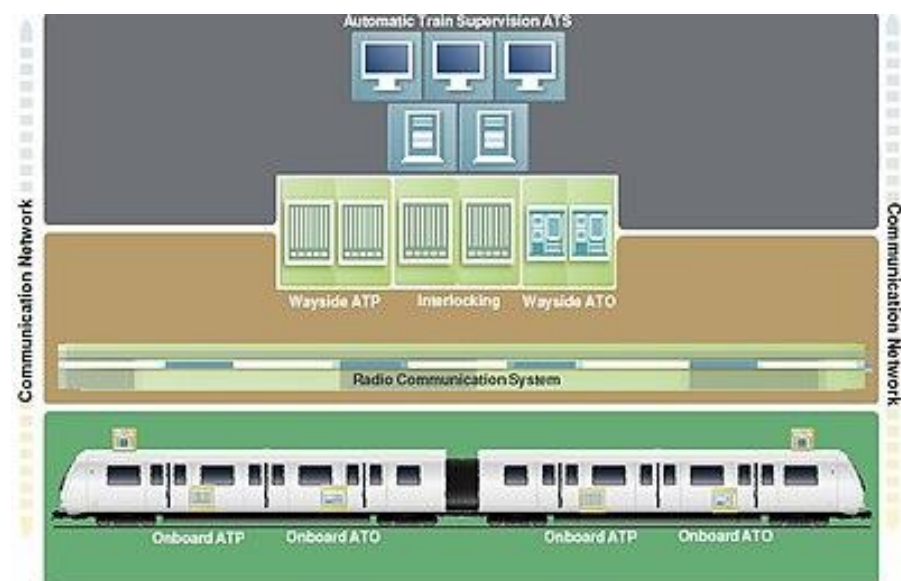
- CBTC systems based on moving block allows the reduction of the safety distance between two consecutive trains.
- This distance is varying according to the continuous updates of the train location and speed, maintaining the safety requirements.
- This results in a reduced headway between consecutive trains and an increased transport capacity.

### Grades of Automation

Grade of Automation	Automation Level for Train operations	Train Operation function allocation – Driver/Attendant or Automatic			
		Setting train in motion	Driving and Stopping train	Surveillance station entry & departure	Operation in event of Disruption
GoA 1 	Conventional with driver Train Stop or ATP	Driver	Driver	Driver	Driver
<b>KOCHI</b> GoA 2 	ATO with driver	Driver or Automatic	Automatic	Driver	Driver
GoA 3 	DTO Driverless with onboard staff	Automatic	Automatic	On-board staff or Automatic	On-board staff
GoA 4 	UTO Driverless Unattended	Automatic	Automatic	Automatic	Automatic

ATP - Automatic Train Protection ATO - Automatic Train Operation  
 DTO - Driverless Train Operation UTO - Unattended Train Operation

### CBTC Architecture:



The typical architecture of a modern CBTC system comprises the following main subsystems:

- Wayside equipment. It includes
  - Interlocking - vital control of the trackside objects such as switches or signals, as well as other related functionality.
  - Trackside ATC - management of the communication with the trains in its area. Calculates the limits of movement authority that every train must respect while operating in the mentioned area.
  - Trackside ATS - Interface between the operator and the system, managing the traffic according to the specific regulation criteria.
- On-board equipment. It includes
  - Onboard ATP - Ensures continuous control of the train speed according to the safety profile, and applying the brake if it is necessary.
  - Onboard ATO - Responsible for the automatic control of the traction and braking effort in order to keep the train under the threshold established by the ATP subsystem.
- Data communication system. It includes
  - Wired part
  - Wireless part (set of Radio Access Points, distributed along the Trackside).

Although, CBTC architectures are always dependent on the supplier and their technical approaches, the aforementioned logical components may be found generally in a typical CBTC architecture:

#### **Advantages of CBTC in brief**

- Continuous bi-directional communication based vs. unidirectional based.
- Moving block vs. the hundred year old traditional fixed block principle.
- Integrated SW based interlocking.
- No secondary detection needed.
- Driverless/Unattended operation possible.
- Fully automated depots.
- Auto coupling possible.
- Less than 90 sec. headway

