The Science and Art of Railway Accidents Prevention, Investigation and Management

(Reading Material for Training of Safety Management for Safety Officers (SFMO), Safety Management for Safety Counsellors (SFMC), Safety Management Programme for Railway Officers (SFMP), Traffic Safety for Traffic Supervisors (TSTS), IRMS Probationary Officers and other Railway Courses)

VOLUME I
(Accident Prevention)

by

Hari Shankar Verma, IRTS
Director General, IRITM



भारतीय रेल परिवहन प्रबंधन संस्थान
INDIAN RAILWAYS INSTITUTE OF TRANSPORT MANAGEMENT

THE SCIENCE AND ART of

INDIAN RAILWAY SAFETY MANAGEMENT

THE SCIENCE AND ART of

RAILWAY ACCIDENTS PREVENTION, INVESTIGATION AND MANAGEMENT

(Reading Material for Training of Safety Management for Safety Officers (SFMO), Safety Management for Safety Counsellors (SFMC), Safety Management Programme for Railway Officers (SFMP), Traffic Safety for Traffic Supervisors (TSTS), IRMS Probationary Officers and other Railway Courses)

VOLUME I

(Accident Prevention)

Hari Shankar Verma,

Indian Railways Traffic Service

Director General,

Indian Railways Institute of Transport Management

वयं राष्ट्रे जागृयाम

INDIAN RAILWAYS INSTITUTE OF TRANSPORT MANAGEMENT

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The work of this volume is
dedicated to the
hard work of all categories of railway staff,
who keeps the wheel of rail moving
round the clock and since 1853.

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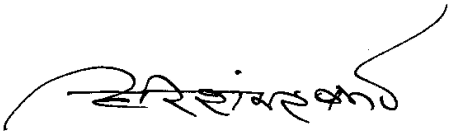
"The Science and Art of Railway Accidents Prevention, Investigation and Management" (Volume I, II & III) is the reading material to the trainee officers and faculty, who are undergoing training in the safety related courses at IRITM. The style of the book has been kept simple and the language is also lucid and easy to understand. A detail index is given to find out the concerned topics with page number. The purpose of this publication is to train the officers and supervisors about the Railway Accidents, their Prevention, Investigation and Management related subjects often occurring in railway working, especially while discharging duties by an official. This multi volume book covers most of the aspects of Safety, Disaster Management, the basics about the track, rolling stocks i.e., coaches, wagons, locomotives, and signal gears. The human element in safety has been discussed in detail. Most of the information has been taken from government publications like Manual, various Safety Bulletins, Publication of RDSO, CAMTEC and other institutions. However, efforts have been made to keep the content as original as possible. However, there may be some variance as the content of the chapters has been taken from different authentic sources in books, government websites, and links. The views expressed in those chapters and content of report are not the views of Central Government, IRITM and Authors of the reading material. This Volume is to be used for learning and academic purposes only and not to be taken as an authentic document. While, reading the book, the reader must keep in mind as under:

1. This book is printed as reading material for the purpose of training and learning by trainee officers.
2. The reading material is always prepared after reading several codes, manuals, and other relevant information from authentic Railway sources. It's for training purposes and nothing to do with the actual working of

Railways in the field.

3. In case, is any contradiction in writing, readers are advised to follow the codes, manuals and other extent instructions of Ministry of Railway and Zonal Railway.
4. I have tried to remain to the point, but it is the responsibility of the trainer to prepare the digital content, especially PowerPoint presentations, etc. as per the latest guidelines.
5. The various subjects, especially the Acts and Rules referred to in the book, keep changing due to need of the time. Therefore, trainee officers need to update the same.
6. All railway officials are subject to following the rules and instructions given time-to-time to them and those must be followed and not to adhere to the contents written in this reading material.
7. As far as the latest amendments to the rules are concerned, the trainee officers are advised to keep them updated. In case, in any deviation, the Railway publication to be relied upon.

The reading material is for internal use and not for any commercial use and cannot be quoted as an authority or in any legal matter.



Hari Shankar Verma, IRTS
Director General, IRITM
Author of
"The Science and Art of Railway Accidents Prevention, Investigation and Management"
Volume I, II, and III

Azadi Ka Amrit Mahotsav

जया वर्मा सिन्हा

JAYA VARMA SINHA

सत्यमेव जयते

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

FOREWORD

Safety is the cornerstone of any robust organization, and for Indian Railways, it is paramount. Indian Railways stands as one of the safest transport systems in the country, with a significant reduction in accidents over the past few decades. However, we must set our sights on an uncompromising goal: zero accidents, zero casualties.

Achieving this ambitious mission demands unwavering commitment. It all starts with impeccable training. Here, IRITM's dedication to safety education through regular courses for railway personnel is truly commendable. The publication of "The Science and Art of Railway Accidents Prevention, Investigation and Management" (Volumes I, II, and III) by Shri Hari Shankar Verma, Director General IRITM, as learning resource for trainees and officials will significantly enhance our training programs. This comprehensive work is expected to illuminate both trainees and current officers, helping to elevate the safety standards of Indian Railways further.

This safety guidebook covers several aspects including accident causes & prevention strategies and using real-world case studies. By emphasizing training, safety counseling and close monitoring, this book aims to achieve a future with zero railway accidents.



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महानिदेशक
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Indian Railway Traffic Service
Director General





PREFACE

For the railway officers and staff, there is a dearth of reading materials on accident prevention, investigation and disaster management in a single format. However, individuals' booklets are available on most of the topics but there is no compilation to address safety as a subject. Most of these books are technical in nature andsometimes quite difficult for the other than the engineering discipline and most particularly the officers occupying general management post like Safety officers, Traffic Officers, ADRMs and DRMs to understand the subject, it is also a fact that these technical books are written for keeping in mind of staff in technical and maintenance discipline.

All Accidents Investigations, whether at Supervisory Level or Officers Level required Traffic Officer or Traffic Inspector or Safety Counsellors to be part of Joint Note Making, Measurements, and Accidents sketch preparation. It is also observed that generally all of the officers and staff are not trained in basic knowledge of all discipline railways i.e., Track, Rolling Stock, Locomotives, and Signalling Gears. Even, most of the direct Officers have few lessons in these technical subjects. To improve the safety in railways, the railway official needs to learn the primary knowledge about most of the technical disciplines but it is not happening due to

non-availability of reading material. The field staff is also not aware about knowledge of technical subjects at different training centers, whatever, knowledge they pick up from the field working alongside of technical staff. There is an urgent need to fill up this gap by way of special training, workshops, and publication of reading material like this book. To emphasize the safety especially work safety, there cannot be better words than the following poem on work safety:

Work Safety

By *Alyssa Grocutt* ©

When you go to work in the morning
Don't just think of yourself
Whether you have a family or not
Other people do
Safety meetings go on and on don't they
At the time they don't seem important
But they are
Don't disregard them
Listen
One day the information may be important
It may even save a life and a family's despair

You may feel you know your job well
You don't want to waste your time
You go for a shortcut
The shortest isn't always the safest
What if a life is lost?
Could you live with yourself?
Knowing it was your decision

Maybe you don't even think about the consequences
You don't think about everyone affected
By one mistake

Or maybe it's even many mistakes

Safety isn't a joke
But there will always be that one guy
The guy that tries to say the safety meetings are pointless

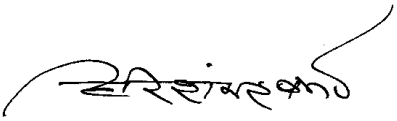
You can't go back in time
You can't undo mistakes
You can't take away an injury
And you definitely can't give back a life

The book is divided into three volumes and 96 chapters in total. Volume I deal with basic knowledge about accidents, infrastructure and focus on prevention of accidents.

Volume II deals with the art of accident investigations including the recommendations of various safety review committees. The proforma of joint measurement and schedule of dimensions has also been appended to this volume to make it a handy volume for accident investigators and joint note signatories.

Volume III deals with accident management and a good portion is covered with disaster management including crisis management plan. The various case studies of different kind of accident on Indian Railways have also been given for better appreciation to learners. I personally feel that prevention, investigation and management of accident is the art as well as science therefore the learner must investigate every aspect of accidents happening on Indian Railways scientifically and device the mechanism for prevention of the same. The basic purpose of this multi-volume book is for accident prevention and achieve a target of zero accident on Indian Railways.

I would like to thank Mrs. Neha Ratnakar, Professor Commercial, Training and Vigilance and Mr. Vikramaditya N.B., Professor Traffic Planning and Costing for helping me in proof-reading and Mr. Rohit Yadav for typing and formatting the contents into printable format. I am also grateful to Shri Rajesh Kumar, IRTS, Sr. Professor (Admin.) and Miss Krishna Tiwari, IRTS, Professor Administration and OSD to Undersigned for getting it published. Shri Kishore Mehta and Mr. Mohd. Mohsin Quadir also deserves to be appreciated for arranging the printing of this book in a shorter time.



Hari Shankar Verma, IRTS
Director General
Author of
"The Science and Art of Railway Accidents Prevention, Investigation and Management" Volume I, II, and III
Sunday, 05.09.2024, Teacher's Day.

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TRAINING NEED ANALYSIS (TNA) *of*
Safety Management for Safety Officers (SFMO)

Course Name : "Safety Management for Officers"
Course Code : SFMO

1.	**Leadership**	
1.1	**Activity** **A1.** Dissemination of knowledge to all the staff related to Railway Safety, about the latest instructions and launching of safety drives and get the instructions followed up. **A2.** Monitoring of the Divisional safety works in departments viz: Engineering, Traction , Signals and Rolling stock and taking appropriate action to tackle the shortcomings **A3.** Counselling the supervisors for follow-up of the directives to ensure safety and assigning the Duties & Responsibilities to these Supervisors for ensuring compliance in the field by all the staff engaged in carrying out the maintenance schedules flawlessly to ensure safety in operations. **A4.** Implementation of the Monitoring System for Safety Drives and follow-up of the Safety Circulars and Safety Schedules in maintaining the assets. **A5.** Counselling of staff: listening of grievances / problems being faced by staff, liaison with respective department/branch for effective resolution	
1.2	**Competencies**	
1.2.1	**Function** 1. Decision making 2. Change management 3. Innovation 4. Joint Reports 5. Joint Inspections	6. Teamwork 7. Persuasion and influencing 8. Compliance & Governance 9. Safety and quality Audits 10. Conflict resolution
1.2.2	**Behavioural** 1. Public Speaking 2. Interpersonal skills 3. Emotional Intelligence 4. Inclusiveness 5. Coaching ability	6. Teamwork 7. Committed to process improvement 8. Persuasiveness 9. Resilience. 10. Amicability
1.2.3	**Domain** 1. Manuals for Rolling Stock (Wagon Coaches, Locomotives), P-way & Signalling	1. G&SR 2. Accident Manual, Block working Manual 3. SWRs 4. Divisional Disaster Plan 5. Safety Circulars Rules & Regulations

2	**Team Player**	
2.1	**Activity** **B1.** Coordination with the other department Officers viz. Engineering, Signal, Traction, Rolling Stock and Operating for Implementation of Safety Drives **B2.** Coordination with all assets maintaining departments for implementation of safety drives.	
2.2	**Competencies**	
2.2.1	**Function** 1. Support, Guidance and Advice 2. People & Organization Development 3. Policy and Governance	
2.2.2	**Behavioural** 1. Team Working 2. Coordination 3. Persuasiveness	4. Public Speaking 5. Performance oriented 6. Employee orientated
2.2.3	**Domain** 1. Broad and deep knowledge of Rules & Regulations	
3	**Safe Train Operations**	
3.1	**Activity** **C1.** Flagging off the unsafe Practices observed during inspections **C2.** Preparation of Reports of Accident Inquiries and apprising DRM and the concerned HQ officers **C3.** Coordination and facilitating CRS enquiries. **C4.** Monitoring and Reporting the Compliance of the safety Drives. **C5.** Implementation of accepted recommendations of the Safety Committees and drawing the status report for advising compliance to the higher authorities.	
3.2	**Competencies**	
3.2.1	**Function** 1. Operations Management 2. Report Writing 3. Organizing Enquiries 4. Reading and inferring the Reports	5. Hazard Identification and risk assessment 6. Managing & Organizing Knowledge & Information
3.2.2	**Behavioural** 1. Coordination 2. Soft Skills	3. Analyzing Power 4. Perseverance
3.2.3	**Domain** 1. Rules & Regulations, 2. Monthly Reports	3. Departmental Safety PCDOs 4. Archives Accident Enquiry Report

4	**Inspectorial Role**	
4.1	**Activity** **D1.** Inspections of Stations, depots and workshops **D2.** Night inspections of crew Lobbies and RRI **D3.** Inspection of Work site of safety related works **D4.** Inspection of Loading sites and weigh bridges **D5.** Inspection of examination Yards and Pit-lines	
4.2	**Competencies**	
4.2.1	**Function** 1. Conducting inspections 2. Ensuring personnel safety while inspecting 3. Records Keeping	
4.2.2	**Behavioural** 1. Critical Analysis 2. Alertness 3. Quality consciousness	
4.2.3	**Domain** 1. Working Rules and Regulations 2. Crew Booking Rules	3. CMS 4. Wagon Loading Capacity 5. Yard Layout and Yard working 6. Standard Yard Facilities
5	**Custodian of Clues**	
5.1	**Activity** **E1.** At any accident site Preservation of Clues and making it a part of inquiry **E2.** Seizure of safety related records like work Diary and Relay Rooms Keys **E3.** Recording of Accident Site Diagram , photographs and video graphs for the Inquiry committee **E4.** Preservation of broken Parts of P-way, Switches, Rolling stock as Clue	
5.2	**Competencies**	
5.2.1	**Function** 1. Accident Investigation 2. Records Keeping	3. Root cause analysis 4. Drawing and charting
5.2.2	**Behavioural** 1. Critical Thinking 2. Teamwork	3. Detective 4. Inquisitive
5.2.3	**Domain** 1. Manuals for Rolling Stock (Wagon Coaches, Locomotives), P-way & Signalling 2. G&SR	3. Accident Manual, Block working Manual 4. SWRs 5. Divisional Disaster Plan 6. Safety Circulars 7. Rules & Regulations

6	**Handling Accident site**	
6.1	**Activity** **F1.** Collecting Information and advising the concerned Branch officers, the DRM and the concerned HQ office. **F2.** Informing RPF and Local police /fire services /NDRF/SDRF as per the need. **F3.** Facilitating evacuation of passengers from the accident site and informing medical team for medical assistance as per requirements **F4.** Coordinating in the restoration work and keeping a log of the events	
6.2	**Competencies**	
6.2.1	**Function** 1. Emergency response Planning 2. Interfacing with state and local agencies	3. Incident Documentation and reporting 4. Time Management 5. Coordination and collaboration
6.2.2	**Behavioural** 1. Site Organizer 2. Coordination	3. Activity planner 4. Soft skills 5. Networking
6.2.3	**Domain** 1. Rules & Regulations 2. Disaster Management	3. Plan 4. Communication Network and hierarchy
7	**Use of IT tools**	
7.1	**Activity** 1. Coaching Maintenance Module , 2. Freight Maintenance module 3. TMS 4. SIMS	
7.2	**Competencies**	
7.2.1	**Function** 1. Information Technology Skills 2. Data analysis	
7.2.2	**Behavioural** 1. Analytical Thinking 2. Research Environment	
7.2.3	**Domain** 1. Dedicated Portals/Apps 2. Rules & Regulations	

Sub: Training Need Analysis (TNA) of Safety Management for Safety Officers (SFMO) Course

The TNA of the subject course (SFMO) has been conducted with inputs from the recommendations of Various Safety Committees , emphasizing the need of Training to the officers and staff related to safety and the recent Railway Board's advice received vide its letter No : 2023/safety(DM)/6/4 dated 16.02.2023and dated 28.04.2023.

1. **Note on the target group:**

   The target group consists of Divisional and Headquarter Officers having 5 to 7 years of service in Railways as an Officer. This focused group is mid-level managerial functionary of Indian Railways. To meet the safety needs of IR, these officers are expected to interact with their counterparts of other departments related to asset safety, for the implementation of various safety drives and compliance of recommendations and directives of safety committees.

2. **Note on the Role/objectives of the organisation where this targeted group works:**

   The target group works in departments related to Railways operations and asset maintenance for ensuring safety in Train operations at the Divisional and at the Zonal Railways level. The group members are supposed to carryout various safety inspections, and also follow-up of the safety drives launched by Zonal Railways and Railway Board. The officers are expected to sensitize the staff working in Engineering, Traction, Signalling, Rolling Stock and Train operations departments, for ensuring periodic completion of all the Asset Safety Maintenance Schedules, with an objective of always keeping the staff working in these departments alert to ensure the target of zero failures.

   The roles and activities of the group are summed up as under:

A. Leadership Role:

A1. Dissemination of knowledge to all the staff related to Railway Safety, about the latest instructions and launching of safety drives to ensure that the instructions are followed up.

A2. Monitoring of the Divisional safety works in departments viz. Engineering, Traction, Signals and Rolling Stock and taking appropriate action to expedite these to achieve desired safety level.

A3. Counselling to the supervisors for being always alert for following -up of the directives to ensure desired level of safety in train operations and assigning them the Duties & Responsibilities for ensuring compliance in the field by maintenance and operating staff to ensure the desired level of safety in train operations.

A4. Devising the monitoring system: For implementation of Safety Drives and follow-up of the Safety Circulars and Safety Schedules of the maintenance of the assets.

A5. Counselling of the staff: Listening to the grievances of the staff and then liaison with respective department/branch for effective resolution.

a. Team Player:

1. B1. Coordination with the officers of other departments viz. Engineering, Signal, Traction, Rolling Stock and the Operating for Implementation of Safety Drives
2. B2. Coordination with all assets maintaining departments for speedy completion of Safety Related works, sanctioned for the Division to ensure safety in Train operations.
3. Monitoring of timely attending of Safety/Refresher/training Courses
4. Monitoring of Timely sparing of staff for Periodic Medical Examination (PME)

b. Safety System Centric approach :

1. C1. Flagging off the unsafe Practices observed during inspections done at various levels
2. C2. Preparation of Reports of Accident Inquiries and apprising DRM and the concerned HQ officers
3. C3. Facilitating CRS enquiries.
4. C4. Monitoring and generating Compliance Reports of the various safety Drives launched by the division or ordered by Zonal HQ.
5. C5. Implementation of accepted recommendations of the Safety Committees and drawing the status report for advising compliance, to the higher authorities.
6. C6. Follow up of DAR Cases arise out of the Accident Enquiry reports

c. Inspectorial:

1. D1. Inspections of Stations, depots and workshops
2. D2. Night inspections of crew Lobbies and RRIs
3. D3. Inspection of Work sites of safety related works
4. D4. Inspection of Loading sites and weigh bridges
5. D5. Inspection of examination yards and pit lines

d. Preservations of Clues :

1. E1. At any accident site, preservation of Clues and making it a part of inquiry report.
2. E2. Seizure of safety related records like work Diaries and Relay

Rooms Keys for handing over the same to the Enquiry committee.

3. E3. Recording of Accident Site photographs and video graphs for the Inquiry committee.
4. E4. Preservation of broken Parts of P-way, Switches, rolling stock collected from accident site, as Clue.

e. Management of Accident site:

1. F1. Collecting Information from accident site and advising the same to the concerned Branch officers, the DRM and the concerned HQ office.
2. F2. Informing RPF and Local police /fire services /NDRF/SDRF as per the need at the earliest.
3. F3.Facilitating evacuation of passengers from the accident site and informing medical team for medical assistance as per requirements
4. F4. Planning the restoration work at accident site for early restoration and keeping the log of each relevant the events

f. **Use of IT tools:**

CMM, FMM, TMS and SIMS for knowing the overall health of the system.

TRAINING NEED ANALYSIS (TNA) *of*
Safety Management for Safety Counsellors (SFMC)

1.	**Leadership**	
1.1	**Activity** **A1.** Dissemination of knowledge to all the staff related to Railway Safety, about the latest instructions and launching of safety drives and get the instructions followed up. **A2.** Monitoring of the Divisional safety works in departments viz: Engineering, Traction , Signals and Rolling stock and taking appropriate action to tackle the shortcomings **A3.** Counselling the supervisors for follow-up of the directives to ensure safety and assigning the Duties & Responsibilities to these Supervisors for ensuring compliance in the field by all the staff engaged in carrying out the maintenance schedules flawlessly to ensure safety in operations. **A4.** Implementation of the Monitoring System for Safety Drives and follow-up of the Safety Circulars and Safety Schedules in maintaining the assets.	
1.2	**Competencies**	
1.2.1	**Function** 1. Decision making 2. Change management 3. Innovation 4. Conflict management a) Meetings b) Seminars c) Counselling Sessions	
1.2.2	**Behavioural** 1. Public Speaking 2. Interpersonal skills 3. Emotional Intelligence	4. Inclusiveness 5. Coaching ability 6. Teamwork
1.2.3	**Domain** 1. Manuals for Rolling Stock (Wagon Coaches, Locomotives), P-way & Signalling 2. G&SR	3. Accident Manual 4. SWRs 5. Divisional Disaster Plan 6. Safety Circulars 7. Rules & Regulations
2	**Team Player**	
2.1	**Activity** **B1.** Coordination with the other department Officers viz: Engineering, Signal, Traction, Rolling Stock and Operating for Implementation of Safety Drives **B2.** Coordination with all assets maintaining departments for implementation of safety drives.	