## GLOSSARY OF TECHNICAL TERMS FOR SIGNAL ENGINEERING MANUAL

S No	Term	Description/Meaning in SEM	Relevant paras
1	Act	Means the Indian Railways Act, 1989	3.5.4, 9.1.1(a)(i)
2	Adequate Distance	Means the distance sufficient to ensure safety. These are known as overlaps in signalling context	7.1.8, 7.1.9, 7.1.15, 7.4.9, ,12.5.4(a), 20.1.4(a)
3	Advance Section	Section between Intermediate Block Signal and First Stop Signal of station in advance (including block overlap)	18.12.1, 18.12.4, Annexure: 18-A5
4	Approach Lighting	Means an arrangement in which the lighting of signals is controlled automatically by the approach of a train.	
5	Approach Locking/Dead Approach Locking	It is a locking provided on points in the route, overlap, isolation (as applicable) to prevent their unlocking or operation of Points in the face of a train, approaching a stop/shunt signal in it's OFF position, such locking shall be effective even if such signal is put back to 'ON' subsequently till lapse of defined time period. <i>(Explanatory notes: Approach locking shall be effective from a distance which is not less than maximum emergency braking distance of a train running at maximum permissible speed in that section, approaching a stop signal. For a home signal, such approach Track commences from concerned Distant signal/Inner Distant signal in rear to Home signal. In the absence of such an approach track circuit , Dead approaching locking is provided with a timer to prevent any unlocking of the said points)</i>	7.6.2(a), 12.28.2(c), 14.1.7(d), 14.1.9(b), 19.8.9 ( b, c), 19.8.11(b), 20.2.3, 21.1.4(f), 21.1.6(i), 21.1.9(d)
6	Approved Guide Lines	A set of guide lines issued for a specific purpose after due approval by competent authority.	
7	Approved Special Instructions	Special instructions approved of or prescribed by the Commissioner of Railway Safety (CRS)	7.1.8, 7.1.9, 7.1.16, 7.1.17(a,b), 12.5.4(a), 12.5.8(b) 20.1.1
8	Approved Specification	A technical specification approved by RDSO/Competent authority	16.4.1(a,f), 18.1.1(d), 21.3.1(f), 22.4.4
9	Approved Type	An equipment/component which confirms to specification issued by RDSO/Competent authority	7.6.9(d), 14.2.1(b), 17.2.10(a), 19.2.1(a), 21.2.1(a)

S No	Term	Description/Meaning in SEM	Relevant paras
10	Approved Type of Design	A Design approved by RDSO/Competent authority	
11	Assurance	Confidence in achieving a goal being pursued. Declaration intended to give confidence.	Annexure: G1
12	Audio Frequency Track Circuit (AFTC)	Is a joint-less Track circuit, uses audio frequencies fed to track, to detect the presence or absence of a train.	17.4.1, 17.5.2(h), 17.5.3(d,e,f), 17.5.3, 22.7.5(b)
13	Audit	Systematic, independent, documented process for obtaining records, statements of fact or other relevant information and assessing them objectively to determine the extent to which specified requirements are fulfilled.	3.5.7(a)
14	Authorized Officer	Means the person who is duly empowered by general or special order of the Railway Administration, either by name or by virtue of his office, to issue instructions or to do any other thing.	
15	Authority To Proceed	Means the authority given to the Loco Pilot of a train, under the system of working, to enter the block section with his train	
16	Automatic Train Protection System (ATP)	A system that enforces compliance with signal interlocking and speed restrictions. Automatic Train Protection (ATP) comprises of the sub-systems which provide the basic safety by way of fail-safe detection of dangerous conditions and controlling and stopping the train when required independent of any action by the driver when the train is being driven manually. ATP also ensures similar fail safe protection even when train is being driven automatically.	5.2.2, 5.2.3(d), 5.3.2(c), 11.1.2(f), 13.1.2, 13.1.3, 13.1.5(a), 13.1.7(a,b), 13.2.1, 13.2.2(a), 13.2.5(i), 13.3.1(b), 13.4.1(c), 13.4.9(g), 13.4.10
17	Automatic Train Operation (ATO)	Automatic Train Operation (ATO) which comprises of sub-systems which can enable automatic operation of the train without any intervention by the driver except for closing of the train doors. ATO obtains the safety instructions from ATP and other operational information from the ATS system automatically and runs the train as required.	Annexure: G2

S No	Term	Description/Meaning in SEM	Relevant paras
18	Automatic Train Supervision (ATS)	Automatic Train Supervision (ATS) which comprises of various sub-systems which are used to regulate and control the operations of all the trains in the network by monitoring the positions of trains all over the network at every instant and implementing the pre defined operator commands for automatic route setting at interlocking and automatic turn backs at the terminal station etc.	Annexure: G2
19	Availability	Ability of an item to be in a state to perform a required function under given conditions at a given instant of time or over a given time interval, assuming that the required external sources are provided.	Annexure: G1
20	Axle Counter	An electrical device which, when provided at two given points on the track, proves by counting axles in and out, whether the section of the track between the said two points is clear or occupied;	7.6.4, 7.8.2(c), 8.7.17, 17.3.13, 17.6.1, 17.7.4, 17.8.1, 18.10.1, 21.1.17
21	Axle Detector	The track device comprising of the coils sealed in a cover mounted on the rail. It will detect the wheel of rolling stock axle passing over the device.	17.6.1, 17.7.2(b) (c)(d)
22	Back Locking/ Route Locking	It is a locking provided on all points in the route of a train (which has passed the signal), in order to prevent their unlocking, till clearance of the last point zone track circuit by the said train. It also provided on LC gates (where required) for preventing such unlocking of LC Gate till the said Train has passed beyond LC gate.	7.6.2, 7.6.3, 14.1.7(e), 14.1.9(b), 19.8.11(g), 14.3.2(k), 20.2.2(i), 21.1.3(d), 21.1.11(c)
23	Balise	Balises mounted between rails transmitting the information electro magnetically through low frequency modulations to be picked up by antenna mounted below the engine of the trains.	13.2.1(b), 13.2.2(d), 13.2.3 (b,c,e,g), 13.2.4 (c,d,e,f), 13.2.5(a,b,c)
24	Berthing Track	That portion of Track which a train occupies, when concerned stop signal is displaying a 'stop' aspect. The Track Circuit that is on the approach to a signal is called berthing track circuit.	7.1.19(a), 7.6.2(b), 14.2.1(a), 17.2.6(a), 19.8.9(e), 21.1.6(i), 21.1.8(b)
25	Block Back	To dispatch a message from a block station intimating to the block station immediately in rear on a double line or to the next block station on either side on a single line, that the block section is obstructed or is to be obstructed	
26	Block Forward	To dispatch a message from a block station on a double line intimation to the block station immediately in advance the fact that the block section in advance is obstructed or is to be obstructed.	

S No	Term	Description/Meaning in SEM	Relevant paras
27	Block Overlap	Block overlap, is the adequate distance in advance of the first stop signal of a block station, which shall be kept clear and unoccupied by any vehicle, before line clear is granted to the station in rear.	7.1.8, 7.1.14(a), 7.5.2(a), 18.12.1(b,c,j)
28	Block Section	That portion of the running line between two block stations on to which no running train may enter until Line Clear has been received from the block station at the other end of the block section.	7.1.14(a,g), 7.5.1, 8.1.1(a), 12.5.14(e), 17.3.7, 17.6.2(d), 17.7.4 18.12.1
29	Braking Distance	It is the distance travelled by a train after application of brakes by its loco pilot.	7.1.13 (b), 7.1.15 (e) 13.3.5(c), 20.1.2 (c)
30	Catch Siding, Slip Siding	Catch Siding is a siding, provided to protect the Station Section, if the gradient is steeper than 1 in 80 falling towards the station section. Slip Siding is a siding, provided to protect the Block Section, if the gradient is steeper than 1 in 100 falling towards the Block Section	7.4.9(b), 7.5.1, 7.5.2, 7.5.3, 7.5.5, 7.5.6, 7.5.7, 9.2.1(d), 21.1.12(a)
31	Centralised Traffic Control (CTC)	It is a system by which the working of trains over a route, to which the system applies, is governed by fixed signals remotely controlled from a designated place.	5.2.2(A), 5.3.2(C), 13.4.1 (e), 13.4.2 (g), 13.4.10(a),
32	Class B Station	Where Line clear may be granted for a train, before the line has been cleared for the reception of the train within the station section.	
33	Clear Standing Length (CSL) Clear Standing Room (CSR)	Distance between foot of the signal to Fouling Mark in the rear on the same line in case of Main line and Directional loop at Station yard. In case of Common Loop at the stations, Clear Available Length/ Clear Standing Length shall be the distance between two starter signals of opposite direction on the same line.	Annexure: 8-A2
34	Colour Light Signal (CLS)	A fixed signal in which the indications are given by the colour of a light only.	16.2.2(a), 16.4.1 (e), 19.2.1, 20.5.1
35	Commissioner of Railway Safety (CRS)	An official, appointed to exercise any functions under the Act. <i>(Explanatory notes: CRS sanctions will be required for carrying out certain types of works. Details given in Chapter 9)</i>	3.6.5(b), 8.1.1(j), 8.1.3(b), 9.2.3, Annexure: 9-A1
36	Competent Railway Servant	A railway servant duly qualified to undertake and perform the duties entrusted to him	

S No	Term	Description/Meaning in SEM	Relevant paras
37	Communication-based train control (CBTC)	Communication-based train control (CBTC) is a railway signaling system that makes use of the telecommunication between the train and track side equipment for the traffic management and infrastructure control	Annexure: G-3
38	Connections	When used with reference to a running line, means the points and crossings, or other appliances used to connect such line with other lines or to cross it.	7.6.5(a), 12.5.6(b),(d)
39	Control Panel /Control Cum Indication Panel (CCIP)	It is a device, through which Station Master/authorised Operating staff control & operate signaling gears such as point, signal, LC gates. It has switches/Knobs/Buttons for such operation. Used in Relay Interlocking/Electronic Interlocking/LC gates. Except in major RRIs, It also contains indications, this called Control Cum Indication Panel (CCIP)	7.7.2,8.1.8(a)
40	Control Terminal	It is a Video Display Unit (VDU) used for controlling signals, Points, LC gates, etc. in Stations provided with Electronic Interlocking.	7.7.1(a)(b), 7.7.5, 8.7.15, 21.1.15, 21.4.2, 21.5.3(a)
41	Control Table	It is set of interdependencies/relationships/requirements with applicable conditions, among various signaling functions/equipments at a station/yard, presented in a logical way in a tabular format with all possible combinations of routes for all the signals to achieve safety and to provide for operational requirements. It is also called Selection Table/Route Control Chart. <i>Note: It's equivalent in Mechanical signalling is Locking Table. It is the basis on which detailed design of circuits is undertaken for implementing Interlocking requirements</i>	1.3.7(b),3.1.1(b), 3.5.3(a),3.6.5(b), 7.8.1(a), 8.1.4(b), 8.1.8(A), 8.7.1(b), 21.1.1(c), 21.1.4(f), 21.1.5(a), 21.4.1 (e), 21.5.2(c)
42	Controller	Means a railway servant on duty who may for the time being be responsible for regulating the working of traffic on a section of a railway provided with the system of speech communication.	11.2.2(d), 13.4.1 (d), 13.4.2(b), 13.4.8(a), 22.8.9(a)
43	Corrective Maintenance	Maintenance carried out after fault detection to effect restoration.	3.4.1(b) Annexure: G2
44	Day	Means from sunrise to sunset	
45	Detection Point	Axle detector/track device and the Field Unit connected to it.	Annexure: 20-A1
46	Dead Section	It is section of track, either within a track circuit or between two track circuits, the rails of which are not part of a track circuit for detecting Trains.	20.1.5(c), Annexure: G2