2.2	**Competencies**	
2.2.1	**Function** 1. Meetings 2. Seminars 3. Counselling Sessions	
2.2.2	**Behavioural** 1. Team Working 2. Coordination	3. Persuasiveness 4. Public Speaking
2.2.3	**Domain** Broad and deep knowledge of Rules & Regulations	
3	**Safety System Centric**	
3.1	**Activity** **C1.** Flagging off the unsafe Practices observed during inspections **C2.** Preparation of Reports of Accident Inquiries and apprising DRM and the concerned HQ officers **C3.** Coordination and facilitating CRS enquiries. **C4.** Monitoring and Reporting the Compliance of the safety Drives. **C5.** Implementation of accepted recommendations of the Safety Committees and drawing the status report for advising compliance to the higher authorities.	
3.2	**Competencies**	
3.2.1	**Function** 1. Operations Management 2. Report Writing 3. Organizing Enquiries	4. Reading and inferring the Reports 5. Hazard Identification and risk assessment
3.2.2	**Behavioural** 1. Concentrated working 2. Coordination	3. Soft Skills 4. Analyzing Power 5. Perseverance
3.2.3	**Domain** 1. Rules & Regulations, 2. Monthly Reports	3. Departmental Safety PCDOs 4. Archives Accident Enquiry Report
4	**Inspectorial Role**	
4.1	**Activity** **D1.** Inspections of Stations, depots and workshops **D2.** Night inspections of crew Lobbies and RRI **D3.** Inspection of Work site of safety related works **D4.** Inspection of Loading sites and weigh bridges **D5.** Inspection of examination Yards and Pit-lines	
4.2	**Competencies**	
4.2.1	**Function** 1. Conducting inspections 2. Ensuring personnel safety while inspecting 3. Records Keeping	

4.2.2	**Behavioural** 1. Critical Analysis 2. Alertness 3. Quality consciousness	
4.2.3	**Domain** 1. Working Rules and Regulations 2. Crew Booking Rules	3. CMS 4. Wagon Loading Capacity 5. Yard Layout and Yard working 6. Standard Yard Facilities
5	**Preservations of Clues**	
5.1	**Activity** **E1.** At any accident site Preservation of Clues and making it a part of inquiry **E2.** Seizure of safety related records like work Diary and Relay Rooms Keys **E3.** Recording of Accident Site Diagram , photographs and video graphs for the Inquiry committee **E4.** Preservation of broken Parts of P-way, Switches, Rolling stock as Clue	
5.2	**Preservations of Clues**	
5.2.1	**Function** 1. Accident Investigation 2. Records Keeping 3. Drawing of accident diagram	
5.2.2	**Behavioural** 1. Detective 2. Critical Thinking	3. Teamwork 4. Cool headed
5.2.3	**Domain** 1. Manuals for Rolling Stock (Wagon Coaches, Locomotives), P-way & Signalling	2. G&SR 3. Accident Manual 4. SWRs 5. Divisional Disaster Plan 6. Safety Circular 7. Rules & Regulations
6	**Handling Accident site**	
6.1	**Activity** **F1.** Collecting Information and advising the concerned Branch officers, the DRM and the concerned HQ office. **F2.** Informing RPF and Local police /fire services /NDRF/SDRF as per the need. **F3.** Facilitating evacuation of passengers from the accident site and informing medical team for medical assistance as per requirements **F4.** Coordinating in the restoration work and keeping a log of the events **F5.** Advising Commercial officers for catering needs. **F6.** Advising Personnel Officers in case of Passenger train accident	

6.2	**Competencies**	
6.2.1	**Function** 1. Emergency response Planning 2. Interfacing with state and local agencies	3. Incident Documentation and reporting 4. Time Management 5. Coordination and collaboration
6.2.2	**Behavioural** 1. Site Organizer 2. Cool Planner 3. Coordination	4. Activity planner 5. Soft skills 6. Networking
6.2.3	**Domain** 1. Rules & Regulations 2. Disaster Management	3. Plan 4. Communication Network and hierarchy
7	**PR & Media**	
7.1	**Activity** Preparation of briefs for the DRM and the GM for Media bytes	
7.2	**Competencies**	
7.2.1	**Function** 1. Presentation skills 2. Organizing meetings 3. Report Writing	
7.2.2	**Behavioural** 1. Communication management 2. Courteous 3. Organizing Skills	
7.2.3	**Domain** 1. Attention to detail 2. Communication Network	
8	**Use of IT tools**	
8.1	**Activity** 1. CMM, FMM, WISE 2. TMS 3. SIMS	
8.2	**Competencies**	
8.2.1	**Function** 1. Using of these portals/apps	2. Report writing 3. Data analysis
8.2.2	**Behavioural** 1. Analytical Thinking 2. Concentrating on critical figures	
8.2.3	**Domain** 1. Dedicated Portals/Apps 2. Rules & Regulations	

SUBJECT: TNA for "Safety Management for Counsellors" (SFMC###)

1. **Organization Goals**
   Safety organizations work to ensure safe train operations. Key to the work is examining practices, counseling, investigations and codification.
3. **Target Audience**
   Safety Counsellors deployed in safety organization. The target group works in departments related to Railways operations and asset maintenance for ensuring safety in the Divisional and the Zonal Railways.
4. **FRACing**
   Framework for Role, Activities and Competency is key to Mission Karm Yogi. Safety Counsellors are drawn from different departments which contribute to safe train operations. These counsellors come equipped with experience of having handled their domain as supervisors. The group members are supposed to carry out various safety inspections, follow-up of the **safety drives and directives** issued by the Zonal Railways and the Railway Board. The officers are supposed to sensitize the staff working in Engineering, Traction, Signalling and Rolling Stock and Operations departments for ensuring periodic completion of all **the asset safety maintenance schedules**. The objective is to keep all the staff working in these departments alert and make them work for a target of zero failures.
5. **Learning Objectives**
   1. Appreciation of human failures.
   2. Understand vulnerabilities in rail operations which are prone to failures.
   3. Analysis of case studies.
   4. Development of soft skills of presentations, counselling.
6. **Goal/Rationale**
   The course is conducted on the instructions of Railway Board.
7. **Basic Information**
   1. Course Name and Number: **"Safety Management for Counsellors" (SFMC###)**

2. Meeting time and place: Onsite at IRITM/LKO
3. Instructors: In-house faculty and Visiting faculty
4. Contact information: Will be listed on course brochure/letters
5. Office hours: 09:30-18:00 hrs.
6. Instructional support staff information: Mentioned in course brochure/letter

7. **Course Content**
   This would be a course run till all Safety Counsellors are covered. This course will cover syllabus suggested by the Railway Board.
8. **Trainee Responsibilities**
   Expected to participate in group and case study-based discussions. They are also expected to go through reading material shared with them.
9. **Grading Method**
   Ungraded.
10. **Material and Access**
    The reading and study material for the course on 'Safety Management for Counsellors' contains soft and hard copies of policy manuals, PPTS of faculty members, case study and AV materials.
11. **Teaching Philosophy**
    Through case studies, group discussion and interaction with experienced serving and retired officers.

TRAINING NEED ANALYSIS (TNA) *of*
Safety Management Programme for Railway Officers (SFMP)

1.	**Leadership Role**	
1.1	**Activity** **A1.** Dissemination of knowledge to all the staff related to Railway Safety, about the latest instructions and launching of safety drives and get the instructions followed up. **A2.** Monitoring of the Divisional safety works in departments viz: Engineering, Traction, Signals and Rolling stock and taking appropriate action to tackle the shortcomings **A3.** Counselling the supervisors for follow-up of the directives to ensure safety and assigning the Duties & Responsibilities to these Supervisors for ensuring compliance in the field by all the staff engaged in carrying out the maintenance schedules flawlessly to ensure safety in operations. **A4.** Implementation of the Monitoring System for Safety Drives and follow-up of the Safety Circulars and Safety Schedules in maintaining the assets. **A5.** Counselling of staff: listening of grievances / problems being faced by staff, liaison with respective department/branch for effective resolution	
1.2	**Competencies**	
1.2.1	**Function** 1. Decision making 2. Change management 3. Innovation 4. Joint Reports 5. Joint Inspections	6. Teamwork 7. Persuasion and influencing 8. Compliance & Governance 9. Safety and quality Audits 10. Conflict resolution
1.2.2	**Behavioural** 1. Public Speaking 2. Interpersonal skills 3. Emotional Intelligence 4. Inclusiveness 5. Coaching ability	6. Teamwork 7. Committed to process improvement 8. Persuasiveness 9. Resilience. 10. Amicability
1.2.3	**Domain** 1. Manuals for Rolling Stock (Wagon Coaches, Locomotives), P-way &Signalling 2. G&SR	3. Accident Manual, Block working Manual 4. SWRs 5. Divisional Disaster Plan 6. Safety Circulars 7. Rules & Regulations
2	**Team Player**	
2.1	**Activity** **B1.** Coordination with the other department Officers viz: Engineering, Signal, Traction, Rolling Stock and Operating for Implementation of Safety Drives	

	B2. Coordination with all assets maintaining departments for implementation of safety drives.	
2.2	**Competencies**	
2.2.1	**Function** 1. Support, Guidance and Advice 2. People & Organization Development 3. Policy and Governance	
2.2.2	**Behavioural** 1. Team Working 2. Coordination 3. Persuasiveness	4. Public Speaking 5. Performance oriented 6. Employee orientated
2.2.3	**Domain** Broad and deep knowledge of Rules & Regulations	
3	**Safety System Centric**	
3.1	**Activity** **C1.** Flagging off the unsafe Practices observed during inspections **C2.** Preparation of Reports of Accident Inquiries and apprising DRM and the concerned HQ officers **C3.** Coordination and facilitating CRS enquiries. **C4.** Monitoring and Reporting the Compliance of the safety Drives. **C5.** Implementation of accepted recommendations of the Safety Committees and drawing the status report for advising compliance to the higher authorities.	
3.2	**Competencies**	
3.2.1	**Function** 1. Operations Management 2. Report Writing 3. Organizing Enquiries	4. Reading and inferring the Reports 5. Hazard Identification and risk assessment 6. Managing & Organizing Knowledge & Information
3.2.2	**Behavioural** 1. Coordination 2. Soft Skills	3. Analyzing Power 4. Perseverance
3.2.3	**Domain** 1. Rules & Regulations, 2. Monthly Reports	3. Departmental Safety PCDOs 4. Archives Accident Enquiry Report
4	**Inspectorial Role**	
4.1	**Activity** **D1.** Inspections of Stations, depots and workshops **D2.** Night inspections of crew Lobbies and RRI **D3.** Inspection of Work site of safety related works **D4.** Inspection of Loading sites and weigh bridges **D5.** Inspection of examination Yards and Pit-lines	

4.2	**Competencies**	
4.2.1	**Function** 1. Conducting inspections 2. Ensuring personnel safety while inspecting 3. Records Keeping	
4.2.2	**Behavioural** 1. Critical Analysis 2. Alertness 3. Quality consciousness	
4.2.3	**Domain** 1. Working Rules and Regulations 2. Crew Booking Rules	3. CMS 4. Wagon Loading Capacity 5. Yard Layout and Yard working 6. Standard Yard Facilities
5	**Custodian of Clues**	
5.1	**Activity** **E1.** At any accident site Preservation of Clues and making it a part of inquiry **E2.** Seizure of safety related records like work Diary and Relay Rooms Keys **E3.** Recording of Accident Site Diagram , photographs and video graphs for the Inquiry committee **E4.** Preservation of broken Parts of P-way, Switches, Rolling stock as Clue	
5.2	**Competencies**	
5.2.1	**Function** 1. Accident Investigation 2. Records Keeping	3. Root cause analysis 4. Drawing and charting
5.2.2	**Behavioural** 1. Critical Thinking 2. Teamwork	3. Detective 4. Inquisitive
5.2.3	**Domain** 1. Manuals for Rolling Stock (Wagon Coaches, Locomotives), P-way & Signalling 2. G&SR	3. Accident Manual, Block working Manual 4. SWRs 5. Divisional Disaster Plan 6. Safety Circulars 7. Rules & Regulations
6	**Handling Accident site**	
6.1	**Activity** **F1.** Collecting Information and advising the concerned Branch officers, the DRM and the concerned HQ office. **F2.** Informing RPF and Local police /fire services /NDRF/SDRF as per the need. **F3.** Facilitating evacuation of passengers from the accident site and informing medical team for medical assistance as per requirements **F4.** Coordinating in the restoration work and keeping a log of the events	

6.2	**Competencies**	
6.2.1	**Function** 1. Emergency response Planning 2. Interfacing with state and local agencies	3. Incident Documentation and reporting 4. Time Management 5. Coordination and collaboration
6.2.2	**Behavioural** 1. Site Organizer 2. Coordination	3. Activity planner 4. Soft skills 5. Networking
6.2.3	**Domain** 1. Rules & Regulations 2. Disaster Management	3. Plan 4. Communication Network and hierarchy
7	**Use of IT tools**	
7.1	**Activity** 1. Coaching Maintenance Module , Freight Maintenance module 2. TMS 3. SIMS	
7.2	**Competencies**	
7.2.1	**Function** 1. Information Technology Skills 2. Data analysis	
7.2.2	**Behavioural** 1. Analytical Thinking 2. Research Environment	
7.2.3	**Domain** 1. Dedicated Portals/Apps 2. Rules & Regulations	

Sub: Training Need Analysis (TNA) of
Safety Management Programme for Railway Officers (SFMP) Course

The TNA of the subject course (SFMP) has been conducted with inputs from the recommendations of Various Safety Committees , emphasizing the need of Training to the officers and staff related to safety and the recent Railway Board's advice received vide its letter No : 2023/safety(DM)/6/4 dated 16.02.2023and dated 28.04.2023 .

1. **Note on the target group:**
   The target group consists of **Divisional and Headquarter Officers having 5 to 7 years of service in Railways as an Officer.** This focused group is mid-level managerial functionary of Indian Railways. To meet the safety needs of IR, these officers are expected to interact with their counterparts of other departments related to asset safety, for the implementation of

various safety drives and compliance of recommendations and directives of safety committees.

2. **Note on the Role/objectives of the organisation where this targeted group works:**

The target group works in departments related to Railways operations and asset maintenance for ensuring safety in Train operations at the Divisional and at the Zonal Railways level. The group members are supposed to carryout various safety inspections, and also follow-up of the **safety drives launched** by Zonal Railways and Railway Board. The officers are expected to sensitize the staff working in Engineering, Traction, Signalling, Rolling Stock and in train operations departments, for ensuring periodic completion of all the **asset safety maintenance schedules, with an** objective of always keeping the staff working in these departments alert to ensure the target of zero failures.

The roles and activities of the group are summed up as:

a. Leadership Role:

1. A1. Dissemination of knowledge to all the staff related to Railway Safety, about the latest instructions and launching of safety drives and get the instructions followed up.
2. A2. Monitoring of the Divisional safety works in departments viz: Engineering, Traction, Signals and Rolling Stock and taking appropriate action to expedite these to achieve desired safety level.
3. A3. Counselling to the supervisors for being always alert for following -up of the directives to ensure desired level of safety in train operations and assigning them the Duties & Responsibilities for ensuring compliance in the field by maintenance and operating staff to ensure the desired level of safety in train operations.
4. A4. Devising of a Monitoring System for implementation of Safety Drives and the follow-up of Safety Circulars and Safety Schedules of maintenance of the assets.
5. A5. Counselling of staff: listening of grievances / problems being faced by staff, liaison with respective department/branch for effective resolution.

b. Team Player:

1. B1. Coordination with the officers of other departments viz: Engineering, Signal, Traction, Rolling Stock and the Operating for Implementation of Safety Drives
2. B2. Coordination with all assets maintaining departments for speedy

completion of Safety Related works, sanctioned for the Division to ensure safety in Train operations.

3. Monitoring of timely attending of Safety/Refresher/training Courses
4. Monitoring of Timely sparing of staff for Periodic Medical Examination (PME)

c. Safety System Centric approach :

1. C1. Flagging off the unsafe Practices observed during inspections done at various levels
2. C2. Preparation of Reports of Accident Inquiries and apprising DRM and the concerned HQ officers
3. C3. Facilitating CRS enquiries.
4. C4. Monitoring and generating Compliance Reports of the various safety Drives launched by the division or ordered by Zonal HQ.
5. C5. Implementation of accepted recommendations of the Safety Committees and drawing the status report for advising compliance, to the higher authorities.
6. C6. Follow up of DAR Cases arise out of the Accident Enquiry reports

d. Inspectorial:

1. D1. Inspections of Stations, depots and workshops
2. D2. Night inspections of crew Lobbies and RRIs
3. D3. Inspection of Work sites of safety related works
4. D4. Inspection of Loading sites and weigh bridges
5. D5. Inspection of examination yards and pit lines

e. **Preservations of Clues :**

1. E1. At any accident site, preservation of Clues and making it a part of inquiry report.
2. E2. Seizure of safety related records like work Diaries and Relay Rooms Keys for handing over the same to the Enquiry committee.
3. E3. Recording of Accident Site photographs and video graphs for the Inquiry committee.
4. E4. Preservation of broken Parts of P-way, Switches, rolling stock collected from accident site, as Clue.

f. **Management of Accident site:**

1. F1. Collecting Information from accident site and advising the same to the concerned Branch officers, the DRM and the concerned HQ office.
2. F2. Informing RPF and Local police /fire services /NDRF/SDRF as per the need at the earliest.
3. F3. Facilitating evacuation of passengers from the accident site and informing medical team for medical assistance as per requirements
4. F4. Planning the restoration work at accident site for early restoration and keeping the log of each relevant the events

g. **Use of IT tools:** CMM, FMM, , TMS, and SIMS for knowing the

overall health of the system.

Based on these inputs, using FRAC framework of Mission Karma-yogi, analysis of target group of trainees is placed at SN: 04 – 08 and the syllabus is placed at SN-09

Syllabus of SFMP

S.N.	Topic
1.	Safety Scenario in IR, Critical issues in Railway Safety, Railway Act and provisions related to safety, General and Subsidiary rules, Statutory regulations, Other Manuals
2.	Recommendations of various safety related committees and action taken, Action Plan on Safety. CCRS organization and functions, roles, responsibilities and functions of Safety Counsellors
3.	Safe Train Operations from Loco Pilot Point of View
4.	Safety Inspections and Safety audits, Safety drives, pointing out system deficiencies including detection and prevention of shortcuts. Human Factors in Safety
5.	**Lab Visit/Demonstrations:** Visit to RDSO Signal Lab, M&C Lab: Functioning of Data Logger, its Reading and Interpretation of Data regarding events, KAVACH, Schedule of Ultrasonic flaw detector
6.	Safety Information Management System, Monitoring of Safety works under RRSK, Root Cause Analysis tools
7.	Precautions during non-interlocked working, Work site Safety and protection measures, salient features of panel interlocking, **RRI, SSI, BPAC, TMS**
8.	Disaster Management: DM Act, DM Plan, Definition and types of disasters from Railway perspective, Emergency Medical Response, Coordination with NDMA & NDRF, Fire Safety
9.	Some Train Accidents discussion: Case Studies, Major lessons learnt
10.	Salient features of FMM, CMM, Online Monitoring of Rolling Stock (OMRS), Hot Axle box Hot Wheel Detector (HAHW), Wheel Impact Load Detector (WILD)
11.	Safe Track Maintenance Practices and TMS
12.	**Innovations for Railway Safety**: Modern Signalling, fog PASS, Data Loggers, Train Collision Avoidance System (KAVACH), interpreting information from Data Loggers and Voice recorders
13.	Accident Inquiries and investigation: classification of accidents, reporting of Accidents, Accident Manual, Accident inquiries including CRS inquiries, observation/measurement proforma for accident investigation/inquiry
14.	Accident site management including media and crowd management, accident site investigation, role of different departments.
15.	**Field Visit** ART Site Visit and Measurement Demonstration
16.	Maintenance practices of various departments having bearing on safety, checklist of inspections of various departments having bearing on safety.

Training Need Analysis (TNA) *of* Traffic Safety Training for Traffic Supervisors (TSTS)

Station Masters, Traffic Inspectors, Chief Yard Masters, Movement Inspectors

Training Need Analysis of Traffic Supervisors of Indian Railway has been conducted along with inputs from divisions and field survey under mission Karm Yogi. A detailed report has been prepared and published (Shisht-ta Amrit, Vol: I-VI, Acc. No. R-1056, IRITM Library). The salient features of training need analysis of the course are as under:

Note on the target group:

The target group consists of Station Masters, Traffic Inspectors, Chief Yard Masters, and Movement Inspectors. This focused group is at the frontline of operating transactions of Indian Railways. They play a vital role in ensuring safe and smooth Railway operations, passenger safety and also first level managerial resource pool. The target group is responsible for managing safe train operations and improving the confidence and trust on the Railway system. So, the focus is on staff and passenger safety with efficient train operations.

Indian Railway is responsible for managing and operating the railway network. It oversees the overall safety aspects, Train, and traffic control. It established safety protocols, enforces compliance with rules and provides guidance to station master's and other railway staff in maintaining traffic safety. The following are some of the roles/ objectives of Indian Railway related to the target group.

1. Safety Culture-promoting safety awareness and ensuring compliance with safety regulations and procedures.
2. Risk Assessment and Mitigation- It conducts risk assessments, analyzes safety hazards, and implements strategies to minimize the likelihood and impact of accidents or unusual incidents.
3. Operational Safety-creating safe environment for train running through laid down procedures such as systems of working, interlocking, and imposing caution orders etc.
4. Emergency Preparedness and Response through mock drills, safety drills
5. Compliance of manuals, circulars, office orders issued from time to time.
6. Accident/unusual Investigation and Analysis to take corrective actions.

7. Training and Education to station masters, traffic inspectors, chief yard masters and movement inspectors to have necessary knowledge and skills to execute their roles safely and efficiently.
8. Continuous learning about up gradation of technologies and safety processes are being practiced.
9. Developing supervisory skills, working with other peer groups, public representative, and customers.

The Role and objectives of the organization where this targeted group works:

Leadership:

1. Serving as communication link between the administration and field.
2. Expediting optimal utilization of staff. Counseling Staff to ensure seamless operations and safety and
3. Monitoring renewal of Competency certificates.
4. Counseling and enabling staff to follow laid down procedures and conditions for granting line clear, taking OFF signals and exchanging hand signals.

Team player:

1. Co-coordinating with sister departments for proper sighting of signals, removing bottlenecks, enhancing speed, and enabling ODC movements.
2. Liaison with supervisors/staff of various sister departments for timely completion of works and blocks.

Safe train operations:

1. Making available a full complement of staff and equipment and ensuring staff are not due for PME/RC.
2. Assisting in traffic planning, SWR variations vis-à-vis ground situation and work studies.
3. Making all staff conversant with the SWR provisions and resolving discrepancy with onsite conditions and obtaining declaration from all staff.
4. Upkeeping all prescribed safety equipments, FA Box, accident diagram and ACC form and Disaster Management Coordination.
5. Upkeeping Block Instruments, CCIP, VDU, points, SPT in working order
6. Checking on a daily basis and ensuring that all entries related to train signaling are in order without omission and commission.
7. Enabling correct marshalling, prompt berthing of rakes, Issuance of Caution Order, BPC, reporting of Guard /Crew and ensuring right time starts.
8. Maintaining liaison with Control Office as well as other departments in day-to-day operations.

9. Making available all forms and counselling staff to adhere to prescribed rules to deal with trains safely during equipment failures.

Inspectorial:

1. Resolving disputes and discrepancies during failure of any assets and fact finding.
2. Conducting Inspections as per schedule to ensure compliance of all rules and safe working.
3. Inspecting stations, Level crossing gates, foot plates, Brake Vans, Running Rooms, crew lobbies frequently to assess site conditions.
4. Making available books and forms to all Stations.
5. Expediting attention to deficiencies noticed in joint Inspection of points and crossings and track circuits.
6. Conducting DAR inquiries, interdepartmental inquiries, fact finding enquiries and accident enquiries.
7. Maintaining, updating, and checking station records.
8. Making available staff in each shift as per sanction, exhibiting duty roster and maintaining Attendance Register.
9. Maintaining and updating Bio data particulars and categorization of staff.
10. Making all staff read, understand, and acknowledge SOP and staff possessing valid CC.
11. Inspecting Station as per schedule and also complying with inspection reports of Officers, TI and other Supervisors.
12. Conducting DAR and accident enquiries.
13. Keeping staff updated with the latest rules/corrections and circulars.
14. Doing operational and safety categorization of Staff.

Management of accident sites

1. Guiding the Staff on measures to be taken to deal failures and accidents enquiries. with trains during
2. Collecting and preserving clues/evidence and making out sketch/drawing of the accident site
3. Rendering first aid to injured passengers, shifting them to nearby hospitals and rendering assistance to the stranded passengers.
4. Maintaining liaison with officer in-charge at site and logging all events.
5. Communicating instructions to the field staff regarding restoration and relief.
6. Implementing the instructions of stabling-regulation- partial cancellation-cancellation-diversion of trains.

Managing traffic block related maintenance activities:

1. Assisting administration in commissioning of new lines, new assets, and CRS inspections.

2. Managing NI working, execution of mega block and abnormal working during failures.
3. Guiding SM to handle accident/abnormal situations and passing messages to/from Control regarding cancellation/ diversion/ regulation/ delayed running of trains.

Managing special movements:

1. Reporting of accidents through messages, sounding of siren, ordering and timely dispatch of ARME, ART, SPART, 140-ton crane, Monsoon Special, etc.
2. Movement of the special coaches.

Learning Objectives:

To equip the frontline supervisors with knowledge, information, and mindset needed to meet the need of roles identified in FRACing exercise after discussions with field officers.

Goal and Rationale:

The course fits into the larger objective of safe train operations, delivering satisfactory services to the rail users and makes the position occupied by the trainee meaningful contributor in chain of command.

Basic Information:

Short code TSTS (……),

Identifier: TSTS/…….

Grading Method:

A quiz will be organized to ascertain that trainee had learned the lessons as perceived and graded with its outcome class.

Materials and Access:

Trainees will be given soft copies of the material delivered in the classroom and encouraged to open and discuss the various case studies and learn lessons. To ensure that trainees are performing as per taught lessons, they will be prompted to discuss with faculty about field condition and constant feedback system established up to one year.

Teaching Philosophy:

The course will be delivered by the in-house faculty of IRITM. However, necessary flexibility will be available to rope in more experts should need arise.

Framework of Role, Activities and Competencies (FRAC) analysis of Traffic Inspectors, Station Masters for Designing a Course for Traffic Supervisors.