S No	Term	Description/Meaning in SEM	Relevant paras
47	Digital Axle Counter (DAC)	Digital axle counters which use Digital Electronics & software to identify & display whether a concerned Track section is Clear or Occupied	17.6.1 (a),(c), 17.7.2 (a), 21.4.3 (b)
48	Direction Of Traffic	On a double line, the direction for which the line is signalled, On a single line, the direction for the time being established, under the system of working, to allow trains to move in that direction;	8.1.1 (b),18.12.1 (m), 18.12.5, 20.1.3(c), 20.1.4 (b), 20.3.3.
49	Driver Machine Interface (DMI)	The interface to enable direct interaction between the on-board equipment of ATP and the Loco Pilot.	13.1.5(e), 13.2.3(b), 13.2.7(a)(b), 13.3.3 (c), 13.3.6
50	Dual Detection	It is an additional detection provided in addition to Main Detection to enhance availability.	9.2.2(d), Annexure:18-A5
51	Dynamic Speed Profile	The speed/distance profile that a train may follow without violating the static speed profile and/or the end of movement authority.	13.1.5(b)
52	Data Logger Management Center (DLMC)	DLMC is a place extensively used for monitoring of Relay Room door opening, fire alarm, Power supply/Battery voltages, ELD and other Specified signalling/Telecom gears continuously or regularly generally situated at divisional HQ.	3.1.4(c), 3.7.1(a)(c)(d)(e)
53	Electrical Communication Instrument	Means a telephone instrument (including Mobile communication equipment/VHF walkie-talkie Set)	
54	Emergency Brake	Application of a maximum brake force in order to stop the train in the shortest distance	13.1.5(f), 13.2.3(b), 13.2.4 (c)(f), 13.2.5.
55	Emergency Braking Distance (EBD)	Is the distance travelled by train before coming to a Dead stop by application of Emergency Brake by Loco-pilot. <i>(Note: For signalling purpose, EBD is reckoned from a Signal displaying a 'Attention' aspect to the signal displaying a 'Stop' aspect)</i>	7.1.13(b), 20.4.1, 7.1.15(e), 14.1.7(d), 14.1.9(b)
56	End of Authority	Location up to which the train is permitted to proceed and where target speed is zero.	
57	Facing And Trailing Points	Points are facing or trailing in accordance with the direction a train or vehicle moves over them. Points are said to be facing points when by their operation a train approaching them can be directly diverted from the line upon which it is running.	7.4.12(a,b), 12.4.3, 12.4.4, 12.11.6, 12.14.1, 12.14.5
58	Failure Mode	Manner in which failure occurs.	

S No	Term	Description/Meaning in SEM	Relevant paras
59	Failure Rate	Limit of the ratio of the conditional probability that the instant of time T, of a failure of a product falls within a given time interval (t, t+ Δt) and the duration of this interval Δt, when Δt tends towards zero, given that the items is in an up state	3.1,3.5 of Annexure: G1
60	Factory Acceptance Test (FAT)	A type of Testing done to check whether Software logics of Interlocking/Equipment, to be Installed are responding fully in accordance with logics defined in Control Tables. This is done without any Interface wiring in Relay Room and no connection to Outdoor equipments.	3.6.5(b), 21.5.2(a) (b)(d), 13.1.9(c),
61	Fixed Signal	Means a signal of fixed location indicating a condition affecting the movement of a train and includes a semaphore arm or disc or fixed light for use by day and fixed light for use by night.	12.5.10(a), 13.2.2 (b), 20.1.2(b), 20.1.3(a)
62	Fouling Mark	It marks at which the infringement of two fixed Standard Dimensions fouling block occurs, where two lines cross or join one another. It is placed at a location, where centre to centre distance is less than 4265 mm for existing works and 5300 mm for new works.	7.1.14(d), 7.3.6(b), 7.4.9(b), 7.6.5(b), 7.6.6(c), 12.5.6, 17.2.4(a)(b)
63	Functional Safety	Part of overall safety that depends on functional and physical units operating correctively in response to their inputs.	Annexure: G1(S.No-4.1)
64	Goods Train	Means a train (other than material train) intended solely or mainly for the carriage of animals or goods.	Annexure: 13-A1
65	Guard	Means the railway servant in charge of a train and includes a Brakesman or any other railway servant who may for the time being be performing the duties of a Guard.	7.1.14(c), 7.5.3, 7.5.6, 7.7.2(f), 8.1.9(e), 22.1.1(c)
66	Hazard	Condition that could lead to an accident.	17.4.2(h), 17.5.4 (e)
67	Hazard Analysis	Process of identifying hazards and analysing their causes and the derivation of requirements to limit the likelihood and consequences of hazards to a tolerable level.	
68	Hazard Rate	Rate of occurrence of hazard.	Annexure: G1 (3.4, 4.12)
69	Hot Standby	It is an arrangement for the changeover of system from one active unit to another active unit, being provided for same purpose.	13.3.3(b)(d), 21.4.6(a)
70	Implantation	Horizontal distance from centre of the track.	19.2.1(b), Annexure: 3-A1