1.	**Leadership**	
1.1	**Activity** 1. Deploying staff in an optimal manner. 2. Counselling Staff to ensure seamless train operations and safety. 3. Monitoring renewal of Competency certificates. 4. Counselling and enabling staff to follow laid down procedures such as conditions for granting line clear, taking OFF signals and exchanging hand signals. 5. Basic level management. Leading subordinate formation while being aligned with senior level administration. 6. Responsible for keeping the safety and operating literature including circulars, pamphlets, gazettes etc. up to date and these must be explained to the staff working under him and got noted by them. 7. Making available staff in each shift as per sanction, exhibiting duty roster and maintaining Attendance Register. 8. Maintaining and updating Bio data particulars and categorization of staff. 9. Making all staff read, understand, and acknowledge SOP and staff possessing valid CC. 10. Keeping staff updated with latest rules / corrections and circulars. 11. Doing operational and safety categorization of Staff.	
1.2	**Competencies**	
1.2.1	**Function** 11. Problem Solving 12. Decision Making 13. Teamwork 14. Conflict Resolution 15. Customer Service	16. Adaptability 17. Resilience 18. Technical Expertise 19. Change Management. 20. Ethical Leadership 21. Results Orientation
1.2.2	**Behavioural** 11. Able to motivate staff. 12. Emotional balance 13. Role model behaviour 14. Integrity	15. Trustworthiness 16. Empathy 17. Collaboration 18. Accountability 19. Influence and Persuasion
1.2.3	**Domain** 1. G&SR 2. Operating Manual 3. Knowledge of railway working	4. Financial Acumen 5. Rules and Compliance Knowledge 6. Operational Excellence 7. Human Resources Management
2	**Team Player**	

2.1	**Activity** 1. Serving as communication link between the administration and the field. 2. Co-ordinating with sister departments for proper sighting of signals, removing bottlenecks, enhancing speed, and enabling ODC movements. 3. Liaison with supervisors/staff of various sister departments for timely completion of works and traffic blocks. 4. In case of accidents, he has to control and coordinate all field activities with personnel at the scene. 5. Coordinate with police, fire, revenue, military, travelling public. 6. Maintaining liaison with Control Office as well as other departments in day-to-day operations.	
2.2	**Competencies**	
2.2.1	**Function** 1. Counselling 2. Communication 3. Guiding 4. Collaboration 5. Relationship Building	6. Flexibility and Adaptability 7. Reliability and Accountability 8. Conflict Resolution 9. Supportiveness 10. Problem Solving
2.2.2	**Behavioural** 1. Negotiations 2. Empathetic 3. Active Listening 4. Cooperation	5. Supportiveness 6. Emotional Intelligence 7. Positive Attitude 8. Trustworthiness
2.2.3	**Domain** 1. ZRTI Training 2. Knowledge of rules 3. Railway -Specific Knowledge	4. Functional Skills 5. Analytical Skills 6. Project Management 7. Process Improvement 8. Customer Focus
3	**Safe Train Operations**	
3.1	**Activity** 1. Making available full complement of staff, equipment and ensuring staff are not due for PME/RC. 2. Assisting in traffic planning, SWR variations vis-a-vis ground situation and time work studies. 3. Making all staff conversant with the SWR provisions and resolving discrepancy with onsite conditions and obtaining declaration from all staff. 4. Upkeeping of all prescribed safety equipment, FA Box, accident diagram and ACC forms and Disaster Management Board. 5. Upkeeping Block Instruments, CCIP, VDU, points, SPT in working order. 6. Checking on a daily basis and ensuring that all entries related to train signalling are in order without omission and commission.	

	7. Enabling correct marshalling, prompt berthing of rakes, Issuance of Caution Order, BPC, reporting of Guard /Crew and ensuring right time starts. 8. Making available all forms and counselling staff to adhere to prescribed rules to deal trains safely during equipment failures.	
3.2	**Competencies**	
3.2.1	**Function** 1. Execution 2. Updating 3. Safety Procedures and Regulations 4. Risk Assessment and Mitigation 5. Train Operation Planning 6. Communication and Coordination	7. Situational Awareness 8. Emergency Preparedness and Response 9. Compliance and Regulatory Adherence 10. Equipment Operation 11. Continuous Improvement 12. Teamwork and Collaboration
3.2.2	**Behavioural** 1. Knowledge of the rules and ability to implement. 2. Punctuality and consistency. 3. Right perspective 4. Safety Mindset	5. Attention to Detail 6. Decision-Making Under Pressure 7. Accountability 8. Emergency Response Preparedness 9. Positive Safety Role Model
3.2.3	**Domain** 1. Competency certificate issued for panel and block operations by ZRTIs. 2. G&SR 3. Operating Manual 4. Block Working Manual 5. SWR	6. Train Operations Procedures 7. Signal Systems and Train Control 8. Train Control Track Safety and Maintenance 9. Train Braking Systems 10. Hazard Identification and Risk Assessment 11. Rolling Stock Knowledge
4	**Communication centric**	
4.1	**Activity** 1. Resolving disputes and discrepancies during failure of any assets and fact finding. 2. Conducting Inspections as per schedule to ensure compliance of all rules and safe working. 3. Inspecting stations, Level crossing gates, foot plates, Brake Vans, Running Rooms, crew lobbies frequently to assess site conditions. 4. Making available books and forms to all Stations. 5. Expediting attention to deficiencies noticed in joint Inspection of points and crossings and track circuits. Conducting DAR inquiries, interdepartmental inquiries, fact finding enquiries and accident enquiries.	

	Maintaining, updating, and checking of station records. Complying to inspection reports of Officers and other Supervisors.	
4.2	**Competencies**	
4.2.1	**Function** 1. Knowledge of rules 2. Inspection Techniques 3. Safety Audit and Assessment 4. Risk Identification and Mitigation 5. Documentation and Reporting	6. Technical Knowledge 7. Compliance Monitoring 8. Investigation and Incident Analysis 9. Training and Education 10. Collaboration and Communication
4.2.2	**Behavioural** 1. Ability to identify deficiencies and suggest improvements. 2. Attention to Detail 3. Integrity and Objectivity 4. Professionalism	5. Analytical Thinking 6. Effective Communication 7. Adapt ability and Flexibility. 8. Time Management 9. Continuous Learning 10. Safety Advocacy
4.2.3	**Domain** 1. Knowledge of rules 2. G&SR 3. Operating Manual 4. Block Working Manual 5. SWR 6. Establishment rules	7. Safety Circulars 8. Train Operations 9. Safety Systems and Equipment 10. Risk Assessment and Management 11. Track and Infrastructure Safety 12. Rolling Stock Safety
5	**Management of accident sites**	
5.1	**Activity** 1. Guiding the Staff on measures to be taken to deal with trains during failures and accidents. He is the officer in charge of the site in case of accidents site, until relieved by higher authority. Collecting and preserving clues/evidence and making out sketch/drawing of the accident site. 2. Movement of the special coaches.	
5.2	**Competencies**	
5.2.1	**Function** 1. Dissemination of Information 2. Emergency Response Planning 3. Incident Command and Control	4. Resource Allocation and Logistics 5. Safety and Risk Management 6. Incident 7. Decision making 8. Regulatory compliance
5.2.2	**Behavioural**	4. Effective Communication 5. Collaboration and teamwork

	1. Able to maintain focus on rescue and restoration activities. 2. Calmness and composure 3. Leadership	6. Crisis Management 7. Empathy and compassion 8. Problem-solving flexibility
5.2.3	**Domain** 1. Accident Manuals 2. G&SR 3. SWR 4. Zonal Railway rules 5. Disaster Management Manual	6. Training at ZRTIs 7. Emergency Response Procedures 8. Scene Assessment and Safety 9. Accident Response 10. Relief Train Operations 11. Resource Management 12. Safety and Risk Management

SYLLABUS OF TSTS

1. Supervisory Skills
2. Inspections: Necessity, objective, types, technique
3. Rules: GSR, Operating Manual, SWR, Temporary Working Order- frequently breached provisions
4. Safety Enquiry committees: Shahnawaz, Kunzru, Wanchoo, Sikri, Khanna and Anil Kakodkar – important recommendations implemented.
5. Counselling- Effective and Productive Counselling
6. Human Element in Safety
7. Accident Site – Role of Operating and Commercial Staff as per provisions of Accident Manual and other instructions
8. Accident Site Investigation -Rolling stock, Track, Signal, Preservation of Clues, and Measurements
9. Work Site Safety and Safe Planning of Traffic Block
10. NI Working and Safety precautions.
11. Avoiding shortcuts in train operation, Shunting and Stabling the stock including securing precautions
12. Failure of block instrument, Track Circuit, Axle counters and Action taken by SMs
13. Responsibility of traffic staff during Special Movement. Ordering of ARME, ART, SPART, 140-ton crane, Monsoon Special etc.
14. Management of traffic During Accidents
15. AWS/ACD/TPWS/TCAS/EOTT -brief overview
16. Case Studies

a. Head-On-Collision, Rear-End-Collision, Side-On-Collision, Rolling Down Collision
b. SPAD
c. Derailment
d. Fire
e. Sabotage
f. Failure of communications
g. Train parting / vehicles escaping Stations.
h. Fire on Train
i. LC Gates-esp. non-interlocked gates
j. Block section occupied.
k. Running of trains with invalid BPC
l. Uneven loading in rakes

17. Field Visit and on-site measurement demonstration
18. ODC Movements
19. Disaster Management and Disaster Management Act
20. Crowd Management during Mela, Summer vacation, Festival rush etc.

Railways Expectation About This Course

This focus group is at the frontline of Indian Railways. The target group is responsible for managing safe train operations and improving the confidence and trust of users on the IR system. TSTS being **a role-based** training module, it focuses on staff and passenger safety with efficient train operations. TSTS is accordingly designed to strengthen the focus group which is also the first level of managerial resource pool of IR.

Focal Points of Course

1. Rooted In Practice – Each element is designed on case study-based approach-carefully screened data.
2. Value Multiplier – Each role is part of value chain-course aims to unlock & enhance value of each role.
3. Safety Centric – How to be safety focused while delivering conflicting requirements.

Objectives of Course

1. Roles - Course develops on these roles of target group.
2. Leadership - Leading subordinate formations
3. Team Player - How to be an effective part of a value chain.
4. Safe train operations - Never lose focus on core.
5. Inspectorial - Keeping work and workflows in order.
6. Management of Accident Sites - Facilitating fast restoration

7. Managing traffic block for Maintenance - Addressing key pain point of balancing traffic flows with maintenance
8. Special Movements

Course Design

The course is based on extensive feedback from the field. The course has been designed by a cross domain interdisciplinary team with razor sharp focus on delivery by IR's frontline team, which is the target group. Today, data and manuals are readily available, hence the course will focus on perspectives of decision making, evaluate between conflicting demands within guard rails of codes and manuals while working as a team member and delivering as a leader.

Thus, the course is built on cases while being role focused instead of being rule focused. Course will be delivered by Team IRITM with each hour of trainee's stay on campus an opportunity to learn and rejuvenate.

Mission Karmayogi:

Shift from Rule based to Role Based Training: In government, every post has an assigned role and each role has activities associated with it. Similarly, each activity needs certain competencies.

CONTENTS

Chapter	Names	Page No.
	Dedication	
	Disclaimer	**I-II**
	Foreword	**III-IV**
	Preface	**V-VIII**
	TNA of Safety Management for Safety Officers (SFMO)	**IX-XV**
	TNA of Safety Management for Safety Counsellors (SFMC)	**XVI-XXI**
	TNA of Safety Management Programme for Railway Officers (SFMP)	**XXII-XXVIII**
	TNA of Traffic Safety for Traffic Supervisors (TSTS)	**XXIX-XXXIX**
	Contents	**XLI-LIII**
VOLUME I: ACCIDENT PREVENTION		
PART A: Railway Safety and its Management		
1	**Introduction of Safety Management in Railways**	**3-14**
1.1	Purpose and Benefits	4
1.2	Four Components and Twelve Elements of a Safety Management System	4
1.3	Component of Safety Management System	6
1.4	Role of Training in Safety Management	8
1.5	Eight Key Components of a Successful Safety Management Program	8
1.6	Here are the Eight key components of a successful safety management program	9
1.7	Safety Management is never-ending, but don't despair!	14
2	**Evolution of Safety Department in Railways and its Functions**	**15-44**
2.1	Set up of the safety Organization	21
2.2	Organization	26
2.3	Manuals and Records used for discharging functions	29
2.4	Categories of documents held	30
2.5	Important Definitions	34
2.6	Classification of Stations	43
3	**Trends and Analysis of Railway Accidents**	**45-68**
3.1	Causes of Consequential Train Accidents	45
3.2	Derailments	52
3.3	Level Crossing Accidents	54

Chapter	Names	Page No.
3.4	Collisions	55
3.5	Fire in trains	56
3.6	The Casualties and victims of railway accidents since 2000-2001 to 2021-2022	57
3.7	Economic loss associated with railway accidents (in lakhs)	59
3.8	Analysis on cause of Accidents (2000-2001 to 2016-17)	61
3.9	Consequential Train Accidents have Declined since 2000-01	65
3.10	The steps taken by government to prevent train accidents	65
4	**The Philosophy of Railway Safety and Preventive Mechanism**	**69-80**
4.1	Understanding philosophy of safety	70
4.2	What is an Accident?	71
4.3	Accident Prevention	71
4.4	The Philosophy of Accident	72
4.5	Few positive approaches to safety	73
5	**Introduction, classification, and reporting of Railway Accidents**	**81-104**
5.1	Accident Manual	83
5.2	Board's letter No.88/ Safety(A&R)/29/8 dated 18.4.1988	84
	Definition	85
5.2.1	Train	85
5.2.2	Passenger Train	85
5.2.3	Other Train	85
5.3	Accident	85
5.4	Injuries	86
5.4.1	Grievous injuries	86
5.4.2	Simple Injurie	86
5.5	Threshold Value	86
5.6	The classification of the Railway accidents	87
5.6.1	Train Accidents	87
5.6.2	Yard Accidents	88
5.6.3	Indicative Accidents	88
5.6.4	Equipment Failure	88
5.6.5	Unusual Incidents	88
5.7	Accidents	90
5.7.1	Class 'A' -- Collisions	90
5.7.2	Class 'B' -- Fire in trains	90
5.7.3	Class 'C' – Level Crossing	90

Chapter	Names	Page No.
5.7.4	Class 'D' – Derailments	93
5.8	Indicative Accidents	93
5.8.1	Class 'F' - Averted collisions	93
5.8.2	Class 'G' - Breach of block rules	94
5.8.3	Class 'H'– Train passing signal at danger	94
5.9	Equipment Failure-	94
5.9.1	Class 'J'– Failure of engine and rolling stock	94
5.9.2	Class 'K'– Failure of Permanent Way	95
5.9.3	Class 'L' – Failure of Electrical equipment	95
5.9.4	Class 'M' - Failure of S&T Equipment	96
5.10	Unusual Incidents	96
5.10.1	Class 'N'- Train Wrecking or attempted train wrecking or Sabotage to a train	96
5.10.2	Class 'P'– Casualties	96
5.10.3	Class 'Q'– Other incidents	97
5.10.4	Class 'R'– Miscellaneous	97
5.11	Reportable Train Accidents	97
5.12	Serious Accident	98
5.13	Reporting of Accident	99
5.14	Level of Enquiry	100
5.15	Rules for the preparation of accident returns	101
5.16	Collection, Compilation and Monthly statement of Accident Statistics	102
6	**Safety Audit: Internal and External**	**105-130**
6.1	Safety Audit	106
6.2	Characteristics of an Audit	106
6.3	Audit Vs Inspection	107
6.4	Audit Basic Definitions	108
6.5	Classification of Audits	108
6.6	Classification based on the type of Audit application Product Audit	109
6.6.1	Product Audit	109
6.6.2	Process Audit	110
6.6.3	System Audit	110
6.7	Classification based on the Nature of Audit	110
6.8	The Four phases of a safety audit	111
6.9	The Safety Audit process	112
6.10	Principles of a Safety Audit	113
6.11	Safety Audit	115
6.12	Safety Inspection Vs Safety Audit Safety Audit	116
6.13	Safety Inspection and Safety Audit	117

Chapter	Names	Page No.
6.14	Objectives of Safety Audit	117
6.15	Limitations of Safety Audit	118
6.16	Benefits of Safety Audit	118
6.17	Types of Safety Audits	119
6.18	Significance of Performing a Safety Audit	121
6.19	What an auditor looks for during an audit?	122
6.20	If you observe when an employee is working unsafely; then	123
6.21	Conducting Safety Audit	123
6.22	On-Site Activities	125
6.23	Opening Conference	125
6.24	Orientation Tour	126
6.25	Overview of Organization and Management Systems	126
6.26	Review of Records and Documents	126
6.27	Staff Interviews	127
6.28	Schedule Interviews Ahead	127
6.29	Conduct Interviews at the Workplace	127
6.30	Make Interviewee Relaxed and be Sensitive	128
6.31	Avert Yes or No Questions	128
6.32	Explore for the Deserving Staff	128
6.33	Physical inspection of Facilities	129
6.33.1	Inspect the Remote Areas	129
6.33.2	Closing Meeting	129
6.33.3	Preparation of Report	129
6.33.4	Post Audit Activities	130
7	**Safety Drives, Safety Circulars, Posters, Bulletins and Pamphlets and Safety Camp**	**131-152**
7.1	Safety Drives in Indian Railways	132
7.2	Safety Circulars	134
7.3	Advantages of Safety Circulars	136
7.4	Safety Posters	139
7.5	Safety Bulletins	145
7.6	Safety Pamphlet	146
7.6.1	Pamphlets vs. brochures	146
7.6.2	How to make a pamphlet in 5 steps	147
7.7	Safety Camps	148
8	**Human Factors in Safety and Safety Counselling**	**153-184**
8.1	Human side of the human element	153
8.2	Human Failures	154
8.3	Factors contributing to quality of human resources	155
8.4	Action plan for improving the efficiency of human resources	160

Chapter	Names	Page No.
8.5	Special Training of drivers on 'Loco Simulator'	160
8.6	Safety Counselling	162
8.7	Human Factors in Railway Accidents	162
8.8	Rationale of Safety Counselling and Suggested Method	166
8.9	Why Safety Counselling?	167
8.10	Duties of Safety Counsellors	167
8.11	Rationalizing the Role of Safety Counsellors	169
8.12	Motivating Safety Counselling	171
8.13	Procedure for Selection of Safety Counsellors	175
8.14	Personality Profile of a Successful Safety Counsellor	176
8.15	Selection of Tools	177
8.16	Workability of The Screening Procedure	177
8.17	Suggestions for Safety Counselling in Railways	178
8.18	Psychology of Safety in Supervision	178
8.19	Teaching safety on the job	181
8.20	Emphasis on safety records	183
9	**Duties & Responsibilities of Operating Staff & Traffic Inspector**	**185-202**
9.1	Responsibilities of Traffic Inspector of the Section	185
9.2	Responsibility of Station Master (supervisory)/Station Manager	186
9.3	Panel Assistant Station Master (ASM)	189
9.4	Deputy Station Master/Manager (Deputy SM) (Outdoor)	191
9.5	Duty list and hours of duty at Railway Stations	194
9.6	SM's responsibility for assurance	195
9.7	Home Address Register	196
9.8	Public and Staff notices for exhibition	196
9.9	Exhibition of public advertisements	197
9.10	Rule Books, Manuals etc. at Stations	197
9.11	Books and Notices at Level Crossing Gates	198
9.12	Handbook for gateman	198
9.13	Filing of Operating Circulars	198
9.14	Instructions for Guards	198
9.15	Correspondence	199
9.16	Playing of Bands and presentation of Guards of Honour etc. on Station platform	199
9.17	Prohibition against Photography/Film shooting on railway premises	200
9.18	Religious Edifices within the railway limits	200
9.19	Normal period for which Station Operating Registers and Records are required to be preserved	200

Chapter	Names	Page No.
Part B: Basics of Railway Assets and Probable cause of Failure		
10	**Understanding Basic Engineering**	**205-222**
10.1	Science	204
10.2	Engineering	204
10.3	Fundamental Units	204
10.4	Relative Velocity	206
10.5	Angular velocity	207
10.6	Mass, Weight, and Force	207
10.7	Newton's Laws of Motion	208
10.8	Work, Energy, and Power	208
10.9	Centre of Gravity	208
10.10	Friction	208
10.11	Laws of Friction	209
10.12	Lubrication	209
10.13	Impulses	211
10.14	Creep	214
10.15	Shear Stress	214
10.16	Punching Shear	215
10.17	Vibrations and Oscillations	216
11	**Basics of Permanent Way for accident investigation**	**223-272**
11.1	Formation	223
11.2	Failure of Formation	224
11.3	Ballast	224
11.4	Sleepers and Fastenings	230
11.5	Rails	233
11.6	Track Geometry	235
11.7	Track Gauge	241
11.8	Marking Stations for Track Measurements	243
11.9	Cross Level	244
11.10	Twist	245
11.11	Creep	248
11.12	Buckling of Track	254
11.13	Unevenness And Low Joints	256
11.14	Curves	257
11.15	Points And Crossings	261
11.16	Safety at Worksites	266

Chapter	Names	Page No.
12	**The Railway Safety on Bridges**	**273-284**
12.1	Track on Bridges	273
12.2	The components of a Bridge	275
12.3	Classifications of Bridges	275
12.4	Design of Bridges	276
12.5	Types of Foundations	279
12.6	Substructures of Bridges	280
12.7	Accidents due to failure of Bridges	281
12.8	Speed over railway Bridges	283
12.9	Maintenance of Bridges	283
12.10	Vulnerability of the Bridges	283
13	**Understanding Coaching Stock**	**285-320**
13.1	Vertical Load Transmission	285
13.2	ICF All-Coil Bogie	288
13.3	EMU Stock	304
13.4	Centre Pivot and Side Bearers	307
13.5	Anchor Links	307
13.6	Hanger And Hanger Blocks	308
13.7	Wheel And Wheel Tread Diameter	308
13.8	High Speed Passenger Bogies on Indian Railways	309
13.9	IR-20 Bogie	309
13.10	Fiat Bogie	309
13.11	Comparisons of Bogies	319
14	**Understanding Freight Stock**	**321-372**
14.1	Wheel Gauge	321
14.2	Bent Axle	323
14.3	Tyre Profile	323
14.4	Route radius	324
14.5	Height of wheel flange	324
14.6	Wheel Defects	324
14.7	Thin Flange	325
14.8	Sharp Flange	325
14.9	Worn Out Flange	325
14.10	Deep Flange	326
14.11	False flange/Hollow Tyre	326
14.12	False Flange	327
14.13	Thin Flange	328
14.14	Deep Flange	329
14.15	Worn Out Flange	330

Chapter	Names	Page No.
14.16	Flat Places on Tyre	331
14.17	Thin Tyre	332
14.18	Difference of Wheel Diameter on Tread	333
14.19	Effect of Play between Wheel Set & Track	336
14.20	Flat Places on Tyre	337
14.21	Difference of Wheel Diameter on Tread	337
14.22	Buffing Gear	343
14.23	Spring and Spring Gear	344
14.24	Twist in Under Frame of Wagon/Bogies	346
14.25	CASNUB Bogie	346
14.26	Flat tyre	372
15	**Break Binding, Stalling, Flat tyre and other defects of wheel and its prevention**	**373-384**
15.1	Brake Binding/Flat Tyre	373
15.2	Detection of locomotive and rolling stock with flat tyre	374
15.3	Mechanical (C & W) Staff	374
15.4	TLC/DPC/C &W Controller	375
15.5	Driver and Guard of the Train	375
15.6	Operating Staff	375
15.7	Section Controller	376
15.8	Engineering Staff and Gatemen	376
15.9	Engineering Control	377
16	**Hot Axle in rolling stock [Cartridge Tapered Roller Bearing (CTRB)]**	**385-396**
16.1	The symptoms of Hot Axle	385
16.2	Causes of Hot Axle	387
16.3	Detection of Hot Axle	388
16.4	Process of Hot Axle CTRB Failure Investigation	390
16.5	The visual inspection of cup	391
16.6	Visual Inspection of CTRB Components at CMT Lab	391
16.7	Temperature on Non-Contact Thermometer	392
16.8	Precautions to avoid hot axle during ROH & POH	393
16.9	Duties of railway servants in case of Hot Axle/ any unusual condition on Running Train	394
16.10	The responsibility of Station Master exchanging all right signal	395
17	**Train Parting**	**397-404**
17.1	Types of Train Parting	398
17.2	Uncoupling of CBC	399