S No	Term	Description/Meaning in SEM	Relevant paras
71	In Advance of A Signal	A term used in defining a territory beyond a signal as seen from the approaching train.	
72	In Rear of A Signal	Means the territory over which an approaching train has to pass before reaching the signal location.	7.1.15(d)
73	Independent Safety Assessment	Process to determine whether the system/product meet the specified safety requirements and to form a judgment as to whether the system/product is fit for its intended purpose in relation to safety.	
74	Indication Locking	The signalled route can be released only after concerned signal is put back to danger after passage of train beyond the signal or route for signal has been cancelled in addition to other conditions. Such locking on points is known as Indication locking on signals. <i>(Note:- The signals are operated by control cum indication panel or VDU control terminal. The point indication relay picks up only after the correspondence between point operation command relay picked up in the relay room and point position at site is satisfied. This locking is known as Indication locking on point).</i>	12.28.2(c), 14.2.1(p), 21.1.9(d)
75	Interlocking	Means an arrangement of signals, points and other appliances, operated from a panel or lever frame, so interconnected by mechanical locking or electrical locking or both that their operation must take place in proper sequence to ensure safety.	1.3.7(b), 2.2.1(d), 2.3.1(b), 3.1.1, 3.1.5(b), 3.2.1(c), 3.5.3(a), 3.5.7, 3.6.3(c), 3.8.2(a)
76	Intermediate Block Post	It is a class 'C' station on a single line, double line or multiple line remotely controlled from the block station in rear.	7.1.14(g)
77	Intermediate Block Signalling (IBS)	Means an arrangement of Signalling on single line, double line, in which a long block section is split into two portions each constituting a separate block section of a block section by providing an Intermediate Block Post.	7.1.14(g), 8.1.1(b), 13.4.2(a), 18.12.1, 18.12.2(a), 18.12.3, 18.12.4, 18.12.5
78	Intermediate Siding/ Outlying Siding	Siding line taking off from running line and located in the block section.	
79	INDIAN RAILWAY STANDARD (IRS)	A set of Standards applicable to Railway specific Equipments/Technologies.	8.2.1

S No	Term	Description/Meaning in SEM	Relevant paras
80	Isolation	Means an arrangement, secured by the setting of points or other approved means, to protect the line so isolated from the danger of obstruction from other connected line or lines.	7.1.18(e), 7.4.11, 7.6.1, 13.1.11, 18.1.1(h), 21.1.6.
81	Last Stop Signal (LSS)	Means the fixed Stop Signal of a station controlling the entry of trains into the next block section.	7.1.12(a), 7.1.18 (d), 7.6.6(b), 12.5.4 (c), 18.1.4(e), 21.1.6(m)
82	Level Crossing	It is an intersection of road with railway track at the same level.	7.1.16, 12.8.1(a)
83	Level Crossing Gate (LC Gate)	Means any form of movable barrier, including a chain, capable of being closed across the road at the level crossing but does not include a wicket or a turnstile for the use of pedestrians.	8.7.11, 9.2.1 (e), 13.3.1(b), 14.1.3, 14.1.7, 14.1.8, 14.1.10(a)
84	Life Cycle	Series of identified stages through which all items go, from its conception to disposal.	Annexure: G1 (1.1) (b)
85	Limit Of Authority	The place beyond which the train has no information but to which the train is authorised to run with a defined target speed higher than zero. The train is expected to receive new information before passing the limit of authority.	
86	Line Capacity	The maximum number of trains that can be run on any given Line during a calendar day of 24 hours.	5.2.2 (c), 5.3.2 (b), 14.1.2(b),
87	Line Clear	Means the permission given from a block station to a block station in rear for a train to leave the latter and approach the former; or the permission obtained by a block station from a block station in advance for a train to leave the former and proceed t	7.5.2(b), 7.6.7, 18.1.2, 18.1.5 (a)
88	Line Verification Box (LV Box)	It is a device consisting of a key actuated push button switch, which is placed close to required track section (Usually a point zone or Line in station section) whose physical clearance of any vehicles is to be verified at site.	17.7.5(a), Annexure-18-A5(D)(iii)
89	Loco Pilot	Means the Loco Pilot/Assistant Loco Pilot/Shunter/Motor man or any other competent railway servant of the time being in charge of driving a train.	3.1.3(b), 7.1.5(d), 7.1.15, 7.4.9, 12.21.1, 13.1.8, 19.2.1(b)
90	Main Line	Means the line ordinarily used for through running trains at a station and between stations.	7.1.12(b), 12.5.12 (a), 12.21.3