Chapter	Names	Page No.
17.3	Guidelines for Preventing CBC Uncoupling	400
17.4	Operating Handle	400
17.5	Anti-Rotation Lug	401
18	**Understanding Locomotives (Diesel and Electrical)**	**405-458**
18.1	Nomenclature of Locomotives	406
18.2	Nomenclature of Locomotive Bogie	407
18.3	Locomotives and bogie type	408
18.4	Wheel wear and General	409
18.5	Locomotives Bogies	411
18.6	CO – CO Tri-mount bogie	411
18.7	High Adhesion Bogie	418
18.8	Flexi-coil Bogie Mark-I	424
18.9	High Tensile Steel Cast (HTSC) GM Bogie	428
18.10	CO - CO Flexi-coil Fabricated Bogie (ABB)	435
18.11	Bo-Bo Flexi-coil Fabricated Bogie (ABB)	441
19	**Movement and Stabling of Dead Loco including Axle Locked Locomotives**	**459-474**
19.1	Procedure for stabling a loco in dead condition	459
19.2	Procedure to be followed by the person/crew making the loco dead	459
19.3	Precaution to be taken While Changing the Cab	460
19.3.1	Cab changing in single loco	460
19.3.2	Cab changing in multiple loco:	461
19.4	Shunting Movement Towards Dead Section	461
19.5	Procedure for Movement of WAG9/WAP7 Locomotives by Lifting/Floating the Locked Axle in the Event of Axle Getting Locked on-line	464
19.5.1	Procedure when Traction Motor Roller Bearing gets Seized	464
19.5.2	Procedure for Floating / Lifting the Locked Axle	464
19.5.3	Items required for Lifting of Axle	465
19.5.4	Precautions to be taken	465
19.5.5	When One of the End Axles (i.e. Axle Nos. 1, 3, 4 or 6) gets Locked	466
19.5.6	Procedure for Assembly of Wheel Set Trolley	467
19.5.7	When Middle Axle (i.e. Axle No. 2 or 5) gets Locked	468
19.6	Procedure for Movement of WAP5 Locomotives by Lifting the Locked Axle in the Event of Axle Getting Locked on-line	471
19.6.1	Procedure when Traction Motor Roller Bearing gets Seized	471
19.6.2	Procedure for Lifting the Locked Axle	472
19.6.3	Items required for Lifting of Axle	472

Chapter	Names	Page No.
19.6.4	Precautions to be taken	472
19.6.5	Procedure for lifting of Axle when it gets locked	473
19.6.6	Procedure for Assembly of Wheel Set Trolley	473
20	**Safety and Signalling**	**475-504**
20.1	Signals	476
20.1.1	Caution Indicator	478
20.1.2	Speed Indicator	478
20.1.3	Stop Indicator	478
20.1.4	Termination Indicator	478
20.1.5	Block Working	479
20.2	Token Instruments	479
20.2.1	Token System	479
20.2.2	Token less Block Instruments	479
20.2.3	Track Circuiting	479
20.2.4	Axle Counters	480
20.3	Interlocking of Points and Signals	480
20.4	Advanced Signalling Systems	481
20.5	Maintenance of Signals	485
20.6	Disconnection memos for maintenance of signals gears	490
20.7	When disconnection notice is necessary	492
20.8	Situations in which disconnection notice need not be issued provided suitable precautions are taken	494
20.9	Do's and Don'ts for Signal Maintainer	495
20.10	Derailment Investigations	497
20.11	Derailments at Points and Crossings	497
20.12	Following Details should be recorded and considered Accident Involving S&T	500
20.13	Do's & Don'ts for S&T staff	502
21	**Shortcuts by Operating Staff causing accident.**	**505-514**
21.1	Shortcut done by Operating Staff breaching safety	505
21.2	The important rules of G&SR, Accident Manuals, and other instructions for Station Masters and other operating staff.	510
21.3	Altering the points immediately on arrival of train (GR 3.38(2))	510
21.4	Block instrument / BPAC failure (Para 8.3 of BWM Part 'A', 'B' & 'C')	510
21.5	Home Signal Failure (G & SR 3.68, 3.69)	511
21.6	Receiving a train on obstructed line (GR 5.09)	511
21.7	Stabling & securing of load (G&SR 5.23)	512
21.8	When Lurch has been reported by Loco pilot (SR 6.07)	512
21.9	Dispatching relief loco (SR 6.02.6) in Absolute Block System	513

Chapter	Names	Page No.
21.10	LC Gate working (Appendix II of G&SR)	513
21.11	Shunting operations (G&SR 5.13, 5.14, 5.20, 8.05, 8.06, 8.09, 8.14 & Appendix XII)	513
PART C – Prevention of Accident During Works		
22	**Prevention of Accident at Work site**	**517-532**
22.1	Prevention of worksite accident	517
22.2	Guidelines to work at worksite	518
22.3	Safety at Work Site Close to the Running Lines and fixed Structures	519
22.4	Measure to be ensured by Engineer In-charge prior to start of Work	519
22.5	Competency Certificate	520
22.6	Precaution to be taken while execution of the Work by Executing Agency and Engineer In-charge	522
22.7	Measures while Undertaking Excavation &Trenching Adjacent to Track	524
22.8	Unloading and stacking of materials along the Railway Track	525
22.9	Precaution Required to be taken during execution of work requiring Traffic Block	526
22.10	Safety aspects to be Observed While Working in OHE Area	527
22.11	Working of Track Machines	528
22.12	Precautions prior to Demolition of Structure Near Running Track	529
22.13	Provisions Regarding safety at Work Site in Contracts	529
22.14	Training	530
22.15	Do's and Don'ts to prevent accident at worksite	530
23	**Non-Interlocking working at Railway Stations**	**533-556**
23.1	Requirement of Non - Interlocked Working	534
23.2	Minor Works for Non-Interlock Working	535
23.2.1	Procedure to be followed for Non-Interlocked Working for Minor Works	535
23.2.1.1	(C1) Duration of Ni working for Minor Works	536
23.2.1.2	(C2) General Instructions for Train Operation	536
23.2.1.3	(C3) Train Running on double line section during Ni working	536
23.2.1.4	(C4) Train Running on single line section during Ni working	537
23.2.1.5	(C5) Staff requirement	537
23.3	Major Work for Non-Interlock Working	537
23.3.1	Procedure to be followed for Non-Interlocked Working for Major Works	537
23.3.1.1	(D1) Duration of Non-Interlocked Working	537
23.3.1.2	(D2) Sanctions, clearances and preparatory works	538

Chapter	Names	Page No.
23.3.1.3	(D3) Level of Supervision/Responsibility	538
23.3.1.4	(D4) Green Notice	539
23.3.1.5	(D5) Time Tabling changes	540
23.3.1.6	(D6) Advance preparation for Train Running	541
23.3.1.7	(D7) Goomty Arrangements	543
23.3.1.8	(D8) Staff Arrangements	544
23.3.1.9	(D9) HOER	545
23.3.1.10	(D10) Duty Rosters shift wise	545
23.3.1.11	(D11) Temporary Working Instructions (TWI)	547
23.3.1.12	(D12) Field level Advance Preparation	548
23.3.1.13	(D13) Mock Drill and Staff Assurance	549
23.3.1.14	(D14) Dissemination of information	550
23.3.1.15	(D15) Telecommunication, Lighting and Medical	551
23.3.1.16	(D16) Safety Equipment	552
23.3.1.17	(D17) Security arrangements	553
23.3.1.18	(D18) Introduction of NI working	554
23.3.1.19	(D19) Train Operation during NI period	554
23.3.1.20	(D20) Failures	555
23.3.1.21	(D21) Revised Station Working Rules	555
23.3.1.22	(D22) Completion of NI Working	555
23.3.1.23	(D23) Post NI analysis	556
24	**Electrification: Safety precautions while working on TSS and SP/SSP**	**557-562**
24.1	General Precaution while Working or Maintenance on OHE	557
24.2	Safety Precautions while working on TSS & SP/SSP.	560
24.2.1	General Safety Precaution	560
24.2.2	Safety Precaution while Working	561
PART D – Prevention of Fire in Trains		
25	**Fire in Train**	**563-600**
25.1	Characteristics of Fire	564
25.2	Classification of Fire	564
25.3	Probable Causes of Fire in Railway Coaches	565
25.4	The type of Fire Extinguishers & it uses.	566
25.5	Fire Hazards in Coaches	568
25.6	Action to be Taken to Prevent Fire Hazard in Coaches	568
25.7	Fire in LHB Coaches	577
25.8	Fire Fighting System in Coaches	580
25.9	Action Taken Against Fire in Trains	587
25.10	Instant Action Team	588
25.11	Role of members of Instant Action Team	588

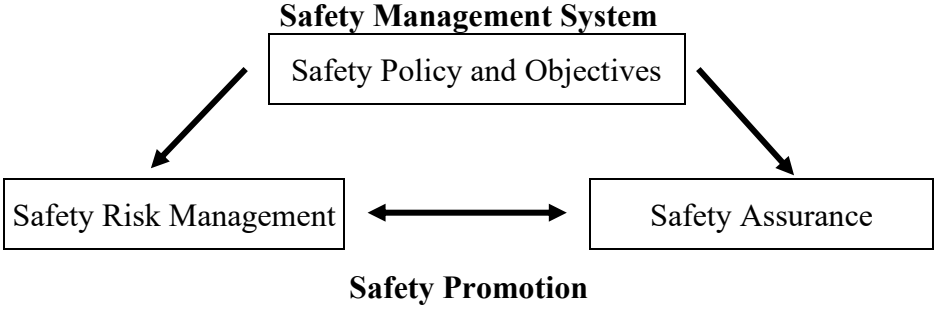
Chapter	Names	Page No.
25.12	When a Person is on Fire	590
25.13	Handling of Injured Passengers	590
25.14	General Safety Instructions and Roles of Various Stakeholders	590
25.15	Fire Risk Management and Safety Review	598
25.15.1	Safety Drive & Campaigns	598
25.15.2	Safety Audit and Inspections	598
25.15.3	Training, Mock drill exercises and Counselling of Railway Officials.	598
25.15.4	Fire and Hospital Directory	598
26	**Fire Prevention in Electrical Loco**	**601-620**
26.1	Transformer, Tap changer, CGR/RGR	601
26.2	Cables	604
26.3	Smoothing Reactor	607
26.4	Relays & Circuits	608
26.5	Operational System	611
26.6	BA/TK panel (EPM contactors, CTF reversers)	612
26.7	General (Locomotive body):	613
26.8	Important instructions to the crew	614
26.9	Rectifier	616
26.10	Auxiliary motors	616
26.11	Compressors / Exhausters	617
26.12	Traction Motors	618
26.13	Under frame and other equipments	619
26.14	Fire Fighting Arrangement	619
27	**About the Author**	**621-628**

PART A:
RAILWAY SAFETY
AND ITS MANAGEMENT

INTRODUCTION OF SAFETY MANAGEMENT IN RAILWAYS

1

Safety Management System (SMS) is a collection of structured, company-wide processes that provide effective risk-based decision-making for daily business functions. Safety Management Systems help organizations offer products or services at the highest level of safety and maintain safe operations. The key processes of a safety management system are hazard identification, occurrence reporting, risk management, performance measurement, and quality assurance.



1.1 Purpose and Benefits

The main purpose of a safety management system is to provide a systematic approach to managing safety risks in operations. It also aims to improve safety by building on existing processes, demonstrating corporate due diligence, and reinforcing the overall safety culture. Effective safety management is crucial in operating and growing the business, especially in high-risk industries, such as aviation, energy, maritime, and construction, where health and safety are paramount.

Developing safety management systems can seem daunting at first, but they are essential to promoting and ensuring workplace safety. With the right technological solution, such as a digital platform, you can streamline this process.

Some benefits of having a safety management system include the following:

- **Improved safety risk management processes:** Using a digital solution with free checklist templates and a smart form builder, you can easily identify hazardous working conditions, assess safety risks, and enforce control measures.
- **More efficient communication:** Work better together and foster a culture of collaboration by promoting openness among workers, ensuring all important information is disseminated easily.
- **Centralized documentation:** With a digital solution that allows you to store documents in the cloud, you can easily share files among workers anytime and anywhere. A single, unified repository also helps you refer back to any audit trail you may create to encourage continuous improvement.

1.2 Four Components and Twelve Elements of a Safety Management System

Safety management systems have four components in their framework. These are:

1. Safety Policy and Objectives
2. Safety Risk Management
3. Safety Assurance
4. Safety Promotion

Each SMS component contains elements that describe specific needs for the successful implementation and maintenance of a safety management system. Originated from ICAO, these 12 safety management system elements that many industries have now adopted are:

1. Management Commitment
2. Safety Accountability and Responsibilities
3. Appointment of Key Safety Personnel
4. Coordination of Emergency Response Planning
5. SMS Documentation
6. Hazard Identification
7. Safety Risk Assessment and Mitigation
8. Safety Performance Monitoring and Measurement
9. Management of Change
10. Continuous Improvement of the SMS
11. Training and Education
12. Safety Communication

The components and elements of a safety management system can be best understood together as illustrated in this image:

Safety Management System

Components	Elements
Safety Policy and Objectives	1. Management Commitment 2. Safety Accountability and Responsibilities 3. Appointment of Key Safety Personnel 4. Coordination of Emergency Response Planning 5. Safety Management System Documentation
Safety Risk Management	1. Hazard Identification 2. Safety Risk Assessment and Mitigation

Safety Assurance	1. Safety Performance Monitoring and Measurement 2. The Management of Change 3. Continuous Improvement of the SMS
Safety Promotion	1. Training and Education 2. Safety Communication

Safety Management System Framework: 4 Components and 12 Elements by ICAO

1.3 Component of Safety Management System

#1: Safety Policy and Objectives

Employers should make safety an integral part of company values, demonstrating their commitment daily. Specifically, top management needs to set safety goals as policy while being visible and personally involved in meeting them.

Once appointed safety personnel have been identified, documentation processes should also be determined because the safety management system will be reviewed periodically to ensure it remains relevant and appropriate to the organization.

#2: Safety Risk Management

In order to effectively control safety risks, designated staff should perform a series of interconnected processes collectively called Safety Risk Management (SRM). Listed below are the 5 steps that go into the safety risk management component of SMS:

1. **System Description and Task Analysis:** As a system design function, system description and task analysis are used by a cross-functional team within the organization to state the facts about the activities and workplace conditions (equipment, environment, etc.) involved in their processes.
2. **Hazard Identification:** Hazards are any real or potential condition, including typical hazardous conditions related to human error, such as time pressure, shift turnovers, and lack of system knowledge that can cause injury, illness, or death to people and/or system, equipment, or property damages or losses.

3. **Risk Analysis:** Analyzing risk involves considering the likelihood and severity of adverse consequences. Since a single hazard can have multiple consequences, increased exposure to hazards can also make it more likely for grave consequences to recur.
4. **Risk Assessment:** To assist with decision-making, perform a risk assessment with a risk matrix and establish whether a safety risk is acceptable or not. If deemed acceptable, the SRM component of safety management systems are complete, and the risk moves to the next component for monitoring. Otherwise, risk controls should be put in place to mitigate or reduce the risk.
5. **Risk Control:** While the severity of risks may be lessened to a certain degree, decreasing their probability or likelihood is what happens in most situations. Risk controls applied to working conditions can be effective instruments for risk reduction and failure prevention.

#3: Safety Assurance

Safety Assurance (SA) is the component of a safety management system that deals with monitoring risk controls during operations. Common SA functions include internal audits, investigations, and employee reporting systems.

Upon gathering all necessary information, these should be analyzed against set objectives and compared with existing norms for patterns from multiple data points and trends over time. Oftentimes, safety risk controls fail due to a lack of leadership, resources, and instruction. In whichever case, preventive and corrective actions should be taken.

#4: Safety Promotion

Interchangeably used with Safety Culture, Safety Promotion is defined as the activities that support safety management systems in an organization, such as training, knowledge-sharing, and communication. Management should also be able to explain why

particular actions are taken to foster an environment for open reporting of safety concerns.

Example Uses

Some use cases for safety management systems include the following:

1. Hazard identification within a workplace and conducting the proper analysis for it.
2. General risk assessment and control.
3. Data gathering for informed decision-making regarding safety concerns.
4. Solutions to existing safety concerns.

1.4 Role of Training in Safety Management

Training plays a crucial role in the implementation and effectiveness of safety management systems. Training sessions that outline the necessary steps and obligations for safety management help ensure that employees are equipped with the knowledge and skills to identify and mitigate hazards, follow safety procedures, and respond to emergencies.

Additionally, regular training helps keep your organization compliant with different safety standards. It ensures that employees are constantly updated on important changes and concerns, as well as with different new processes and procedures.

Online training courses, in particular, are beneficial for seamlessly facilitating training for safety management systems. With these kinds of training content, you and your employees can train anytime and anywhere, all at your own pace.

1.5 Eight Key Components of a Successful Safety Management Program

The importance of a well-designed safety management program is known by most, but unfortunately not implemented by all. An organization's ability to keep its employees safe depends on its ability to design, implement, and improve upon safety management processes and programs within their company.

The best companies in the world prioritize employee health and safety to make it a shared responsibility for all. These companies do so in a strategic way that enables them to effectively practice prevention, while also equipping them to effectively handle any incident that may occur. According to the National Safety Council, an effective safety management program should:

1. Reduce the risk of workplace incidents, injuries, and fatalities through data-driven measurements and improvements.
2. Involve people from different parts of the organization to make safety a shared responsibility.
3. Be well organized and structured to ensure consistent growth and performance.
4. Be proactive, preventive and integrated into the culture of the entire organization.

Given those requirements, we assembled a collection of "must haves" from industry leaders to provide you with a guide for creating a top-notch safety management program.

1.6 Here are the Eight key components of a successful safety management program:

1. Formalized safety policies

The first step to safety success is to outline the organization's safety policies – your organization's position on the importance of safety management, and the general expectations from each employee as to how to act in certain situations.

Safety policies should include critical operating information for employees to embrace and follow throughout their day to day working lives. These policies should include everything from general operating procedures such as: what to do in case of a fire, how often fire drills are practiced to detailed instructions for dealing with injuries if someone is hurt on the job or while in the building.

According to Jake Woolfenden, Owner of Summit Safety Group, having a written, shared, and embraced safety policy is the most basic requirement that shows an organization's commitment to safety.

> "Not only should the policy be written, but it should also be actively lived out each day. That includes consistent, proactive safety audits, site inspections, hazard identification, and regular interactions to ensure employees know and live the policy—and that risks are discussed and corrected quickly in the company each day."
>
> – Jake Woolfenden, owner of summit safety group

2. **Effective and regular communication about safety and health**

   Having safety policies that are frequently communicated and accessible to everyone is important. It's critical that organizations discuss the safety policies with employees and managers to ensure understanding and adoption.

   It's also a good idea to remind employees often that safety takes priority over productivity. This message can sometimes get lost with the daily pressures of meeting order commitments. Employees sometimes feel that they get mixed messages, so be sure to remind employees of the priority of safety.

   Focused, consistent messaging about safety and health can create loyal, productive, and accountable employees who feel respected and valued by the company. Regular, ongoing communication educates employees, helps to show the values of the company, and it helps to reinforce the right behaviours.

   Make sure that employees feel a strong personal connection to their own safety and the safety of others – "shared accountability." The benefits of this mutual caring by employees will be recognized instantly. You'll see that employees embrace safety policies rather than avoid them. As a result, you'll find a reduction in the frequency and severity of incidents and near-misses improving the overall effectiveness of your safety management program.

3. **Support for behaviour-based safety**

   The safest companies in the world recognize the importance of creating habits around safety. That's why many of them focus on behaviour-based safety – a safety methodology that focuses on

improving safety through habit creation.

Unsafe behaviour is naturally habitual for most employees, and they are unaware of it. Oftentimes, an activity has been done the wrong way for so long that employees aren't even conscious of the incorrect behaviour in many cases. Companies can create good behaviour by forming positive habits while breaking old ones. That's where the concept of habit change comes into play.

According to behavioural expert James Clear, it takes 66 days on average to develop a new habit. That means that organizations must dedicate themselves to continuous improvement in order to achieve optimal safety results.

In order to create habit change, Clear uses a framework called the 3R's of Habit Change:

1. Reminder (the trigger that initiates the behaviour)
2. Routine (the behaviour itself; the action you take)
3. Reward (the benefit you gain from doing the behaviour)

In your personal life, you might use a fitness tracker, set an alarm or leave notes on your bathroom mirror to remind yourself of things to help create healthy habits. You can use these same principles with your employees in the workplace, perform and record regularly near misses, behaviour-based observations and/or spot checks.

4. **Utilization of both leading and lagging indicators**

Organizations with outstanding safety records develop a systematic method to measure what's going on throughout their entire safety operation. It enables them to quickly and easily understand why something went wrong if it ever does. However, most organizations are far from this type of systematic reporting capability.

Many organizations primarily utilize lagging indicators – a measure of what's happened in the past such as lost workdays, workers' comp costs, or injury frequency. As safety leaders know, these reactive metrics do very little for future prevention of accidents and injuries.

The ability to quickly and precisely identify high-risk situations is something that should be on every safety leader's checklist for safety performance. Leading indicators can provide insight so that the organization can predict what could happen and take action to avoid accidents from occurring. Leading indicators include measures such

as frequency of safety training, number of and results of safety audits and inspections, as well as the behaviours reflecting operations including mean time of completion of corrective action, employee involvement in proactive activities and even leadership involvement. Through gaining insights into leading and lagging indicators, organizations can gain a complete picture of all safety program activity, with the ultimate goal of preventing accidents before they ever happen.

Some anecdotal stories describe companies compiling data for days for their annual meetings. Investing in safety management software with customizable analytics can resolve the issue and give you time and money back.

5. **Cutting edge tools and systems**

Companies with low injury rates equip their employees for success and they do so through more than just processes and safety management programs. They leverage cutting-edge tools and systems to keep their employees prepared and ready to handle whatever they need to.

The most impactful safety management program is one that equips any employee to quickly access the information they need and report an issue. Whether that information is an SDS Sheet, a training record, or the result of a safety audit, companies are now leveraging mobile safety management solutions to improve the timeliness of response and communication.

Just like companies provide their employees with PPE, the best safety leaders recognize the importance of mobile safety software to improve their overall safety management program. This is becoming even more important as younger workers who grew up as digital natives look for employers that accommodate working in ways that are natural and preferred for them. They can't imagine having to fill out a paper form, fax it to someone, keep a copy for their file, etc. They expect employers to use tools that they use in their daily life to ease their adoption of organizational operations.

6. **Frequent safety training and discussion**

The safest companies in the world recognize the importance of

continuous education of their employees, and they prioritize it.

According to OSHA, safety training provides managers, employees, and supervisors with:

1. Knowledge of proper practices to do their job safely
2. Awareness of how to eliminate hazards to reduce risk
3. Specialization when their specific roles require unique preparation

These three components are critical to reducing incident frequency while improving overall safety. One issue that employers face when looking to implement frequent training is that training sessions can be long and boring. When's the last time you remember seeing an employee get excited about a training session?

Public speaker and training expert Richard Hawk has a solution to helping you keep training engaging, fun, and effective for all employees: keep your content high energy and use storytelling to connect with people.

7. **Empowered and motivated employees**

Empowering employees through your approach to safety management can result in tremendous outcomes for your organization. However, many organizations struggle to achieve the proper level of employee engagement.

According to industry expert Jake Woolfenden "The biggest problem with most safety management programs is that they focus on preventing injuries by highlighting how bad things can get – scaring employees straight. While that's somewhat effective, it does very little to motivate employees to perform better." This results in a fear-based culture rather than one based on success, thus reducing employee morale.

Successful safety management programs and plans consistently promote proper safety through continuous education, consistent reinforcement, and ongoing improvements.

Interested in some ideas to improve engagement and empowerment? Try highlighting a safety person of the week/month!

8. **Comfort with reporting issues related to safety**

It's natural to want to get the job finished on schedule — or even

ahead of time — but with a "get it done quick" attitude, accidents happen. Top tier organizations emphasize the importance of reporting potential problems before they occur, or reporting safety incidents the moment they happen.

Make sure employees understand that they shouldn't take shortcuts and that safety is the top priority. An accident impacts productivity more than anything in a business, so make sure that the correlation between safety and productivity is understood by all – especially those managers who are evaluated on productivity.

Employees should feel interested and obligated to report a hazard or potential issue when they see it. When everyone feels a sense of responsibility for carrying out safety policies and procedures, the entire organization will improve its safety.