S No	Term	Description/Meaning in SEM	Relevant paras
91	Main Signal /Running Signal	The Signal governing the movement of a running train. (Not a shunt movement)	12.26.3(a), 21.1.4, 7.1.3, 7.1.5(d), 20.3.3(b), 21.1.9(c)
92	Maintainability	Ability to be retained in, or restored to, a state to perform as required, under given conditions of use and maintenance.	Annexure: G1(1.1,(3.2)
93	Material Train	Means a departmental train intended solely or mainly for carriage of railway material when picked up or put down or for execution of works, either between stations or within station limits.	Annexure: 22-A2
94	Mixed Train	Means a train intended for the carriage of passengers and goods, or of passengers, animals and goods.	
95	Most Restricted Speed Profile	The speed which a train must not exceed. It is the lowest speed taking into account all the various speed profiles.	
96	Movement Authority (MA)	Safe distance of travel communicated by the Automatic Train Protection System.	13.2.1(d), 13.2.3 (c),(e)
97	Moving Block	Considering the need for higher order of safety, as well due to the presence of halts at frequent intervals of even less than a KM length, Primarily the train detection is done by communication, based on the train location, the movement of authority is to be updated which is known as a moving block, which include a safety envelope behind and in front of a train, always moving along with the train.	Annexure: G-3 (11,13)
98	Multi Section Digital Axle Counter (MSDAC)	Multi Section Digital Axle Counter is a Digital Axle Counter used to monitor more than single track section either at Stations or in Block sections.	3.8.4(e), 8.7.1(c), 11.1.2(f), 21.1.1 (d), 21.1.17(d)
99	Multiple Aspect Signalling (MACLS)	Means a Signalling arrangement in which signals display at any one time any one of the three or more aspects and in which the aspect of every signal is pre-warned by the aspect of the previous signal or signals.	7.1.8, 7.3.2, 7.3.6(a), 12.5.12, 12.5.13, 14.1.7(b),

S No	Term	Description/Meaning in SEM	Relevant paras
100	Neutral Section	A short section of Insulated Dead over-head equipment which separates the sectors fed by two adjacent substations which are connected to different phases. (Ref: ACTM Vol-II Annexure –I.2.12 & 16.0) <i>Note: It has no power supply to drive Electric locomotive engine.</i>	14.2.2(b), 18.12.1 (a)
101	Night	Means from sunset to sunrise.	2.2.1(c), 3.2.2(b), 7.4.5(b), 12.5.5(b)
102	Obstruction	It's cognate expressions includes a train, vehicle or obstacle on or fouling a line, or any condition which is dangerous to trains.	3.1.3(b), 12.14.5, 19.3.5, 19.3.6(a), 19.4.1(b), 19.4.6
103	Off Position	Means any position other than the 'ON' position of a signal.	
104	On Position	Means the most restrictive position of a signal.	3.8.4(c), 7.1.18, 7.6.1(b), 19.8.9
105	On-Board Equipment (OBE)	The part (software and/or hardware) of the ATP system located in Locomotive, which fulfills the approved ATP specification.	13.1.5, 13.2.4 (c), 13.1.6, 13.1.8, 13.2.1, 13.2.5(c)
106	Overhead Equipment (OHE)	Means the electrical conductors over the tracks together with their associated fittings, insulators and other attachments by means of which they are suspended and registered in position for the purpose of electric traction.	8.1.8, 13.4.3(a), 16.2.1(a)(b), 17.5.6(e), 22.1.2(a), 22.1.3, 22.3.1, 22.3.4(a)
107	Passenger Train	Means a train intended solely or mainly for the carriage of passengers and other coaching traffic, and includes a troop train.	9.2.1, 13.4.2(c),
108	Permitted Speed	The speed limit at which a train is allowed to proceed without warning and/or intervention from the onboard equipment.	7.1.15(d), 13.1.5 (b), 13.2.4(a), 13.2.5 (i), 13.4.5
109	Point And Trap Indicators	Are not signals, but are appliances fitted to and working with points to indicate by day or by night the position in which the points are set.	12.13.2(a)
110	Position Light Signal	A fixed signal in which the indications are given by the position of two or more lights.	7.1.19(b)

S No	Term	Description/Meaning in SEM	Relevant paras
111	Preventive Maintenance	Maintenance to carry out to mitigate degradation and reduce the probability of failure.	
112	RAM Plan	Documented set of time scheduled activities, resources and events serving to implement the organizational structure, responsibilities, procedures, activities, capabilities and resources that together ensure that an item will satisfy RAM requirements relevant.	
113	Rear Section	The Section between LSS and IB Signal (including 400 meters of overlap).	18.12.1(a)(b)(d) (e)
114	Reference Location	A location on the track (e.g. balise group reference location or RFID tag location) used as a reference for the information sent from trackside or for the train position.	
115	Relay	An electromagnetic device, which is used to convey information from one circuit to another circuit through a set of contact i.e. front or back contact.	3.5.7(a), 7.8.1(a), 11.1.2, 17.1.1(e), 18.2.4, 18.8.1(f), 19.8.8(a), 20.2.2(a,b)
116	Release Speed	A speed value to allow a train to approach the end of its movement authority.	13.2.3(g)(j)k)
117	Reliability	Ability to perform as required, without failure for a given time interval, under given conditions.	7.8.8, 8.7.1(c)(d), 21.1.1(e), 21.3.4(a) Annexure: G1
118	Required Distance	Minimum distance between two points duly taking gradients into consideration to ensure functionality & safety.	
119	Reset-Hard	Hard Reset is a type of reset which when applied will directly reset the failed Axle counter system. It is not to be applied in a working Station/Section.	
120	Reset – Cooperative	A type of reset (applied on a failed axle counter system) by due Co-operation between two Operating Staff/Station Masters or One Station Master & Another Operating staff at site after ensuring laid down conditions - such as arrival of last vehicle or clearance of the track section (using line verification box after physical verification of Failed Track section). The axle counter will show 'clear' after application of this type of reset.	17.7.5 (a)
121	Reset - Conditional	-do-	17.7.5 (a)