1.7 Safety Management is never-ending, but don't despair!

Keep in mind that the commitment to safety and establishing a safe and healthy culture is never-ending. You will always find areas of opportunity for improvement, new employees to train, new hazards to address and more. These challenges keep the job interesting and rewarding! Through a top-notch safety management program, you'll gain a systematic approach to evaluating, improving, and reviewing your safety activities to increase organizational success.

If you implement any of these 8 components, you'll be one step closer to a productive, healthy, and safe organization. If you implement all 8, you are sure to see your injury rate reduced and your workers' comp premiums low. Most of all, everyone will leave safe and sound to go home to their families each night. That is the greatest measure of success for you as a safety leader.

SEEK SAFETY,
AIM SAFETY,
FOLLOW SAFETY,
ENSURE SAFETY,
TEACH SAFETY,
YIELD SAFETY.

EVOLUTION OF SAFETY DEPARTMENT IN RAILWAYS AND ITS FUNCTIONS

2

Before independence, functions of safety department were managed by traffic department. In zonal headquarter, one of the operating officers was being nominated as safety officer and in field level i.e., district level, one of the officers was looking for function of safety officer. The Railway accident committee 1962, popularly known as Kunzru Committee after its name of its chairman Pandit H.N. Kunzru had recorded as under:

> A safety cell functions in the Operating Branch of the Railways, extending right from the Railway Board to the Divisional or District level. This is as it should be and is in consonance with the practice followed on foreign Railways where safety is integrated with the normal work of rail operations. This ensures effective preventive measures coming into operation as soon as safety is jeopardized. It is worthwhile mentioning that,

> out of 11,669 important accidents that took place on Indian Railways during the six years, 1957-58 to 1962-63, only 88 were enquired into by the Railway Inspectorate and the remaining accidents, which constituted more than 99 per cent of the total number of important accidents, were dealt with by the Railway authorities themselves with a view to fixing the responsibility for them and formulating measures for prevention of similar accidents in future. They have also to deal with other accidents like train partings, trains passing signals at danger, breach of block rules. averted collisions, etc. We have, therefore, to examine the nature and working of this internal safety organization on the Railways in order to assess its effectiveness in preventing accidents and improving the safety element in railway working.

Kunzru Committee has further noted that safety organisations at zonal headquarters level concerning with accident and operating rules are delt within the operating branch headed by Chief Operating Superintendent who is Chief Operating Superintendent. assisted in this work by a Deputy The latter officer, besides dealing with safety problems, is also responsible for the preparation of timetables, movement of coaching traffic, arranging special moves, allotment of carriages to the public and the establishment work pertaining to the transportation staff controlled by the headquarters.

With the recommendation of the committee as given in part I of their report, an additional temporary post of Traffic Superintendent (Safety) has been created on each Railway Zone. He has been

entrusted with the responsibility of coordinating the component parts of the emergency programme, suggested by us for dealing with the specific failures of the Station staff, Drivers, Gateman and Permanent Way 'staff, as brought out in the analysis carried out by us.

The duties required to be performed by these officers were detailed by committee in their previous Report and the Railway Board have taken care not to burden them with the normal work of dealing with accidents, enquiry reports, etc., which continue to be dealt with by the Deputy Chief Operating Superintendent as heretofore. This arrangement was suggested for dealing with a specific situation and is, therefore, temporary, by its very nature.

During that time the work of safety cell of operating department was so heavy that Kunzru committee has described it in detail. The committee had noted that the existing organization org is Inadequate to deal of safety in the context of the enhanced satisfactorily with the problems of sat functions proposed by us. have been supported in this view by a We have retired Chairman and Member, Transportation of the Railway Board, who said.

> *"The Deputy Chief Operating Superintendent, who is dealing with accident cases, cannot devote his full attention as his work has become fairly heavy. Therefore, it seems to me that a post of a separate officer of the rank of a Deputy Chief Operating Superintendent under the Chief Operating Superintendent should be created whose duty should be to deal with accidents and working rules. Some sort of standardization is necessary in the rules, so that the same practice*

is followed all over. In the olden days, in the headquarters office there always used to be a check on the working rules but this check does not exist today because he is very busy. The new Deputy Chief Operating Superintendent should deal with trends of accidents, rules and regulations, training programme and building of personnel. He should be a pretty senior officer who has not to send every case to Chief Operating Superintendent for orders."

Kunzru committee had endorsed the above view and recommended for separate safety department with traffic cadre. The major recommendations of committee are as under:

1. We have examined the inspection notes of the Heads of Departments and consider that despite their heavy work, they should be able to devote more attention to the safety aspects of the working of the Rail ways and thus guide and instruct the Divisional officers in the technique of inspection and in drawing useful conclusions from inspections. [Paragraphs 227(i) and (ii)]
2. We consider the present machinery dealing with safety at the headquarters of each zone, inadequate in the context of the increased functions proposed by us and suggest its strengthening by putting it under a Deputy Chief Operating Superintendent who should exclusively deal with the problems of safety, detailed by us. This organization should carry out a periodical analysis of accidents with a view inter alia to locating any persistent trends or pattern of the causes of accidents, bringing out their relative position on the various Divisions etc. The results of the studies should be presented in an easily assimilable form and circulated widely up to the supervisors' level. [Paragraph 227 (iii)]
3. We suggest the formation, on every Railway, of a Safety Committee consisting of the Heads of Departments, with the

Deputy Chief Operating Superintendent (Safety) as er-officio Secretary, to review the accidents and the measures for their prevention. [Paragraph 227(iii)]

4. We consider it essential to provide an effective machinery at the Railway Board's level for coordinating the activities of the Zonal Safety Organizations, maintaining liaison with the Commissioner of Railway Safety and dealing with the problems of safety, as suggested by us. For this purpose, we recommend the creation of a Safety Organization, under an Additional Member, assisted by a Joint Director, in the Transportation Branch of the Railway Board. [(Paragraph 228)]
5. We also consider that the Member, Transportation, should be responsible for the working of the Efficiency Bureau in the Railway Board's office. [Paragraph 228]
6. We find that the Divisional Safety Officers have been saddled with certain miscellaneous duties which do not relate to safety. We suggest that they should be relieved of them. [Paragraph 229(i)]
7. We consider that inspecting officials themselves need training and instruction and should be provided, on all Railways, with manuals of station inspections. [Paragraph 229 (ii)]
8. We suggest that the results of the analysis of accidents, their causes, and types, for a sufficiently long period, and the conclusions reached, should be made available to the supervisors and even the staff online. [Paragraph 229 (ii)]
9. We find that the Traffic Inspectors are burdened with extensive jurisdictions and suggest that they should not normally be given charge of more than 20 to 25 stations, depending on local conditions, we also suggest rationalization of the categories of Inspectors, by a suitable amalgamation of their duties. [(Paragraph 229 (iv)]
10. We consider that the strength of Loco and Carriage & Wagon Inspectors should be determined on a rational basis. [Paragraph 229(iv)]
11. We suggest that the number of Signal Inspectors should be determined on the basis of the number of lever units to be maintained by them. [Paragraph 229 (iv)]

12. We consider that it is the immediate supervisor who should normally impart safety instructions to staff under him; the Safety Supervisors engaged in in the short-term programme, suggested by us in Part I of our Report, should be eventually absorbed in the permanent cadres. [Paragraph 229 (iv)]
13. There should be suitable machinery in each Division to watch and rectify the quality, quantity and the type of inspections carried out by the Inspectors. [Paragraph 229 (v)]
14. We suggest certain alterations and additions to the form and content of accident statistics, published by the Railway Board in its Annual Report. [Paragraph 230 (i)]
15. We suggest that the Railway Administrations should keep a special watch on, and maintain statistics of, technical accidents and also compile additional information regarding accidents at level crossings, as indicated by us. [Paragraph 230 (ii)]
16. We consider that all four-wheeler medical relief vans should be progressively replaced by bogie vehicles. [Paragraph 231 (ii)]
17. We suggest the completion of the provision of sidings with double ends for stabling the medical vans, within a year's time. [Paragraph 231 (ii)]
18. We suggest that detailed road maps should be kept in all control offices and in railway hospitals which should also be equipped with ambulance vans, on a programmed basis, to rush, whenever possible, medical aid by road. [Paragraph 231 (iii)]
19. We suggest that there should be ample provision of dehydrated and tinned foodstuff in relief trains. As on the British Railways, a kitchen car, with cooks, should also be provided on relief trains. [Paragraph 231 (iv)]
20. We suggest the provision of emergency lighting equipment in all passenger trains running at night and of searchlights with portable generators in relief trains which should also be equipped with portable telephones, a public address system, a push trolley, two dip lorries and overhead tanks to carry drinking water on all its bogles. [Paragraph 231 (v)]
21. We feel that the preservation of clues should not take precedence over mitigation of human suffering and suggest that the State

Governments should be approached to issue clear instructions to the police authorities in this respect. [Paragraph 231 (vi)]

22. We suggest consideration of the methods used on foreign Rail ways for the expeditious restoration of through communication after accidents, particularly on electrified sections. [Paragraph 231 (vi)]
23. We suggest that the Railway Board should devise a procedure to help ad hoc Claims Commissioners in making, within a period of six months, payments against claims for compensation to the victims of railway accidents or their dependents. [Paragraph 232]

Wanchoo Committee had shown the satisfaction on the work of having separate safety department under traffic cadre. The recommendation of Wanchoo committee were primarily repetition of work of Kunzru committee but broaden the horizon of the safety department in railway. The railway accident enquiry committee, 1978, popularly known as Sikri Committee has noted about the safety organization in railway as under:

2.1 Set up of the safety Organization

The set up of the safety Organization on the Indian Railways, created in pursuance of the recommendations of the Kunzru Committee and enlarged and strengthened on the basis of further recommendations made by the Wanchoo Committee, is now functioning in a three-tier arrangement.

- At the apex there is the Safety Directorate in the Railway Boards' office under the charge of a director, assisted by two Joint Directors and supporting staff.
- In the headquarters of the zonal railways, there is a Chief Safety Superintendent in the Senior Administrative grade assisted by a Senior Transportation Officer (Safety).
- On the divisions, there is a Divisional Safety Officer in the senior scale with a team of safety counsellors drawn from different disciplines. (Para no. 442 of RAEC (Sikri), 1978 of Part II)

Committee had noted that the Incumbents of the posts of divisional safety officers as also chief safety superintendents were getting frequently transferred; the stay of a person in one post, during the last 5 years, was in some cases as low as 6 to 9 months only. (Para no. 444 of RAEC (Sikri), 1978 of Part II)

Further, that the divisional safety officers are allotted a variety of duties unrelated to safety. such as supply of uniforms, postings and transfers of operating staff, etc. In addition, they are also often deployed on sundry trouble-shooting assignments for the Operating Department. By a recent order, they are also required to deal with disciplinary enquiries on commercial matters pertaining to station masters, guards, etc. (Para no. 445 of RAEC (Sikri), 1978 of Part II)

A handicap which was forcefully represented on all the divisions was the relatively junior status of the divisional safety officers. In the present set up, when all the divisional officers of the executive departments are in the junior administrative grade, the divisional safety officer, who is in the senior scale, placed at a disadvantage in status and is unable carry weight with his peers in other departments. (Para no. 446 of RAEC (Sikri), 1978 of Part II)

The officers manning the safety Organization in its three-tier arrangement are, at present, all drawn from the Traffic Department, and in some cases from the Commercial Department also. There was no unanimity among officers from other departments that there is need to make the safety Organization mor broad-based by drawing officers from the other major departments like Mechanical Engineering, Civil Engineering, Signal and Telecommunication Engineering and Electric Traction, which play a major role in safety of train operations. The ed for need inducting other technical officers was accepted by some officer of the Safety and Operating Departments also. (Para no. 447 of RAEC (Sikri), 1978 of Part II)

In so far as safety counsellors are concerned, we found that there is no uniformity in the composition of the team on the divisions. On some railways major disciplines like Signalling and Telecommunication, and Electric Traction have no safety counsellor at the divisional level. There were cases where safety counsellors are shared between two divisions which apart from being inadequate, results in their spending large part of their time in journey only. The posts of safety counsellors in some cases had remained unfilled for long periods. Not infrequently. the divisional safety officers had to be content with indifferent calibre posted as counsellors. As against this, instances were quoted where persons specially selected for the job departments were not spread by the executive. (Para no. 448 of RAEC (Sikri), 1978 of Part II)

The safety counsellors themselves were not very clear about their functions. Examination of the work done by safety counsellors on some of the railways showed that they have become yet another category of inspectors who do little else besides pointing out acts of omission and commission on the part of staff and calling for remarks and explanations. They seem to have very little idea what the counselling function is and how to go about it: they had not been trained and guided for such work. (Para no. 450 of RAEC (Sikri), 1978 of Part II)

The Sikri Committee had recommended about safety organizations as under:

1. The Safety Organization should primarily be a service Organization and not an executive department. The responsibility of ensuring safety on the Railways is squarely that of the different departments and their accountability in this respect must not be diluted. (Para 452)
2. The Safety Organization should be manned by officers from any of the 5 major departments, namely. Operating, Civil Engineering, Mechanical Engineering, Signal & Telecommunication Engineering and Electric Traction, who are mainly concerned with safety in train operations. (Paras 447 & 452)

3. At the divisional level, the Divisional Safety Officer should put up periodic reports to the Divisional Railway Manager/Divisional Superintendent on deficiencies and problems so that the latter can get the executive officers to take action. At the headquarters level, the Chief Safety Superintendent should report directly to the General Manager. (Paras 453 & 454)
4. Men of ability and dynamism should be posted to the Safety Organization to dispel the impression that it is a refuge for unwanted people. (Para's 443 4 455)
5. Persons posted to the Safety Organization should have a minimum tenure of 2 years. (Paras 444 & 455)
6. The Divisional Safety Officer should be relieved of his miscellaneous function and left free to concentrate on his main responsibility of promoting safety on the division. (Paras 445 & 455)
7. The status of the Divisional Safety Officers should be brought on par with divisional officers of other executive departments. (Paras 446 & 455)
8. Each division should have safety counsellors from the four main disciplines, namely, Operating, Civil Engineering, Mechanical Engineering and Signal and Telecommunication Engineering. There should be provision to add to these counsellors from specialised disciplines like Electric Traction, wherever necessary. (Paras 448 & 455)
9. Safety counsellors should be appointed after a careful selection so as to ensure that they have, in addition to some technical background, a proper understanding of human nature and a flair for counselling work. (Paras 448 & 455)
10. The persons selected as safety counsellors should be given appropriate training in counselling techniques. (Para 455)
11. An effective system of monitoring the follow-up action on recommendations made by committees of inquiry into railway accidents should bd followed at the divisional and headquarters levels of zonal railways. (Paras 450 & 455)
12. Regular statistical studies must be done at the divisional and headquarters levels of zonal railways to analyse the short and long-

term trends of various types of accidents and take remedial measures. (Paras 451 & 455)

13. Safety should be the only charge of Director, Safety in the Railway Board. He should also coordinate the efforts of zonal railways in the field of safety. (Para 457)

The Railway Safety Review Committee (RSRC), 1998 has recommended about the safety organization as under:

1. The Safety Department on IR should be made broad based and suitable officers from Traffic, Civil, Mechanical. The Signal and Electrical Engineering Departments should be posted as Safety officers at all levels. Our committee further recommends the following:
   (i) The Chief Safety Officer should be given the status of PHOD, and the incumbent should have worked successfully as DRM.
   (ii) There should be four officers of Dy HOD rank (from departments other than that of CSO) reporting to him.
   (iii) A similar pattern should be adopted on the Divisions where the DSO should invariably be in JA grade. He should have Assistant/Senior Scale officers reporting to him.
   (iv) All safety officers should have a minimum tenure of three years.
   (v) Each safety group should have transport available for surprise checks.
   (vi) Experience as DSO/CSO should be necessary for promotion to PHOD/ GM (Para no. 6.8.6 & 6.8.7 of RSRC (Khanna) of Part II)
2. The concept of safety audits should be introduced on IR. Details can be worked out by IR. (Para no. 6.9.11 of RSRC (Khanna) of Part II)

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The Safety Organization was created in Indian Railway arising out of the recommendations in reports of Inquiries into Serious Train Accidents by Kunzru and Sikri Committees. Initially the Safety Organization was functioning as one of the wings of the Operating department. Based on the recommendations of Justice Khanna Committee (Railway Safety Review Committee), a broad-based Safety department was set up with officers and staff drawn from all disciplines concerned with safety in train operations, viz. Operating, Engineering, Mechanical, Electrical and Signal & Telecommunication departments manning the posts.

2.2 Organization

The Principal Chief Safety Officer is the Head of the Safety department, assisted by officers and supervisory staff of other departments connected with safety. At the divisional level, the safety department is headed by Sr. DSO assisted by ADSO and supervisory staff.

The Safety Organization functions at all the three levels of organizational structure of the Indian Railway - Railway Board, Zonal Railways and Divisions. At the Railway Board level, the Safety directorate is headed by an Adviser assisted by Directors, other officers and Inspectors drawn from various disciplines. At the Zonal Railway level, the Chief Safety Officer heads the Safety department assisted by officers and supervisory staff from other departments connected with Safety. At the Divisional level, the Safety department is headed by Senior Divisional Safety Officers. An assistant officer is also available in all divisions. Supervisory level staff from all concerned departments are available for providing assistance at Divisional level.

The broad scope and functions of the Safety Department is:

1. To sensitize all concerned on Safety related issues
2. To oversee all Safety matters
3. To identify Safety related Susceptibilities and Vulnerabilities
4. To enable the concerned departments of Deliver

The following activities are undertaken by the Safety Department

1. Auditing the Safety awareness/consciousness of the Railway employees at all levels through normal and surprise inspections as well as super-checks. This will also include checks on availability and adequacy of rules and procedures laid down by various departments for ensuring safety in train operations and their compliance by various levels of staff
2. Reporting of accidents, conducting accident inquiries, analyze the causes leading to such situations and recommend corrective action so as to prevent such incidents in future.
3. Monitoring of Disaster Management mechanism for providing effective response to untoward incidents on the Railways and also coordinating with State Government and other agencies in disaster management activities
4. Creating awareness amongst public for ensuring safety in Railway compartments and at level crossings
5. Creating safety awareness amongst Staff through publication of bulletins, magazines, posters, calendars etc., and also
6. Motivating staffs who has acted in manner as to avoid an accident or untoward incident through cash awards and other schemes
7. Follow-up of implementation of recommendations made by the Railway Safety Review Committee, High level committee on Disaster management, and those by the Commissioners of Railway Safety as a result of inquiries into train accidents

Following duties are discharged by Safety Officers to fulfill the Railway Safety Mission

The Principal Chief Safety Officer is the Head of the Safety department. The PCSO audits the operations on the Railway with respect to safety through inspections, supervision of Inspections, safety audits and other checks. All audits are also analyzed, and action suggested preventing accidents.

1. Reporting of accidents to General Manager, Railway Board and Commissioner of Railway Safety
2. Compilation of accident statistics and its analysis
3. Assisting Commissioner of Railway Safety in conducting accident inquiries
4. Monitoring of Accident inquiries and follow up on the recommendations and disciplinary action cases arising out of such inquiries and ensure adequacy of punishments imposed.
5. Liaison with all departments for safe practices in maintenance and working of trains and apprising the General Manager about deficiencies and short comings in these areas
6. Follow up action on Inspection reports of Commissioner of Railway Safety
7. Conducting super-checks in all areas connected with operation and maintenance of train services from the safety point of view
8. Co-ordination with State Governments for promoting safety at level crossings

Preparation and circulation of safety circulars, bulletins and posters as well as release of advertisements in newspapers on safety related issues.

Ordering and coordinating safety drives

1. Co-ordination regarding Disaster management functions including interaction with agencies outside Railways.
2. Implementation of Corporate Safety Plan and follow up of Zonal Safety Action Plan.

3. Co-ordination and conduct of safety audit and Inter-Railway Joint Safety Inspection (in other zonal Railway) with a multi-disciplinary team of Senior administrative grade level officers.
4. Monitoring of progress of safety related works.
5. Monitoring of assets reliability and equipment failures.

2.3 Manuals and Records used for discharging functions

1. General & Subsidiary Rules
2. Block Working Manual
3. Accident Manual
4. Disaster Management Plan – Zonal Plan and Divisional plans of Allahabad, Jhansi and Agra divisions
5. Indian Railway Permanent Way Manual
6. Indian Railway Works Manual
7. Indian Railway Bridge Manual
8. Indian Railway Signal Engineering Manual
9. AC Traction Manual
10. Maintenance Manual for BG coaches of ICF design
11. Maintenance Manual for Wagons
12. IRCA Conference Rules (Part-III) for Wagons
13. IRCA Conference Rules (Part-IV) for Coaches
14. Working Timetables
15. Indian Railway Schedule of Dimensions (BG) Revised
16. Corporate Safety Plan
17. Recommendation of Railway Safety Review Committee (Part-I and Part-II)

2.4 Categories of documents held

The following documents are held by the Headquarters Safety Department:

1. Policy directives from Railway Board on matters concerning Safety
2. Inquiry Reports of Accidents
3. Inquiry Reports of Commissioner of Railway Safety

4. Inspections Notes of Officers of Headquarters Safety Department
5. Inspection Notes of General Manager and Railway Board officers in areas connected with Safety
6. Reports of Safety Audits and Joint Safety Inspections conducted by the multi-disciplinary team of SAG level officers

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On the recommendation of RSRC, 1998, Railway Board had implemented the broad basing of safety organization in railways.

Sub: Strengthening of Safety Organization on Indian Railways.

Railway Safety Review Committee, while reviewing the efficacy of existing Safely Organization on the Railways, have recommended that "Safety department should be made broad-based and suitable officers from Traffic, Civil Engineering. Mechanical, Signalling and Electrical departments should be posted as Safety Officers at all levels". The recommendation has been accepted by the Board. Instructions to broad-base the Safety Organization at the Zonal Headquarters were issued vide Board's letter No. E(O)III-98/TR/298 dated 19/02/2003. Board have further decided to broad base the Safety Organization at divisional level also vide letter number ibid dated 04/10/2004,

2. With broad basing the Safety Organization at Zonal and Divisional levels general functions, exclusive to the Traffic Department being dealt with by CSO at the Zonal level and Sr. DSOs/DSOs at Divisional level, as at Annexure 'A', will now be dealt with by Operating Branch under COMS/Sr. DOMs Zonal Railway Training Institutes will remain under the control of Chief Operations Managers. However, ZRTI will continue to impart training to staff of other disciplines as at present

3. Board have also approved duty list of the new multi-disciplinary Safety outfit in headquarters and divisional offices as per Annexure B. This duty list will be applicable

to all Zones/Divisions including where the posts of CSOs/Sr DSOs are manned by officers from Traffic Cadre.

4. General Managers will make arrangements to provide adequate organizational support to the multi-disciplinary organization at the non-gazetted level both in headquarters and at the divisional offices.

5. Kindly acknowledge receipt of the letter.

Reference: Letter No. 98/Safety-I/27/1 dated 20.10.2004 is signed and issued by Nikhil Pandey, Director/Safety-I, Railway Board and is given to General Managers (Open Line), and All Zonal Railways.

Annexure- A

1. General functions of traffic department to be dealt by COM's office in the zonal railways and Sr. DOM's/DOM's office in the divisions
2. Framing and review of subsidiary rules and enforcing of GR & SRs.
3. Making of rules regulations and manuals for traffic dept.
4. Enforcement of and modification in accident manual, block working manual and operating manual etc.
5. Framing, checking and circulation of station working rules (SWRs)
6. Organizing and involvement in non-interlocked working and issuance of traffic work order (TWO)
7. Overseeing functioning of ZTCs/Area Training Schools.
8. Training management for traffic dept. Review of training modules functioning of zonal training schools, functioning of divisional traffic schools, arranging initial, promotional and refresher courses for operating staff etc.
9. Issuance of competency certificate for both running and station staff Liaison with CRS on issues relating to operating dept.
10. Implementation of recommendations (CRS or otherwise) pertaining to operating branch and follow up of DAR cases pertaining to operating dept.
11. Review of vacancies and progress of selections of staff in safety categories of operating dept. and coordination with the personnel dept.