S No	Term	Description/Meaning in SEM	Relevant paras
122	Reset – Preparatory	After application of this type of resetting, axle counter will continue to show ‘Occupied’ until one train movement is carried out through the failed section and ‘In Count’ is matched with ‘Out Count’.	17.7.4(a), 17.7.5 (b)
123	Supervisory Track Section & Reset	A section of track between two Detection Points completely covering more than one track section and is used to automatically reset failed Track sections under its jurisdiction, when it is safe to do so without manual intervention. This is also called Auto-Reset.	Annexure: 18-A4 II (B),(D), Annexure:21-A1 (C), (D)
124	Risk	Combination of expected frequency of loss and the expected degree of severity of that loss.	17.5.6 (c), 19.8.12 (f), 21.1.11(c)
125	Running Line	Means the line governed by one or more signals and includes connections, if any, used by a train when entering or leaving a station or when passing through a station or between stations.	7.1.14(c),7.4.5, 7.4.6(a),7.4.12, 12.5.6(d), 12.26.3(a) Annexure: 7-A1
126	Running Train	Means a train, which has started under an authority to proceed and has not completed its journey.	15.2.2(e), Annexure: 7-A1
127	Rusty Rail	It is a Rail which has developed rust formation on its surface and does not cause De-Energisation of Track relay as required, when a Train/Light Engine/Motor Trolley is occupying it, thus causing an unsafe side failure.	17.3.13
128	Safety	Freedom from unacceptable risk.	9.1.1(a), 9.2.1, 9.2.4, 9.2.5
129	Safety Assurance	Positive declaration intended to give confidence that Risk Process and behaviors are being managed to acceptable levels through appropriate measures.	Annexure: G1(2.2)
130	Safety Case	Documented demonstration that the product (eg. a system, subsystem or equipment) complies with the specified safety requirements.	
131	Safety Function	Function whose sole purpose is to ensure safety.	21.4.5(b), Annexure: G1(4.4)
132	Safety Integrity	Ability of a safety related system to achieve its required safety functions under all the stated conditions within a stated operational environment and within a stated duration.	13.1.3(c), 21.4.1(b), Annexure: G1(4.8)



S No	Term	Description/Meaning in SEM	Relevant paras
133	Safety Integrity Level	One of a number of defined discrete levels for specifying the Safety Integrity requirements for safety related functions to be allocated to the safety related systems.	13.1.3(c), Annexure: G1(4)
134	Safety Plan	Documented set of time scheduled activities, resources and events serving to implement the organizations, responsibilities, procedures, activities, capabilities and resources that together ensure that an item will satisfy given safety requirements of relevant.	Annexure: G1
135	Safety Related Systems	A system is safety related if its failure can cause harm to life and property eg. Interlocking System, ATP or carries responsibility for safety.	Annexure: G1
136	Site Acceptance Test (SAT)	A type of Testing done to check whether Software logics & Hardware of Equipment are responding in accordance with given Control Tables. This is done duly connecting Equipment Hardware with Interface wiring in Relay Room and simulating outdoor signals, Points, Track circuit.	21.5.2(a)
137	Section Capacity	The maximum number of trains that can be dealt on a given section of Railway during the period of twenty four hours.	18.12.1(a)
138	Sectional Route Release (SRR)	Route releasing designed to release sequentially usually one track section at a time behind the train on it's passage.	17.3.13, 19.8.9(d), 21.1.12(a)
139	Semaphore Signal	A signal in which the day indications are given by the position of a semaphore arm.	Chapter 12, Section 5
140	Service Brake/ Normal Brake	It is the brake command which reduces the Brake Pipe pressure to 1.5 Kg/Cm <sup>2</sup> .	13.1.5(d), 13.2.3(i), 13.3.5(b)
141	Shunting	Means the movement of a vehicle or vehicles with or without an engine or of any engine or any other self-propelled vehicle for the purpose of attaching, detaching or transfer or for any other purpose.	7.3.5, 7.3.6(c), 7.4.7, 18.1.6(c), 12.22.1(a)
142	Sighting Distance	The distance over which the most restrictive aspect of a signal is visible from the driving compartment of an approaching train under normal conditions of visibility.	14.1.9(a)(iii)
143	Signal Overlap	Adequate distance in advance of a stop signal, which should be kept clear before the signal in rear can be taken 'OFF'.	7.1.9, 8.1.5(b), 13.2.3(j)