12. Conduct of psychological tests for different categories of operating staff both from direct recruitment and promotion etc.
13. Preparation, circulation and printing of safety circulars, posters, bulletins pertaining to operating staff.
14. Launching and monitoring of safety drive pertaining to traffic staff
15. Ensuring availability of Registers and forms used for operation of trains and records.
16. Review of format of Registers and forms from time to time to cater to the operational needs commensurate with changes in technology, pattern of traffic and type of infrastructure.
17. Management and supervision of material stores and safety equipment for guard and station staff (such as detonators, signal lamps, tail lamps, fusee lamps, first aid boxes, fire extinguishers etc.)
18. Budget relating to operating dept.
19. Ensuring availability and distribution of uniform for the operating staff.
20. Traffic safety inspections of stations, yards, cabins, brake vans, level crossing", panels, RRIs, guards and drivers' lobbies, footplate inspection and window trailing inspections etc.
21. Review and functioning of amenities in running rooms managed by operating deptt.
22. Associating in conduct of accident enquires as a representative of operating department.

Annexure- B

1. Duty List of the new multi-disciplinary safety outfit in headquarters
2. Reporting accidents to GM/DRM, Commissioner of Railway Safety and Railway Board.
3. Compilation of accident statistics and Analytical Reviews of trends of accidents and suggesting remedial measures in coordination with other departments.

4. Assisting CRS in conducting inquiries into the serious accidents and supervise the accident inquiries and associate with accidents inquiries
5. Assisting GM/AGM/DRM in acceptance and Review of all accident inquiry reports.
6. Monitoring of DAR cases, arising out of accidents and review thereof to assess adequacy of punishments by disciplinary, appellate and reviewing authorities.
7. Monitoring implementation of the recommendations of CRSs and various Safety related committees.
8. Monitoring the implementation of all directives issued by Railway Board in the matters pertaining to Safety.
9. Apprising GM/DRM of deficiencies in implementation of Safety measures adopted by various departments: Keep liaison with other departments for safe working of maintenance and operational practices.
10. Will carry out safety super-checks of the functioning of operational and maintenance machinery on the Railways, including inspections of track machines, tower wagons, OHE, RCRV, inspections of loco sheds, C&W depots, inspections of track points and crossings, trolley and motor trolley inspections, ambush checks, station/yard inspection, B/Van inspection etc., super check of coaching and goods trains, conducting night inspections, Joint inspections with Officers/staff of Civil Engineering, S&T, Electrical, and Mechanical departments etc; Safety audit. Coordination with other Government agencies for promoting Safety at level crossings.
11. Preparation and circulation of Safety circulars, posters, bulletins etc.
12. Safety drives based on the safety environment prevailing on the Railway Regular counselling and monitoring of staff involved in maintenance and operation. Nomination of signal sighting committees and ensuring rectification of deficiencies recorded.
13. Coordination of improvements in Crew and Guard booking lobbies, running rooms, for running staff.
14. Suggestions related to various manuals of different disciplines.

15. Working of Safety counsellors of all disciplines
16. Checks on HOERS, bringing out deficiencies affecting safety
17. Safety Officers should make suggestions about the proposals for new works having bearing on safety in train operation and maintenance of operational assets.
18. regarding Disaster Management functions - Relief and restoration etc. coordination and implementation of Zonal/Divisional disaster management plan.
19. Implementation of Corporate Safety Plan and follow up of Zonal/Divisional Safety action Plan.
20. Follow up of Breathalyzer applications and adoption of preventive measures to curb drunkenness.
21. Safety officer must ensure that all clues relevant to accident investigation are preserved.
22. Safety Officer must ensure that all relevant measurements are jointly recorded
23. Any other functions assigned by GM/DRM.

2.5 Important Definitions

Following definitions must be known before understanding railway operations. These definitions are given in the **Indian Railways (Open lines) General Rules. Commonly these rules are called General and Subsidiary Rules (G&SR). General Rules are framed by Central Government and Subsidiary Rules are framed by authorized officer of a zonal railway, which is Principal Chief Operating Manager (PCOM). The general rules are amended time-to-time as per operation, maintenance, and safety requirement.**

1. **Act**
   Act means The Railways Act., 1989 (24 of 1989).
2. **Adequate Distance**
   Adequate Distance means the distance sufficient to ensure safety.
3. **Approach Lighting**
   Approach Lighting means an arrangement in which the lighting of signals is controlled automatically by the approach of train.

4. **Approved Special Instructions**
   Approved Special Instructions means special instructions approved of or prescribed by the Commissioner of Railway Safety.
5. **Authorized Officer**
   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.
6. **Authority To Proceed**
   Authority To Proceed means the authority given to the Loco Pilot of the train, under the system of working, to enter the block section with his train.
7. **Axle Counter**
   Axle Counter means an electrical device which, when provided at two given points on the track, proves by counting axles in and counting axles out, whether the section of the track between the said two points is clear or occupied.
8. **Block Back**
   Block Back means 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.
9. **Block Forward**
   Block Forward means to dispatch a message from a block station on a double line intimating to the block station immediately in advance the fact that the block section in advance is obstructed or is to be obstructed.
10. **Block Section**
    Block Section means 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.
11. **Centralized Traffic Control**
    Centralized Traffic Control means 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.

12. **Centralized Traffic Control Operator**
    Centralized Traffic Control Operator means the person on duty who may for the time be responsible for the working of trains on the Centralized Traffic Control.
13. **Commissioner of Railway Safety**
    Commissioner of Railway Safety means an Inspector appointed to exercise any functions under the Act and includes an Additional Commissioner of Railway Safety.
14. **Competent Railway Servant**
    Competent Railway Servant means a railway servant duly qualified to undertake and perform the duties entrusted to him.
15. **Connections**
    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.
16. **Controller**
    Controller means a railway servant on duty who may for the time be responsible for regulating the working of traffic on a section of a railway provided with the system of speech communication.
17. **Day**
    Day means from sunrise to sunset.
18. **Direction of Traffic** means –
    a) on a double line, the direction for which the line is signalled.
    b) on a single line, the direction for the time being established, under the system of working, to allow trains to move in that direction; established, under the system of working, to allow trains to move in that direction.
19. **Loco Pilot**
    Loco Pilot means the engine driver or any other competent railway servant for the time overseeing driving a train.
20. **Electrical Communication Instrument**
    Electrical Communication Instrument means either a telephone or a Morse telegraph instrument.

21. **Facing And Trailing Points:**
Facing And Trailing 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.
22. **Fixed Signal**
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.
23. **Fouling Mark**
Fouling Mark means the mark at which the infringement of fixed Standard Dimensions occurs, where two lines cross or join one another.
24. **Gangman**
Gangman means a railway servant employed on permanent way or work connected there with.
25. **Gangmate**
Gangmate means the person in charge of a gang of workmen employed on permanent way or work connected therewith.
26. **Gateman**
Gateman means a competent railway servant posted at a level crossing for working the gates.
27. **Goods Train**
Goods Train means a train (other than a material train) intended solely or mainly for the carriage of animals or goods.
28. **Guard**
Guard means the railway servant in charge of a train and includes a Brakes man or any other railway servant who may for the time being performing the duties of a Guard.
29. **Inspector of Way or Works**
Inspector of Way or Works means any Inspector or Assistant Inspector responsible for the construction or maintenance of permanent way, point and signals, bridges or other works connected therewith.
30. **Interlocking**

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.

31. Intermediate Block Post

Intermediate Block Post means a class 'C' station on a single line or double line or multiple line remotely controlled form the block station in rear.

32. Intermediate Block Signalling

Intermediate Block Signalling means an arrangement of signalling on single line or double line or multiple line in which a long block section is split into two portions each constituting a separate block section by providing an intermediate Block Post.

33. Isolation

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.

34. Last Stop Signal

Last Stop Signal means the fixed Stop signal of a station controlling the entry of trains into the next block section.

35. Level Crossing

Level Crossing means the intersection of the road with railway track at the same level.

36. Level Crossing Gate

Level Crossing 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.

37. Line Clear

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 towards the latter.

38. Main Line

Main Line means the line ordinarily used for running trains

through and between stations.

39. Material Train

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.

40. Mixed Train

Mixed Train means a train intended for the carriage of passengers and goods, or of passengers, animals and goods.

41. Multiple-Aspect Signalling

Multiple-Aspect Signalling 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 prewarned by the aspect of the previous signal or signals.

42. Night

Night means from sunset to sunrise.

43. Obstruction and its cognate expressions include a train, vehicle or obstacle on or fouling a line, or a stop signal at "on" or any condition which is dangerous to trains.

44. Overhead Equipment

Overhead Equipment 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.

45. Passenger Train

Passenger Train means a train intended solely or mainly for the carriage of passengers and other coaching traffic and includes a troop train.

46. 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.

47. Running Line

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.

48. Running Train

Running Train means a train which has started under an authority to proceed and has not completed its journey.

49. "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.

50. Special Instructions

Special Instructions means instructions issued from time to time by the authorized officer in respect to particular cases or special circumstances.

51. Station

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.

52. Station Limits

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.

53. Station Master

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 trains under the system of working in force.

54. "Station Section" means that section of station limits –

1. At a class 'B' station provided with two aspect signals, which is included: -
   a) on a double line, between the home signal and the last Stop signal of the station in either direction; or
   b) on a single line: -
      i. between the shunting limits boards or advanced starter (if any) or
      ii. between the home signals if there are no shunting Limit Boards or Advanced Starters, or
      iii. between the outermost facing points, if there are no home signals or Shunting Limit Boards or Advanced Starters.

2. At a class 'B' station provided with manually operated multiple-aspect or modified lower quadrant signals, which is included: -
   a) on a double line: -
      i. between the outermost facing points and the last Stop signal of the Station in either direction or
      ii. between the Block Section Limit Board, where provided and the last Stop signal of the station in either direction; or
   b) on a single line: -
      i. between the Shunting Limit Boards or Advanced Starters (if any), or
      ii. between the outermost facing points, if there are no Shunting Limit Boards or Advanced Starters.

55. Subsidiary Rule

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.

56. System of Working

System of Working means the system adopted for the time being for the working of trains on any portion of a railway.

57. Track Circuit

Track Circuit means an electrical circuit provided to detect the presence of a vehicle on a portion of track, the rails of the track forming part of the circuit.

58. Train

A train means an engine with or without vehicles attached, or any self-propelled vehicle with or without a trailer, which cannot be readily lifted off the track.

59. Train Examiner

Train Examiner means a railway servant duly qualified to examine trains and certify their fitness for safe running and includes any other railway servant who may for the time being perform the duties of a Train Examiner.

60. Two-Aspect Signalling

Two-Aspect Signalling means a signalling arrangement in which each signal displays at any one time either of the two aspects.

General Rules & Subsidiary Rules - The General Rules

apply to all Railways. The Subsidiary Rules are prefixed S. R.

Revision of Rules - The General Rules are issued and are liable to revision by the Government of India (Railway Board) and Subsidiary rules by the General Manager. Authority to issue SRs is vested with the Principal Chief Operations Manager alone. It is not delegated to any other officer. Revisions will be notified by Amendment slips.

Authority to issue Working Rules and Instructions.

a) The Principal Chief Operations Manager is authorized to issue working rules and instructions.
b) Powers to issue working rules and instructions is also delegated personally to Sr. Divisional Operations Managers/Divisional Operations Managers within their Divisions. No other Officer has authority to issue working rules and instructions except, when necessary, in an emergency and then only in the name of Sr. Divisional Operations Manager/Divisional Operations Manager.
c) All Working Rules and Instructions must be in conformity with the General and Subsidiary Rules and is equally binding on the staff.
d) Working Rules of stations must be sent to the Commissioner of Railway Safety for approval before they are brought into use if they involve any matter in which the General Rules require the issue of Approved Special Instructions.

Definition of Engines-

The following terms are used to designate engines according to the work on which they are employed: -

a) A train engine is an engine which hauls a running train beyond station limits.
b) An Advance Pilot is an engine which runs in advance of a train as a Safety Precaution.
c) An assisting engine is an extra engine attached to a train which is too heavy to be hauled by train engine alone.
d) A banking engine is an assisting engine used to help a train up to a heavy grade. It usually pushes the train.
e) A relief engine is an engine sent out in the place of another engine which has broken down, has been damaged or has been derailed. or to bring in vehicles which through some

accidents have been left outside station limits.

f) An attached engine is an engine other than a train, assisting, banking or relief engine, attached to train running outside station limits.

g) A light engine is an engine running outside station limits without vehicles attached.

h) A shunting engine or pilot is an engine specially provided for shunting trains/or vehicles.

Train Despatcher –

At certain large stations two Assistant Station Masters are on duty at a time. The Assistant Station Master entrusted with line clear working and the control of signals for the reception and dispatch of trains, in addition to any other duties that may be allotted to him, is designated 'Train Despatcher'. At stations at which Train Despatcher is provided the working rules must clearly specify their duties and responsibilities in respect of reception and dispatch of trains.

2.6 Classification of Stations: -

1. Stations shall, for the purpose of these rules, be divided into two categories - block stations and non-block stations.
2. Block stations are those at which the Loco Pilot must obtain an authority to proceed under the system of working to enter the block section with his train; and under the Absolute Block System consists of three classes.
   - **Class 'A' Stations -** where Line Clear may not be given for a train unless the line on which it is intended to receive the train is clear for at least 400 meters beyond the home signal, or up to the Starter.
   - **Class 'B' Stations -** where Line Clear may be given for a train before the line has been cleared for the reception of the train within the station section; and
   - **Class 'C' Stations -** block huts, where line clear may not be given for a train, unless the whole of the last preceding train has passed completely at least 400 meters beyond the home signal and is continuing its journey. This shall include an

Intermediate Block Post.

- **Non-block stations or Class 'D'** Stations are stopping places which are situated between two consecutive block stations, and do not form the boundary of any block section.

TRENDS AND ANALYSIS OF RAILWAY ACCIDENTS

3

The term 'accident' envelopes a wide spectrum of unusual occurrences with or without significant impact on the system. Consequential train accidents include mishaps with serious repercussion in terms of loss of human life or injury, damage to railway property or interruption to rail traffic of laid down threshold levels and values. These consequential train accidents include collisions, derailments, fire in trains, road vehicles colliding with trains at level crossings, and certain specified types of 'miscellaneous' train mishaps.

3.1 Causes of Consequential Train Accidents

Broad causes of consequential train accidents which keep occurring on Indian Railways are as under and same are maintained statistically:

1. Failure of Railway Staff
2. Failure of Persons other than Railway Staff
3. Failure of Equipments – Rolling Stock, Track, Electrical and Signal & Telecommunication (S&T)
4. Sabotage

5. Combination of factors
6. Incidental*
7. The cause of accident could not be established.

*The incidental causes include acts of nature like falling of boulders, sinkage of track due to heavy rain and cattle getting run over, etc.

The Railway Accidents which had happened since 1960-61 to 2022-23 are tabulated in tables no. 1. If we see the number of accidents since 1960-61 then we can say that Indian Railway Safety performance has improved commendably. The improvement is attributed to technological upgradation, monitoring and constant emphases on inspections at field and training and counselling.

Table 1: Train Accidents on Indian Railways Since 1960-61 to 2022-23

Year	Coll.	Derailment	Level Crossing	Fire in tr.	Misc.	Tot al	M.T.K.	Accidents P.M.T.K.
1960-61	130	1415	181	405		2131	388.1	5.50
1961-62	124	1433	160	236		1953	396.2	4.90
1962-63	98	1316	168	55		1637	408.3	4.00
1963-64	93	1300	161	81		1635	421.9	3.90
1964-65	81	1035	146	31		1293	433.2	3.00
1965-66	74	962	123	42		1201	450.8	2.70
1966-67	67	876	104	48		1097	451.7	2.40
1967-68	66	892	111	47		1111	455.3	2.40
1968-69	47	684	129	47		908	460.1	2.00
1969-70	54	751	111	12		963	473.0	2.00
1970-71	59	648	121	22		840	466.5	1.80
1971-72	57	667	118	25		864	474.4	1.80
1972-73	59	598	131	13		813	473.1	1.70
1973-74	66	578	125	23		782	432.8	1.80
1974-75	66	696	140	27		925	430.1	2.20
1975-76	64	768	105	16		964	487.4	2.00
1976-77	45	633	86	14		780	511.6	1.50
1977-78	54	705	93	12		966	521.6	1.60
1978-79	55	778	86	21		931	504.1	1.80
1979-80	72	692	115	29		900	503.4	1.80
1980-81	69	825	90	23		1013	504.5	2.00
1981-82	87	936	84	20		1130	516.6	2.20

Year	Coll.	Derailment	Level Crossing	Fire in tr.	Misc.	Tot al	M.T.K.	Accidents P.M.T.K.
1982-83	54	653	70	17		797	530.9	1.50
1983-84	47	621	82	30		768	541.7	1.40
1984-85	39	678	65	21		812	541.1	1.50
1985-86	46	588	62	13		717	570.4	1.30
1986-87	28	538	65	12		644	582.3	1.10
1987-88	40	490	62	3		604	590.2	1.02
1988-89	30	457	55	8		545	602.2	0.90
1989-90	34	456	42	9		540	681.0	0.87
1990-91	41	446	36	9		532	617.1	0.86
1991-92	30	444	47	9		530	629.2	0.84
1992-93	50	414	51	9		524	632.3	0.83
1993-94	50	401	66	3		520	634.2	0.82
1994-95	35	388	73	5		501	641.9	0.78
1995-96	29	296	68	5		398	655.9	0.61
1996-97	56	286	65	4		381	667.1	0.57
1997-98	35	289	66	6		396	675.8	0.58
1998-99	24	300	67	6		367	686.9	0.58
1999-00	20	329	93	21		463	717.7	0.65
2000-01	20	344	83	15	2	464	723.8	0.64
2001-02	30	279	88	9	8	414	756.4	0.55
2002-03	16	216	96	14	7	349	786.2	0.44
2003-04	9	197	95	14	5	320	790.8	0.41
2004-05	13	136	70	10	3	232	810.1	0.29
2005-06	9	130	75	15	4	233	825.4	0.28
2006-07	8	95	79	4	8	194	847.8	0.22
2007-08	**7**	100	77	5	4	193	793.89	0.24
2008-09	13	85	69	3	7	177	833.39	0.21
2009-10	9	80	70	2	4	165	887.79	0.18
2010-11	5	78	53	2	1	139	921.73	0.15
2011-12	9	55	61	4	2	131	969.05	0.13
2012-13	6	48	58	8	0	120	1008.09	0.11
2013-14	4	52	51	7	3	117	1051.64	0.11
2014-15	5	60	56	6	4	131	1095.26	0.11
2015-16	3	64	35	0	4	106	1101.51	0.09
2016-17	5	78	20	1	0	103	1106.15	0.09

Year	Coll.	Derailment	Level Crossing	Fire in tr.	Misc.	Total	M.T.K.	Accidents P.M.T.K.
2017-18	3	54	13	3	0	72	1159.55	0.06
2018-19	0	46	6	6	1	59	1221.48	0.05
2019-20	5	40	1	8	1	54	1208.41	0.05
2020-21	1	17	1	3	0	21	1230.94	0.01
2021-22	2	27	1	4	1	34	1415.87	0.03
2022-23	6	36	1	4	1	48	1,509.10	0.04
Total	**2463**	**29579**	**4982**	**1586**	**70**	**38752**	**44416.95**	**76.2**
Mean	**39.10**	**469.51**	**79.08**	**25.17**	**3.04**	**615.11**	**705.03**	**1.21**

The most important indices to judge a railway systems safety is accident per million track kilometers. In the year 1960-61, accident P.M.T.K was 5.50, which has now reduced to 0.04 in the year 2022-23, which is almost negligible, but all efforts be made to maintain it at the level of 0.01.

I have compiled the train accident data in 10-year wise period since 1960 and placed in table no. 2, 3, 4, 6, 7, and 8. This data is also clearly showing ever improving trend in reduction of train accident. Over the years, Indian Railways has had improved a lot technologically and managerially. A lot of input has been given by Government of India in term of money for safety improvement in railways.

Table 2: Train Accidents on Indian Railways Since 1960-61 to 1969-70

Year	Coll.	Derailment	Level Crossing	Fire in tr.	Misc.	Total	M.T.K.	Accidents P.M.T.K.
1960-61	130	1415	181	405		2131	388.1	5.50
1961-62	124	1433	160	236		1953	396.2	4.90
1962-63	98	1316	168	55		1637	408.3	4.00
1963-64	93	1300	161	81		1635	421.9	3.90
1964-65	81	1035	146	31		1293	433.2	3.00
1965-66	74	962	123	42		1201	450.8	2.70
1966-67	67	876	104	48		1097	451.7	2.40
1967-68	66	892	111	47		1111	455.3	2.40
1968-69	47	684	129	47		908	460.1	2.00
1969-70	54	751	111	12		963	473.0	2.00
Total	**834**	**10664**	**1394**	**1004**	**0**	**13929**	**4338.6**	**32.8**
Mean	**83.4**	**1066.4**	**139.4**	**100.4**	**0**	**1392.9**	**433.86**	**3.28**

Table 3: Train Accidents on Indian Railways Since 1970-71 to 1979-80

Year	Coll.	Derailment	Level Crossing	Fire in tr.	Misc.	Total	M.T.K.	Accidents P.M.T.K.
1970-71	59	648	121	22		840	466.5	1.80
1971-72	57	667	118	25		864	474.4	1.80
1972-73	59	598	131	13		813	473.1	1.70
1973-74	66	578	125	23		782	432.8	1.80
1974-75	66	696	140	27		925	430.1	2.20
1975-76	64	768	105	16		964	487.4	2.00
1976-77	45	633	86	14		780	511.6	1.50
1977-78	54	705	93	12		966	521.6	1.60
1978-79	55	778	86	21		931	504.1	1.80
1979-80	72	692	115	29		900	503.4	1.80
Total	**597**	**6763**	**1120**	**202**	**0**	**8765**	**4805**	**18**
Mean	**59.7**	**676.3**	**112**	**20.2**	**0**	**876.5**	**480.5**	**1.8**

Table 4: Train Accidents on Indian Railways Since 1980-81 to 1989-90

Year	Coll.	Derailment	Level Crossing	Fire in tr.	Misc.	Total	M.T.K.	Accidents P.M.T.K.
1980-81	69	825	90	23		1013	504.5	2.00
1981-82	87	936	84	20		1130	516.6	2.20
1982-83	54	653	70	17		797	530.9	1.50
1983-84	47	621	82	30		768	541.7	1.40
1984-85	39	678	65	21		812	541.1	1.50
1985-86	46	588	62	13		717	570.4	1.30
1986-87	28	538	65	12		644	582.3	1.10
1987-88	40	490	62	3		604	590.2	1.02
1988-89	30	457	55	8		545	602.2	0.90
1989-90	34	456	42	9		540	681.0	0.87
Total	**474**	**6242**	**677**	**156**	**0**	**7570**	**5660.9**	**13.79**
Mean	**47.4**	**624.2**	**67.7**	**15.6**	**0**	**757**	**566.09**	**1.379**

Table 5: Train Accidents on Indian Railways Since 1990-91 to 1999-2000

Year	Coll.	Derailment	Level Crossing	Fire in tr.	Misc.	Total	M.T.K.	Accidents P.M.T.K.
1990-91	41	446	36	9		532	617.1	0.86
1991-92	30	444	47	9		530	629.2	0.84
1992-93	50	414	51	9		524	632.3	0.83

1993-94	50	401	66	3		520	634.2	0.82
1994-95	35	388	73	5		501	641.9	0.78
1995-96	29	296	68	5		398	655.9	0.61
1996-97	56	286	65	4		381	667.1	0.57
1997-98	35	289	66	6		396	675.8	0.58
1998-99	24	300	67	6		367	686.9	0.58
1999-00	20	329	93	21		463	717.7	0.65
Total	**370**	**3593**	**632**	**77**	**0**	**4612**	**6558.1**	**7.12**
Mean	**37**	**359.3**	**63.2**	**7.7**	**0**	**461.2**	**655.81**	**0.712**

Table 6: Train Accidents on Indian Railways Since 2000-01 to 2009-10

Year	Coll.	Derailment	Level Crossing	Fire in trains	Misc.	Total	M.T.K.	Accidents P.M.T.K.
2000-01	20	344	83	15	2	464	723.8	0.64
2001-02	30	279	88	9	8	414	756.4	0.55
2002-03	16	216	96	14	7	349	786.2	0.44
2003-04	9	197	95	14	5	320	790.8	0.41
2004-05	13	136	70	10	3	232	810.1	0.29
2005-06	9	130	75	15	4	233	825.4	0.28
2006-07	8	95	79	4	8	194	847.8	0.22
2007-08	**7**	100	77	5	4	193	793.89	0.24
2008-09	13	85	69	3	7	177	833.39	0.21
2009-10	9	80	70	2	4	165	887.79	0.18
Total	**134**	**1662**	**802**	**91**	**52**	**2741**	**8055.57**	**3.46**
Mean	**13.4**	**166.2**	**80.2**	**9.1**	**5.2**	**274.1**	**805.557**	**0.346**

Table 7: Train Accidents on Indian Railways Since 2010-11 to 2019-20

Year	Coll.	Derailment	Level Crossing	Fire in tr.	Misc.	Total	M.T.K.	Accidents P.M.T.K.
2010-11	5	78	53	2	1	139	921.73	0.15
2011-12	9	55	61	4	2	131	969.05	0.13
2012-13	6	48	58	8	0	120	1008.09	0.11
2013-14	4	52	51	7	3	117	1051.64	0.11
2014-15	5	60	56	6	4	131	1095.26	0.11
2015-16	3	64	35	0	4	106	1101.51	0.09
2016-17	5	78	20	1	0	103	1106.15	0.09

2017-18	3	54	13	3	0	72	1159.55	0.06
2018-19	0	46	6	6	1	59	1221.48	0.05
2019-20	5	40	1	8	1	54	1208.41	0.05
Total	**45**	**575**	**354**	**45**	**16**	**1032**	**10842.87**	**0.95**
Mean	**4.5**	**57.5**	**35.4**	**4.5**	**1.6**	**103.2**	**1084.287**	**0.095**

Table 8: Train Accidents on Indian Railways Since 2020-21 to 2023-24

Year	Coll.	Derailment	Level Crossing	Fire in tr.	Misc.	Total	M.T.K.	Accidents P.M.T.K.
2020-21	1	17	1	3	0	21	1230.94	0.01
2021-22	2	27	1	4	1	34	1415.87	0.03
2022-23	6	36	1	4	1	48	1,509.10	0.04
Total	**9**	**80**	**3**	**11**	**2**	**103**	**4155.91**	**0.08**
Mean	**3.00**	**26.67**	**1.00**	**3.67**	**0.67**	**34.33**	**1385.30**	**0.03**

*Fire in train, **Million train kilometer, ***Accident per million train kilometers
Source: Indian Railway Year Books 2004-05, 2009-10, 2014-15, 2019-20, 2020-21, 2021-22, 2022-23.

If we analyze the data as in all tables from 1960-61 to 2022-23, it is well established that there are four major categories of accidents viz. derailment, level crossing accidents, collisions, and fire in trains. The rest were categorized under miscellaneous accidents. Out of the accidents occurred since 1960-61, the number of accidents is maintaining following trends:

Derailment > Level crossing accidents > Collisions > Fire in trains > Miscellaneous accidents

In the year 2020-21 there was complete suspension of all passengers carrying trains from 22nd March 2020 due to lockdown imposed because of COVID-19 pandemic. There was only partial resumption of some 230 pairs of trains from May-2020, but overall traffic was very low resulting in fewer accidents. The year 2021-22 was also affected by COVID-19 pandemic but unlike previous year there was no complete lockdown. Hence the railway services were not completely suspended. Therefore, the data of 2020-21 and 2021-22 should not be taken for serious study.

Table 9: Type and contribution of accidents (% of total accidents) in Indian Railway (2000-2023)

Year	Collisions	Derailments	Level Crossing accidents	Fire in trains	Misc.
2000-01	4.2	74.0	17.8	3.6	0.4
2001-02	7.2	67.5	21.2	2.2	1.9
2002-03	4.6	62.1	27.4	4.0	2.0
2003-04	2.8	62.2	29.2	4.3	1.5
2004-05	5.6	59.0	29.9	4.3	1.3
2005-06	3.8	56.0	32.1	6.4	1.7
2006-07	4.1	49.2	40.5	2.1	4.1
2007-08	4.1	51.5	39.7	2.6	2.1
2008-09	7.3	48.0	39.0	1.7	4.0
2009-10	5.5	48.5	42.4	1.2	2.4
2010-11	3.5	56.7	37.6	1.4	0.7
2011-12	6.9	42.0	46.6	3.1	1.5
2012-13	5.0	40.5	47.9	6.6	0.0
2013-14	3.2	42.1	46.8	5.6	2.4
2014-15	3.7	46.7	41.5	4.4	3.7
2015-16	2.8	60.7	32.7	0.0	3.7
2016-17	4.8	75	19.23	0.96	0
2017-18	4.1	73.97	17.8	4.1	0
2018-19	0	77.96	10.7	10.1	1.69
2019-20	9.09	72.72	1.81	14.54	1.81
2020-21	4.54	77.27	4.54	13.63	0
2021-22	5.71	77.14	2.9	11.42	2.85
2022-23	12.5	75	2.1	8.33	2.08
Total	**115.04**	**1395.76**	**631.38**	**116.58**	**41.83**
Mean	**5.00**	**60.69**	**27.45**	**5.07**	**1.82**

3.2 Derailments

The derailments are the most common and major contributing accident type in Indian Railways. The data revealed that 2317 derailments occurred in Indian Railways since 2000-01 to 2022-23 as table is given below.

Table 10: Contribution of Derailments in total accidents in % (2000-01 to 2022-23)

Year	Total Accidents	Derailments	Percentage
2000-01	464	344	74.14
2001-02	414	279	67.39
2002-03	349	216	61.89
2003-04	320	197	61.56
2004-05	232	136	58.62
2005-06	233	130	55.79
2006-07	194	95	48.97
2007-08	193	100	51.81
2008-09	177	85	48.02
2009-10	165	80	48.48
2010-11	139	78	56.12
2011-12	131	55	41.98
2012-13	120	48	40.00
2013-14	117	52	44.44
2014-15	131	60	45.80
2015-16	106	64	60.38
2016-17	103	78	75.73
2017-18	72	54	75.00
2018-19	59	46	77.97
2019-20	54	40	74.07
2020-21	21	17	80.95
2021-22	34	27	79.41
2022-23	48	36	75.00
Total	**3876**	**2317**	**1403.54**
Mean	**168.52**	**100.74**	**61.02**

If we see the trends of derailment since 2000-01 to 2022-23, in actual number the derailments have come down from 344 to 36, which means just 10% of 2000-01 but if we see the percentage of derailments in overall accidents it is showing the constant trend around 70-75% since 2015-16 but reduction in from 2001-02 to 2014-15. Probably, it may be due to reporting pattern and severity of the accident.

3.3 Level Crossing Accidents

The level crossing accidents in Indian Railway (both manned and unmanned crossing) has been presented in Table 10. The data revealed that it was the major accident type in Indian Railway after derailments. The average level crossing accidents occurred at a rate of 70 accidents per year (2000-2016). But now level crossing accidents have been reduced drastically due to manning of unmanned level crossing, regular construction of road under bridges and road over-bridges. There is a policy of Government of India for zero unmanned level crossings gates on Indian Railways.

Table 10: Contribution of Level Crossing in total accidents in % (2000-01 to 2022-23)

Year	Total Accidents	Level Crossing	Percentage
2000-01	464	83	17.89
2001-02	414	88	21.26
2002-03	349	96	27.51
2003-04	320	95	29.69
2004-05	232	70	30.17
2005-06	233	75	32.19
2006-07	194	79	40.72
2007-08	193	77	39.90
2008-09	177	69	38.98
2009-10	165	70	42.42
2010-11	139	53	38.13
2011-12	131	61	46.56
2012-13	120	58	48.33
2013-14	117	51	43.59
2014-15	131	56	42.75
2015-16	106	35	33.02
2016-17	103	20	19.42
2017-18	72	13	18.06
2018-19	59	6	10.17
2019-20	54	1	1.85
2020-21	21	1	4.76
2021-22	34	1	2.94

2022-23	48	1	2.08
Total	**3876**	**1159**	**632.39**
Mean	**168.52**	**50.39**	**27.50**

It is expected that after sometime the level crossing accident will come to zero due to ever construction of road-overbridges and road-underbridges.

3.4 Collisions

The collision is the third major accident type having huge potential to cause very severe impact on life and property in Indian Railways. Although the number of collisions has come down from 20, in the year of 2000-01 to 6 in 2022-23. We must eliminate the collision from Indian Railways as it impacts serious loss to the human life. The detail of number of collisions is given in following table no. 11.

Table 11: Contribution of Collisions in total accidents in % (2000-01 to 2022-23)

Year	Total Accidents	Collisions	Percentage
2000-01	464	20	4.31
2001-02	414	30	7.25
2002-03	349	16	4.58
2003-04	320	9	2.81
2004-05	232	13	5.60
2005-06	233	9	3.86
2006-07	194	8	4.12
2007-08	193	**7**	3.63
2008-09	177	13	7.34
2009-10	165	9	5.45
2010-11	139	5	3.60
2011-12	131	9	6.87
2012-13	120	6	5.00
2013-14	117	4	3.42
2014-15	131	5	3.82
2015-16	106	3	2.83
2016-17	103	5	4.85
2017-18	72	3	4.17
2018-19	59	0	0.00

2019-20	54	5	9.26
2020-21	21	1	4.76
2021-22	34	2	5.88
2022-23	48	6	12.50
Total	**3876**	**188**	**115.93**
Mean	**168.52**	**8.17**	**5.04**

In the case of collisions, it is not important to the number but severity of the accident as few collisions may not impact any loss of human life but even one collision of serious type may cause to hundreds of lives and several hundred injured. Collisions are basically Signal Passing at Danger; thus, it must be avoided at any cost.

3.5 Fire in trains

The fire in trains accidents is the least contributor to total railway accidents in Indian Railways. The incidence of fire has reduced over the year since 2000-01 but could not be eliminated completely.

Table 12: Contribution of Fire in total accidents in % (2000-01 to 2022-23)

Year	Total Accidents	Fire in trains	Percentage
2000-01	464	15	3.23
2001-02	414	9	2.17
2002-03	349	14	4.01
2003-04	320	14	4.38
2004-05	232	10	4.31
2005-06	233	15	6.44
2006-07	194	4	2.06
2007-08	193	5	2.59
2008-09	177	3	1.69
2009-10	165	2	1.21
2010-11	139	2	1.44
2011-12	131	4	3.05
2012-13	120	8	6.67
2013-14	117	7	5.98
2014-15	131	6	4.58
2015-16	106	0	0.00
2016-17	103	1	0.97

2017-18	72	3	4.17
2018-19	59	6	10.17
2019-20	54	8	14.81
2020-21	21	3	14.29
2021-22	34	4	11.76
2022-23	48	4	8.33
Total	**3876**	**147**	**118.33**
Mean	**168.52**	**6.39**	**5.14**

The incidence of fire may be less but their severity for loss of human life is quite high. Since last few years the number of fire cases in Mail-Express train were noticed and a point for worry. Although Indian Railways is installing fire alarm system in coaches, but the effectiveness of fire alarm is under question. The incidences of fire are difficult to investigate as there are multiple reasons for fire especially outside interference. The electric wiring system in coaches need to be done carefully to avoid short-circuiting.

3.6 The Casualties and victims of railway accidents since 2000-2001 to 2021-2022

The casualties and victim of railway accidents has been analyzed since 2000-01 to 2021-22 as under :

Table: 13- The % of Casualties and Compensation

Year	Killed	Injured	Total affected	Casualties per Million passengers carried	Compensation paid in lakh*
2000-01	55	281	336	0.01	886.12
2001-02	144	595	739	0.02	482.46
2002-03	157	658	815	0.03	505.40
2003-04	84	279	363	0.02	757.07
2004-05	35	86	121	0.01	513.63
2005-06	168	483	651	0.03	221.63
2006-07	38	227	265	0.01	500.89
2007-08	9	245	254	0.01	121.37
2008-09	52	257	309	0.01	218.94
2009-10	67	253	320	0.01	265.81
2010-11	235	358	593	0.08	585.79

2011-12	100	586	686	0.08	498.00
2012-13	61	248	309	0.04	319.63
2013-14	42	94	136	0.02	149.22
2014-15	118	324	442	0.05	127.48
2015-16	40	126	166	0.02	263.00
2016-17	195	346	541	0.07	303.00
2017-18	28	182	210	0.03	188.51
2018-19	16	90	106	0.04	641.15
2019-20	0	73	73	0.05	376.10
2020-21	0	0	0	0.03	104.38
2021-22	9	45	54	0.03	85.88
Total	**1653**	**5836**	**7489**	**0.7**	**8115.46**
Mean	**75**	**265**	**340**	**0.03**	**369**
SD (±)	**67.2**	**183.8**	**238.3**	**0.02**	**223.5**
# Excluding Konkan Railway					
*The compensation paid during a year relates to cases settled and not necessarily to the number of accidents/casualties during that year.					

Source: Indian Railway Year Books 2004-05, 2009-10, 2014-15, 2019-20, 2020-21, 2021-22 issued by Government of India

The casualties have been remained zero in 2020-21, and rest of the years, there had been casualties. Our mission in safety is to be zero casualties.

I have analysed the casualties of passenger in railway accidents in percentage term as under:

Table 14: Casualties and injuries in Indian railway accidents (2000-01 to 2021-22)

Year	Total Casualties			% of Casualties	
	Killed	**Injured**	**Total**	**Killed**	**Injured**
2000-01	55	281	336	16.37	83.63
2001-02	144	595	739	19.49	80.51
2002-03	157	658	815	19.26	80.74
2003-04	84	279	363	23.14	76.86
2004-05	35	86	121	28.93	71.07
2005-06	168	483	651	25.81	74.19
2006-07	38	227	265	14.34	85.66
2007-08	9	245	254	3.54	96.46
2008-09	52	257	309	16.83	83.17
2009-10	67	253	320	20.94	79.06
2010-11	235	358	593	39.63	60.37

2011-12	100	586	686	14.58	85.42
2012-13	61	248	309	19.74	80.26
2013-14	42	94	136	30.88	69.12
2014-15	118	324	442	26.70	73.30
2015-16	40	126	166	24.10	75.90
2016-17	195	346	541	36.04	63.96
2017-18	28	182	210	13.33	86.67
2018-19	16	90	106	15.09	84.91
2019-20	0	73	73	0.00	100.00
2020-21	0	0	0	0	0
2021-22	9	45	54	16.67	83.33
Total	**1653**	**5836**	**7489**	**425.41**	**1674.59**
Mean	**75.14**	**265.27**	**340.41**	**19.34**	**76.12**

Above show every fifth to sixth person affected by railway accident lost life. The ratio is very high and needs to be considered seriously while planning for management of disaster in Indian Railway. The trends pertaining to the casualties per accident and economic loss per accident in Indian Railway have been presented in Table 13 and Table 14, above respectively.

The data on casualties per accident revealed that, it ranged from 0.12 in 2000-01 to 1.67 persons per accident in 2010-11. On an average, 0.76 persons got killed per accident in Indian Railway in last 16 years (2000-2016). The trend clearly indicated that, the casualties per accident has increased from 2000-01 to 2015-16 which is a matter of great concern for Indian Railway. It indicates that the severity of the railway accidents is increasing.

3.7 Economic loss associated with railway accidents (in lakhs)

The data pertaining to the economic loss due to accidents in Indian Railways in terms of rolling stock loss, permanent way loss and compensation paid to victims has been presented in Table 15.

In last 24 years Indian Railway faced a total loss of Rs. 234067 lakhs due to accidents. Thus, Indian Railway lost Rs. 4561 lakhs per year due to accidents. The total loss to Indian Railway due to accidents ranged between Rs.3235 cr. (2004-05) and Rs.9493 cr. (2011-12). Out of total loss of Rs. 234067 cr. during 2000-2023, Indian

Railway paid Rs.2365 lakhs towards the compensation to the incident victims and rest Rs. 115851 cr. faced for permanent plus rolling stock. The Indian Railway faced a total loss of Rs.61620 cr. during the 16 year under study as loss due to rolling stock. The rolling stock loss was found highest in the year 2011-12 (Rs.8210 cr.) followed by 201415 (Rs.6313 cr.). The lowest loss in rolling stock was observed in 2013-14 in which railway faced a loss of Rs.2003 cr. (Table 15).

Similarly, the Indian Railway lost Rs.18453 cr. as loss in permanent way due to accidents during the period under study. The permanent loss to Indian Railway averaged as Rs.1153 cr. per year in last 16 years. The highest permanent way loss of Rs.1831 cr. was recorded in 2000-01 followed by Rs.1799 cr. in 2013-14, whereas the least loss in permanent way of Rs.497 cr. burdened Indian Railway in 2004-05. Indian Railway paid Rs.6412 cr. towards compensation to incident victims in last 16 years under study which averaged Rs.401 cr. per year. The compensation paid by Indian Railway to accident victims ranged from Rs.121 cr. (2007-08) to Rs. 886 cr. (2000-01) during 2000-2016. Thus, a huge amount of Rs. 234067 lakhs were lost by Indian Railway due to accidents till 2023.

Table: 15- Economic loss associated with railway accidents (in lakhs)

Year	Rolling stock	Permanent Way	Total	Compensation paid	Grand total
2000-01	3693	1831	5524	n/a	11048
2001-02	3235	1647	4882	n/a	9764
2002-03	3158	617	3775	n/a	7550
2003-04	4029	816	4845	n/a	9690
2004-05	1516	303	1819	n/a	3638
2005-06	3248	835	4083	n/a	8166
2006-07	2321	871	3192	n/a	6384
2007-08	2970	1085	4055	n/a	8110
2008-09	5011	1052	6063	n/a	12126
2009-10	4126	1244	5370	n/a	10740
2010-11	4584	1311	5895	n/a	11790
2011-12	8210	717	8927	n/a	17854
2012-13	4142	1281	5423	n/a	10846

2013-14	2003	1798	3801	149	7751
2014-15	6313	894	7207	127	14541
2015-16	5089	834	5923	263	12109
2016-17	5457	7230	12687	303	25677
2017-18	2243	702	2945	189	6079
2018-19	2219	833	3052	641	6745
2019-20	3232	566	3798	376	7972
2020-21	1765	477	2242	104	4588
2021-22	3915	472	4387	86	8860
2022-23	5,570	386	5956	127	12039
Total	88049	27802	115851	2365	234067
Mean	3828	1209	5037	103	10177
SD (±)	1580	1349	2276	162	4561

Values in crore INR

Source: Indian Railway Year Books 2004-05, 2009-10, 2014-15, 2019-20, 2020-21, 2021-22, 2022-23 issued by Government of India.

3.8 Analysis on cause of Accidents (2000-2001 to 2016-17)

A study of the Railway Accident from 2000-2001 to 2016-17 (16-years) showed that out of total 3588 accidents, 2097 accidents were derailments which is about fifty-eight percent of total (Table 10).

The level crossing accidents contributed thirty-two percent to the total accidents that occurred during 2000-2016 in Indian Railway. The level crossing accidents included both manned and unmanned crossing. Thus, derailment and level crossing accidents together contributed ninety percent of total rail accidents in India.

The collision in Indian Railways, also the frequent occurring accident type ranged from 3-30 collisions year wise during 2000-2016 with an average of 10 collisions per year. The collision contributed five percent to the total train accidents. The trend analysis of total railway accidents, derailments, level crossing accidents and collisions over the 16-year period (2000-2016) revealed the fact that the year wise total accidents as well as accident type viz. derailments, level crossing accidents and collisions decreased over the years (Table 16). It indicates the adaptation of preventive measures by Indian Railways. The Indian Railway adopted measures like technological advancements, training to staff, periodic maintenance, safety audit, disaster prevention etc. in management of disasters.

Table 16: Detail of causes and their contribution to railway accidents in India in percentage (2000-2001 to 2016-17)

Year	Human error	Failure of equipments	Sabotage	Other	Unidentified/under investigation
2000-01	85.0	7.0	4.0	3.2	0.8
2001-02	84.6	5.8	3.4	4.8	1.4
2002-03	86.6	5.1	2.8	4.8	0.6
2003-04	82.5	5.5	5.5	5.8	0.6
2004-05	84.2	6.0	1.7	7.3	0.9
2005-06	88.0	3.4	2.1	4.7	1.7
2006-07	86.7	4.6	4.1	4.1	0.5
2007-08	80.4	4.6	8.8	4.1	2.1
2008-09	84.7	0.0	7.3	4.5	3.4
2009-10	83.6	3.6	8.5	3.0	1.2
2010-11	80.1	3.5	11.3	5.0	0.0
2011-12	87.8	3.8	4.6	3.1	0.8
2012-13	86.0	5.0	2.5	5.8	0.8
2013-14	89.7	2.6	3.4	3.4	0.9
2014-15	87.4	3.0	2.2	5.9	1.5
2015-16	86.9	1.9	0.9	9.3	0.9
2016-17	83.4	1.9	1.9	8.9	3.9
Total	**1447.6**	**67.3**	**75**	**87.7**	**22**
Mean	**85.15**	**3.96**	**4.41**	**5.16**	**1.29**

The 17-year (2000-2017) study of railway accidents revealed three major causes of railway accidents in India viz. human error, failure of equipment and sabotage (Table 16). Out of 3588 railway accidents which occurred during 2000-2016, the causes of 3549 accidents were identified whereas cause of 39 accidents is either not identified or these are still under investigation. The data revealed the fact that, eighty-five percent accidents were caused due to human error (Table 16).

The number may increase as one percent accidents are still under unidentified/under investigation. Failure of equipment or mechanical reason contributed for five percent of total accidents occurred in Indian Railways. Sabotage was again the important cause of railway accidents which contributed four percent of total railway incidents. The rest five percent railway

accidents occurred due to other reasons like natural and other factors.

The huge contribution of human error in the railway accidents showed the lack of management, training, coordination etc. among the railway staff and Indian Railway. Aguirre et al. (2013) reported similar findings.

The year wise decrease in all the causes and accidents (Table 1-10) showed the necessary actions taken by Indian Railways to tackle with these cheap causes of accidents. In order to reduce the human induced accidents, Indian Railway initiated and adapted and focused on mechanization and computerization, automatic signalling system, adaptation of newer technologies, training to the staff and recruitment of adequate staff.

The causes and their contribution to rail accidents have been more or less similar worldwide.

Okoh and Haugen (2013) stated that lack of maintenance was the causative factor for occurrence of fatal accidents. Baysari et al. (2008) identified that half the incidents resulted from an equipment failure, most of these being the product of inadequate maintenance or monitoring programs. The rest fifty percent were direct human errors like slips of attention (that is, skilled-based errors) and decreased alertness in railway of Australia.

Zhan et al. (2017) also reported that human factor has been the prime cause to railway accidents and suggested Human Factors Analysis and Classification System-Railway Accidents (HFACS-RAs) framework for identification and classification of human and organizational factors involved in railway accidents.

The Indonesian railway accidents analysed using Human Factors Analysis and Classification System (HFACS) indicated 72 factors that were closely related to the accidents.