S No	Term	Description/Meaning in SEM	Relevant paras
144	Single Section Digital Axial Counter (SSDAC)	Single Section Digital Axle Counter is generally used to monitor single track section.	21.1.1 (d), 21.1.17(d) Annexure-18-A5, Annexure: 20-A1
145	SPAD	Means 'Signal Passing At Danger'. It is an alarming event, in which a speeding train overshoots a Stop/Shunt signal displaying a 'Stop' aspect, and can cause a potential risk of accident to itself and other trains.	7.6.9, 13.3.1(a)
146	Special Instructions	Means instructions issued from time to time by the authorized officer on a case to case basis.	7.1.5(b), 7.1.8, 7.1.17, 20.4.1 (a)
147	Specially Permitted	Lawful approval for a special Case exception.	21.3.1(c)(e)(g), 21.3.2(g)
148	Static Speed Profile	The description of the fixed speed restrictions of a given line. The speed restrictions can be related to items such as maximum line speed, gradients, curves, points, tunnel profiles, bridges etc.	
149	Station	Means any place on a line of Railway at which traffic is dealt with, or at which an authority to proceed is given under the system of working.	3.5.2(a), 3.8.1(d), 7.1.10, 8.1.1, 12.25.8, 14.1.8
150	Station Limits	Means the portion of a railway, which is under the control of a Station Master and is situated between the outermost signals of the station or as may be specified by special instructions.	7.4.12, 14.1.7, 14.1.8, Annexure 14-A1
151	Station Master	Means the person on duty who is for the time being responsible for the working of the traffic within station limits, and includes any person who is for the time being in independent charge of the working of any signals and responsible for the working of them.	7.6.6(c), 12.25.8, 13.4.8(d), 19.9.7
152	Station Section	Means that section of station limits, Where shunting is permitted even after granting Line clear.	7.5.1, 15.2.3(k), 17.6.2(c), 19.2.6
153	Subsidiary Rule	Means a special instruction, which is subservient to the General Rule to which it relates and shall not be at variance with any General Rule.	3.5.2(a), 3.8.6(a), 9.1.1(a),
154	Sufficient Distance	A reasonable distance to be provided if there is no site constraints. It is more than "Required Distance".	

S No	Term	Description/Meaning in SEM	Relevant paras
155	System Assurance	Is an analytical branch of engineering technology about ensuring high values of confidence, reliability, availability, maintainability and safety of complex engineering systems. System Assurance = RAM Assurance + Safety Assurance.	
156	System of Working	Means the system adopted for the time being for the working of trains on any portion of a railway.	Annexure-18-A5(I)
157	Target	Location where the train speed should be below the given target speed.	13.2.3(j)(i), 13.3.1(b)(ii),
158	Tolerable Hazard Rate	A hazard rate which guarantees that resulting risk does not exceed a target individual risk.	Annexure: G1(3.4, 4.12)
159	Track Description Data	Information containing static speed profile and gradient profile which complements the Movement Authority.	13.1.4(b), 13.1.5(b), 13.1.9(e), 13.3.4(h),
160	Track Side Equipment	The equipment with the aim of exchanging information with the vehicle for safely supervising train movement. The information exchanged between track and trains can be either continuous or intermittent according to the ATP level and to the nature of it.	13.1.4(b), 13.2.3(b), 13.2.5(b), 13.3.2
161	Train Detection	Means an electrical circuit provided to detect the presence of a vehicle on a portion of track. It's purpose is to detect the presence or absence of train on a defined section. <i>(Note: DC track circuits, AFTC track circuits, Axle Counters are used for this purpose)</i>	7.6.4, 7.8.2(c), 8.7.17, 19.8.7(a), 20.1.5, 21.1.17
162	Train Examiner	Means a railway servant duly qualified to examine trains and certify their fitness for safe running and includes and their railway servant who may for the time being be performing the duties of Train Examiner.	
163	Train Integrity	The level of belief in the train being complete and not having left coaches or wagons behind.	13.2.2(c), 13.3.4(c)
164	Train Interface Unit	The unit, inside the on-board equipment, that provides the interface between the on-board equipment of ATP and the train.	13.2.3(b)(c), 13.3.3(f),
165	Trap Siding	Has Points leading to a short dead end and used solely for the purpose of trapping the running line or sidings. This shall also be treated as derailing switch.	7.4.10(c)(d),
166	Track Locking	An electric lock on a point mechanism and/or on its connections, effective when a train occupies a given track circuit, to prevent movement of points under the wheel.	12.28.2(c), 21.1.9(d),

S No	Term	Description/Meaning in SEM	Relevant paras
167	Two-Aspect Signalling	It is a type of Signalling, in which a signal can show only two aspects i.e Stop/Proceed for Stop Signals and Caution/Proceed for Permissive Signals. No pre-warning of aspect of next signal in advance is possible.	14.1.7 (a), 14.1.8 (b)
168	Universal Failsafe Block Interface (UFSBI)	Universal Fail Safe Block Interface (UFSBI) is an Equipment used in Block working.	3.5.3(a), 18.2.2(c), 18.10.1, 21.1.1(d)
169	Validation	Confirmation, through the provision of objective evidence that the requirement for a specific intended use or applications have been fulfilled.	3.7.1(b)(f), 9.2.3(f), 11.1.3(i)
170	Verification	Confirmation through the provision of objective evidence that specified requirements have been fulfilled.	17.3.13, 17.7.5(a)(c), 20.1.5(d),
171	Video Display Unit (VDU)	It is display device cum controlling device. Used in Electronic Interlocking to operate Signals & Points, Crank Handles etc and also for getting display of Field status of them.	7.7.1(a), 7.7.5, 8.1.8(a)(v), 8.7.15, 21.1.15, 21.4.2
172	Warning	Audible and/or visual indication to alert the driver to a condition which requires a positive action by the Loco Pilot.	7.2.1, 7.3.1, 14.1.9(a)

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