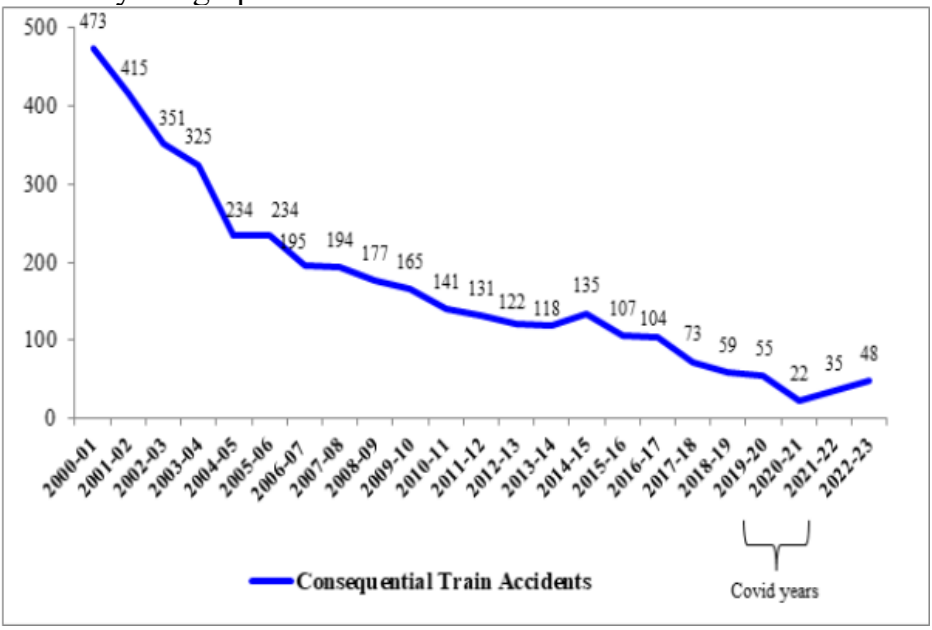
Of these, roughly twenty-two percent were considered as operator acts while about thirty-nine

percent were related to preconditions for operator acts. Supervisory represented fourteen percent of the factors, and the remaining (about 25%) was associated with organizational factors (Iridiastadi and Ikatrinasari 2012). Besides HFACS, an Intuitionistic Trapezoidal Fuzzy Numbers (ITFNs) method also suggested for railway accident analysis to decrease the occurrence possibilities of similar accidents (Liu et al. 2015). Santos-Reyes et al. (2005) also suggested an analytical model for railway accident analysis based on past accidents that occurred in British Railway. The model was generalized and applicable irrespective of country. Giles (2011) emphasized need and implementation of legislation for prevention of railway accidents.

In last 16 years (2000-2016), 1405 people lost their life in railway accidents and 5100 people got injured affecting total 6505 people in the country (Table 13). Among the total people affected by railway accidents, 21.60 percent lost their life while 78.40 percent got injured.

3.9 Consequential Train Accidents have Declined since 2000-01

Consequential train accidents have declined over the years, as shown by the graph below:-



The average number of consequential train accidents during the period, 2004-14 was 171 per annum, while the average number of consequential train accidents during the period, 2014-23 has declined to 71 per annum.

3.10 The steps taken by government to prevent train accidents

The following steps have been taken by the Government to enhance safety and to prevent train accidents:

1. **Rashtriya Rail Sanraksha Kosh (RRSK)**
   Rashtriya Rail Sanraksha Kosh (RRSK) has been introduced in 2017-18 for replacement/renewal/upgradation of critical safety assets, with a corpus of Rs. 1 lakh crore for five years. From 2017-18 till 2021-22, Gross expenditure of Rs. 1.08 lakh crore was incurred on RRSK works. In 2022-23, the Govt. extended the currency of RRSK for another period of five years with

Gross Budgetary Support (GBS) of Rs. 45,000 crores.

2. **Electrical/Electronic Interlocking Systems**
   Electrical/Electronic Interlocking Systems with centralized operation of points and signals have been provided at 6521 stations up-to 31.12.2023 to eliminate accident due to human failure.
3. **Interlocking of Level Crossing (LC) Gates**
   Interlocking of Level Crossing (LC) Gates has been provided at 11143 level Crossing Gates up to 31.12.2023 for enhancing safety at LC gates.
4. **Complete Track Circuiting**
   Complete Track Circuiting of stations to enhance safety for verification of track occupancy by electrical means has been provided at 6558 stations up-to 31.12.2023.
5. **Safety of Signalling**
   Detailed instructions on issues related with safety of Signalling e.g. mandatory correspondence check, alteration work protocol, preparation of completion drawing, etc. have been issued.
6. **System of disconnection and reconnection**
   System of disconnection and reconnection for S&T equipment as per protocol has been re-emphasized.
7. **Vigilance Control Devices (VCD)**
   All locomotives are equipped with Vigilance Control Devices (VCD) to ensure alertness of Loco Pilots.
8. **Retro-reflective sigma boards**
   Retro-reflective sigma boards are provided on the mast which is located two OHE masts prior to the signals in electrified territories to warn the crew about the signal ahead when visibility is low due to foggy weather.
9. **GPS based Fog Safety Device (FSD)**
   A GPS based Fog Safety Device (FSD) is provided to loco pilots in fog affected areas which enables loco pilots to know the distance of the approaching landmarks like signals, level crossing gates etc.
10. **Modern track structure**
    Modern track structure consisting of 60kg, 90 Ultimate Tensile

Strength (UTS) rails, Prestressed Concrete Sleeper (PSC) Normal/Wide base sleepers with elastic fastening, fan shaped layout turnout on PSC sleepers, Steel Channel/H-beam Sleepers on girder bridges is used while carrying out primary track renewals.

11. Mechanisation of track laying activity

Mechanisation of track laying activity through use of track machines like PQRS, TRT, T-28 etc to reduce human errors.

12. Long Rail Panels

Maximizing supply of 130m/260m long rail panels for increasing progress of rail renewal and avoiding welding of joints, thereby ensuring safety.

13. Laying of longer rails

Laying of longer rails, minimizing the use of Alumino Thermic Welding and adoption of better welding technology for rails i.e. Flash Butt Welding.

14. Oscillation Monitoring System

Monitoring of track geometry by OMS (Oscillation Monitoring System) and TRC (Track Recording Cars).

15. Patrolling of railway tracks to look out for weld/rail fractures.
16. The use of Thick Web Switches and Weldable CMS Crossing in turnout renewal works.
17. Inspections at regular intervals are carried out to monitor and educate staff for observance of safe practices.
18. Web based online monitoring system of track assets viz. Track database and decision support system has been adopted to decide rationalized maintenance requirement and optimize inputs.
19. Detailed instructions on issues related with safety of Track e.g. integrated block, corridor block, worksite safety, monsoon precautions etc. have been issued.
20. Preventive maintenance of railway assets (Coaches & Wagons) is undertaken to ensure safe train operations and to keep a check on Rail Accidents across the country.
21. Replacement of conventional ICF design coaches with LHB design coaches is being done.

22. All unmanned level crossings (UMLCs) on Broad Gauge (BG) route have been eliminated by January 2019.
23. Safety of Railway Bridges is ensured through regular inspection of Bridges. The requirement of repair/rehabilitation of Bridges is taken up based upon the conditions assessed during these inspections.
24. Indian Railways has displayed Statutory "Fire Notices" for widespread passenger information in all coaches. Fire posters are provided in every coach so as to inform and alert passengers regarding various Do's and Don'ts to prevent fire. These include messages regarding not carrying any inflammable material, explosives, prohibition of smoking inside the coaches, penalties etc.
25. Production Units are providing Fire detection and suppression system in newly manufactured Power Cars and Pantry Cars, Fire and Smoke detection system in newly manufactured coaches. Progressive fitment of the same in existing coaches is also underway by Zonal Railways in a phased manner.
26. Regular counselling and training of staff is undertaken.
27. Concept of Rolling Block introduced in Indian Railways (Open Lines) General Rules vide Gazette notification dated 30.11.2023, wherein work of maintenance/repair/replacement is planned up to 52 weeks in advance on rolling basis and executed as per plan.

Posted On: 02 FEB 2024 4:57PM by PIB Delhi, **YB/AS/PS** (Release ID: 2001905)

THE PHILOSOPHY OF RAILWAY SAFETY AND PREVENTIVE MECHANISM

4

Generally, the Philosophy interprets facts and findings, it searches for common principles lying at the root of facts, it finds generality of totality, it does not need experience or experiment, its approach is intellectual and logical, it may include theories of opposite opinions viz. reality and ideology, spiritualism and materialism, theistic and atheistic, free behaviour, and morality etc. The Science is based on experience, observation, experiment and examinations, its rules are universal, unaltered, and unchangeable. It has no two opposite statements or opinions, and it does not recognize religion. Therefore, the subject need to be in greater introspection requires to think about the subject, which has paramount importance to human living. The safety of human being or safety of environment or safety in activity of human working have greater impact then only to be left to the concerned people. Safety encompasses most of the related subjects to find the truth.

The idea of safety depends on both scientific perspectives and philosophical speculative thinking of mind of interpretation of facts and reality and human being.

4.1 Understanding philosophy of safety

The need of safety is continuous. The objectives of philosophy of safety are to protect humans from adverse effects of safety violations, suggest and apply the safe ways of behaviour, human action, the safe working conditions and the safe environment. This necessitates highest importance given to the subject of safety.

Safety is directly connected with science, technology, engineering, health, hygiene, psychology, and management. The philosophy of safety tries to search and coordinate the common causes and remedial measures for general as well as specific safety problems.

The philosophy of safety begins with the basic need or requirement of safety, its fundamentals, causation analysis and assessment, methods of detection of unsafe condition, unsafe action, reason, and sequence of accident occurrence. It searches for the principles and methods of accident prevention and its control. This includes safety devices, fittings, techniques and measures, factors impeding and enhancing safety, safety responsibility and roles of various agencies, scope of terminology, theories and mysteries of accident causation, prevention, and control.

The philosophy of safety also considers the study for physical, physiological, psychological, and other factors affecting humans and strengthening safety. It studies costs and types of accidents and their significance, type of safety management necessary. This includes the ways and means of providing and maintaining safe working conditions, human actions affecting health and safety of people and the safety of environment. The philosophy of safety touches the origin, development and amendment of safety law and its innovation and all safety needs in the areas of industrial safety and environmental safety.

The area and its scope are very wide to include the entire subjects of safety from origin to the research, the latest development and from causation and behavioural analysis. The scope also includes the modern concept of design, testing, reliability, hazard control

technology, risk analysis, assessment and audit, emergency planning, public awareness and involvement programmes and all future developments.

4.2 What is an Accident?

An accident is defined as an unexpected, unintended event or mishap. It is also an unplanned event that interrupts the completion of an activity or process, and it may or may not cause damage to person, property, or environment. An accident can be the occurrence in a sequence of events, which produces unwanted and unintended injury, death, or property damage. An accident is an uncontrolled event where the action or reaction of an object, substance, person, results in personal injury or increases its probability.

An accident interrupts or interferes the orderly progress of the activity which causes or likely to cause injury with or without damage to property or environment. An accident may occur due to carelessness, casualness or any fault known or unknown and may cause injury.

Here, the main objective of discussion on philosophy of safety is to avert the railway accident and ensure that there is no functional injury or damage to body, limbs or health or mental disorder occurring during the travel of a passenger and must not result in death or total or partial, permanent, or temporary disability to work.

4.3 Accident Prevention

Accident prevention is a science and art. It represents the control and monitoring performance of human, machine, and physical environment. To control unsafe human actions, knowledge of psychology, and management is necessary. To control unsafe conditions, knowledge of engineering, health effects, industrial hygiene, ergonomics etc. is necessary.

Accident prevention requires fact-finding, analysis of the facts found, selection and application of remedial actions. The safety implementation and monitoring process includes measurement of

result, comparing with legal criteria or standard, feedback and further improvement if necessary.

4.4 The Philosophy of Accident

The unsafe act is main factor of more than 90% of accidents. It is also presumed that unsafe act is a major cause of unsafe condition. So, continuous safety training is must for workers to adopt safe work practices.

As per the psychologists, majority of accidents occur due to human behaviour in form of unsafe act only.

The research on the real causes of accidents derived that the real cause of accident is an unsafe condition, which must be removed in such a way so that human error or mistake may not turn into accident. The interlock or automatic guards, trips, and alarms, checks and counter checks, auto-stop, auto control and auto-correction etc. prevent the accident as they help to overcome human error.

The accident may be caused by personnel error, malfunctions and failures of equipment, dangerous characteristic of equipment or adverse environmental conditions. There may be personnel error by designers, testing and monitoring person and maintenance men, workers or anyone connected with the activity or process. To minimize accidents, it is necessary to eliminate or control any of the hazards involved at each stage of design, manufacturing, testing, maintenance, and operation.

The unsafe condition and unsafe action, exist and play their role in accident occurrence. The working environment condition needs to be thoroughly examined in depth to detect root cause of human failure. Unsafe condition has more accident potential and can lead to a serious accident which can be detected by safety inspections or safety audits which can be eliminated by proper engineering controls.

The study on behavioural or psychological of workers, established that unsafe action should be corrected before it may cause any

unsafe condition, hazard or accident. The study also establishes that structured safety training of the workers is must to minimize man-made hazards or unsafe conditions.

4.5 Few positive approaches to safety

1. Keep safe and clean workplace and working conditions.
2. Consider in design safe and ergonomic application to reduce health hazards.
3. Teach safe work method, monitor job performance and best practices.
4. Carry our risk assessment, take precautions required and provide eco-friendly process technology and hazard control technology.
5. Take preventive and corrective actions to control any unsafe situation and environment including exposure to hazards and maintain all control measures.
6. Improve on methods of manpower selection, training, placement, and supervision.
7. Carry out periodical medical health check-up and follow-up of medical advice for workers.
8. Conduct periodical psychological study of human behaviour for safety and conduct behaviour-based safety training.
9. Create safety awareness, have preparedness, and arrange safety programs

It concluded and well accepted fact that majority of accidents happen with contract or outsource workers as they are illiterate, untrained, unskilled, less equipped, and poorly supervised hence more attention to be given to train them.

In conclusion, the unsafe act or unsafe condition are the causes and are equally important and to eliminate them self-motivated sincere efforts are required. The safety management system calls for adequate investment for man, machine, material, manufacturing

process. The best safety practices and better working conditions contribute less error and less hazards for which safety training is utmost necessary at all levels.

Safety Philosophy is a study of reality and of its forms. It analyses and examines the fundamental reasons of safety compromises. It coordinates the scientific results with moral experience of man. It visualises or assesses the knowledge, its root, measure, and limitations. The philosophy of safety is considered the foundation of safety culture structure.

*****

With an experience of 37 years in railways, especially working in safety department of Indian Railways as DSO (Branch Officer) in Jhansi division, Principal/Zonal Training Centre, Bhusawal for 4 years. Later Sr. DOM and Sr. DSO at Mumbai/Central Railway, ADRM in Mumbai/Central Railway and DRM/Salem. My whole experience says that Accidents Are Preventable and There Is Possibility to Run Rail Operation with Zero Accidents and I Have Achieved in My Period as Divisional Railway Manager (DRM)/Salem and also as Principal Chief Operation Manager (PCOM), South-Western Railway (SWR)**.** To give a detailed philosophy of safety and how to ensure safety, I would like to share it with my colleagues, junior officers, and staff. It is not intended for just casual reading but deep insight and initiating thought process.

To understand safety, we must be aware about the background of safety in industrial and railway working. With the advent of industrial revolution in Great Britain, the idea of safety in working environment and personal safety of the workers had taken prime importance way back in the beginning of 19th Century, a safety saying was in wide circulation in those days, which read as **“Do not think because an accident has not happened to you that it can’t**

happen" further another saying of same era read as **"Carefulness costs you nothing. Carelessness may cost you your life".**

Aeschylus said that **"Obedience is the mother of success and is wedded to safety."** It further added by the quote that **"For safety is not a gadget but a state of mind."** by Eleanor Everet. Working with safety is not expensive but it is priceless and only action required for the safe working is to **"Prepare and prevent, don't repair and repent."** Jerry Smith quote that **"Safety doesn't happen by accident."** The management and leadership take the lead to ensure safe working practices, especially the railway operation.

The famous quote on safety **"Luck runs out, but safety is good for life."** is always true that safety can certainly be achieved by meticulous planning, hard work, better training and counselling by supervisors and officers.

Before we go into the philosophy of safety, we must understand the literal meaning of safety as such. Safety is defined as under:

> **"The condition of being protected from or unlikely to cause danger, risk, or injury.**
>
> - Oxford Dictionary**".**
>
> **"The condition of being safe from undergoing or causing hurt, injury, or loss".**
>
> - Merriam & Webster
>
> **"Safety is the state of being safe from harm or danger".**
>
> **-** Collins's dictionary

With the above meaning of safety, **safety is the state where we are safe from any danger, risk, injury, and monetary losses.**

The employees are the most valuable resources of any business organization, keeping them safe is the responsibility of the management. Any business or production line can't be more important than the personal safety of its workers. It is a fact that all

accidents can be prevented. Safety is an integral part of everyone's job. The customers, employees, supervisors, and managers are responsible for ensuring safety on the floor as well as whereas production and services are produced. It is the right of the employee and labourers to have a safe environment for their work and it is legislated by several state and central governance acts.

The core safety beliefs are centered around a safer work environment as well as ensuring safety for the customers. It is the value integrated with the product and service to be provided by any business organization. The core safety values are as under:

1. **All accidents are preventable.**
2. **All injuries and deaths are preventable. Incidents can be managed.**
3. **Working safely is a condition of employment and employee has the right to ask for it. No job is worth getting hurt for.**
4. **All operating and managerial exposures can be safeguarded. Safety is everyone's responsibility.**
5. **Learning, Training, and counselling of the employees to work safely is essential and Continuous process.**
6. **Injury/Illness prevention has a direct impact on employee Moral, productivity, company earnings and customer satisfaction.**
7. **Recognizing safe behaviours fosters better understanding of our policies, philosophy, and practices.**
8. **Safety as a "way of life" for 24 hours/day.**
9. **All individuals have the responsibility and accountability to identify eliminate or**

manage risks associated with their workplace.

The above core safety values are universal and lay the foundation of philosophy of safety. If we go by human psyche, the fulfilment of safety comes through mindfulness. The person who devotes his all action to the present moment then safety can be ensured. It is often seen that the person who falls victim to an accident or incident is either in the past moment or thinking ahead of the movement. Safety is not an activity in itself, but an attitude of the person that whatsoever he or she performed will be safe for humankind.

Some Safety Quote

"Safety brings first aid to the uninjured."

– F.S. Hughes

"You don't need to know the whole alphabet of Safety. The A, B, C of it will save you if you follow it: Always Be Careful."

– Colorado School of Mines Magazine

"Safety isn't expensive, it's priceless."

– Anon.

"If you don't think it is safe, it probably isn't"

– Jerry Smith

"Working safely may get old, but so do those who practice it."

– Anon.

"Safety is something that happens between your ears, not something you hold in your hands."

– Jeff Cooper

"The danger which is least expected soonest comes to us."

– Voltaire, – Jerry Smith

"Work injuries and illnesses can affect every aspect of life for workers and their families."

– Maine Department of Labor

"You are your last line of defense in safety. It boils down to you."

– Kina Repp

"It takes leadership to improve safety."

– Jackie Stewart

"Your employees learn by example. If they don't see you practicing good safety habits, they won't think safety is important."

– Electrical Construction & Maintenance

"One earnest worker can do more by personal suggestion to prevent accidents than a carload of safety signs."

– Making Paper, – Aeschylus

"Work safely today. Remember, somebody expects you home tonight".

– Anon.

"Teaching the world to be careful is a constructive service worthy of God's great gift of life to man."

– Harold H. Burton, **U.S. Supreme Court Justice (1946)**

"Someone is sitting in the shade today because someone planted a tree a long time ago."

– Warren Buffett,

"Safety applies with equal force to the individual, to the family, to the employer, to the state, the nation and to international affairs. Safety, in its widest sense, concerns the happiness, contentment and freedom of mankind."

– William M. Jeffers

"The danger which is least expected soonest comes to us."

– Voltaire, French dramatist, poet and reformer born in 1694

"At the end of the day, the goals are simple: Safety and security."

– Jodi Rell, former Governor of Connecticut

"Nothing is of greater importance than the conservation of human life."

– Calvin Coolidge, Former U.S. President

"It is my sincere wish and hope that the day will come when the protecting arms of Universal Safety will spread-out over-all industry and reach all the millions of workers who make industry possible."

– Charles M. Schwab, steel magnate born in 1862

"We must never forget that the highest appreciation is not to utter words, but to live by them."

– **John F. Kennedy**, Former U.S. President

"They were willing to work all the time; and when people did their best, ought they not to be able to keep alive?"

– Upton Sinclair, The Jungle

"Safety work is today recognized as an economic necessity. It is the study of the right way to do things."

– **Robert W. Campbell,** first president of the National Safety Council

INTRODUCTION, CLASSIFICATION AND REPORTING OF RAILWAY ACCIDENTS

5

Indian Railways is one of the largest railway systems in the world and is fully owned and operated by Ministry of Railways, Government of India. It plays a significant role in driving economic growth of the country, offering highly affordable, environment-friendly transportation to passengers and freight, especially bulk commodities, across the country. Indian Railways, like any other transportation system, is technology intensive not only for ensuring high productivity of its assets but also safety in train operations.

Indian Railway (IR) is a vast system comprising of nearly 65,000 route kilometers with over 7,500 block stations and holding nearly 13,000 locomotives, 63,000 passenger coaches, 12000 electrical and diesel multiple units and 3,20,000 thousand wagons. Further the Indian Railway (IR) system has 12.13 lakh strong work force, handles 25 million passengers and 1518 million tonnes of freight, and earns Rs.1,91,000 crores on yearly basis which makes the Indian Railway network one of the busiest railway networks in the world, handling massive numbers of passengers and quantities of

goods daily. (Source: Railway Yearbook 2021-22)

The IR has long served as the backbone of this nation's economy by being the most popular means of long-distance transportation in India. Besides the huge network, heavy traffic, over-saturation of rail tracks, extreme weather conditions and many more challenges; IR is committed to safe journey to avoid loss of life and property through continuous modernization and strengthening the infrastructure, adopting latest technologies, engagement of experienced and trained manpower, periodic maintenance and checkups, safety audits etc.

Indian railway also has its own disaster management plan to manage the railway accidents in all the phases viz. pre, during and after the disaster. But the safety on the railways is the end product of the coordination among all the factors. A single flaw in the complex network of track that crisscross the country, a defect in over several hundred locos, coaches and lakh of wagons that haul about millions of passengers and nearly several million tonnes of freight every day, an incorrect indication on one of the thousands of signals that dot the rail landscape, a mistake or an act of negligence by one of its staff directly associated with train running, even a rash act by one of the millions of road users who daily negotiate around odd level crossing gates spread across the system, an irresponsible act of carrying inflammable goods, any one of these multiple possibilities has the potential to cause a major tragedy. Added to these are the acts of sabotage by misguided elements spanning the whole country.

> The consequential train accidents include mishaps with serious repercussion in terms of loss of human life or injury, damage to railway property or interruption to rail traffic in excess of laid down threshold levels and values which include collisions, derailments, fire in trains, road vehicles colliding with trains at level crossings, and miscellaneous train mishaps.

The train accidents trends, fatalities, causes and management has been continuously studied worldwide and also in Indian Railways and it is established that "human error induced factors being the major contributor for railway accidents."

Railway is one of the safest and most convenient modes of transportation, but occasional occurrence of Railway accidents causes worry and shake the confidence of the common travelling person. If the Railway accidents are controlled, it may boost the economy of the country and greater satisfaction among public.

The Accidents happens when there is a breach of the Rules or there is laxity in the maintenance of track or rolling stock or the Signals or due to the wrongdoing by the Railway staff or may be due to the outside interference. The accidents and untoward incidences on the Railways system are not only affecting the normal operation but, the loss to the human life and loss to the Railway asset which dents the image of the Railway.

An accident or an incident is not only the cause of concern for the safety of the travelling people, but it also leads to the great loss to the railways by way of condemnation of Railway assets, such as Railway Locomotives, Rolling Stock, track and, bridges. In addition to this a large amount of compensation is also to be paid to the passengers. Therefore, it is the duty of each and every Railway official to work for preventing the Accidents by all means.

5.1 Accident Manual

It is mandated that every Zonal Railway must maintain and implement a set of instructions in detail including actions to be taken after an accident compiled in a book form. This book is called the **Accident Manual**.

The accident manual is the principal document, which is required to be followed by every Railway official in zone. Beside Accident manual, every zonal Railway must compile a disaster management plan also.

In the year 2000, the Railway Board has issued a circular for Definition and Re-classification of Accidents on Indian Railways vide letter no. 2000/Safety(A&R)/19/20, New Delhi dt. 13.12.2000 addressed to The General Manager (Safety)/OSDs, All Indian Railways Including Metro Railway, Konkan Railway Corporation and Railway Electrification. The letter has been approved by CRB (Railway Board) and signed by Shri Indra Ghosh, Executive Director/Safety, Railway Board. The letter mentioned following:

(a) Follow up action on DAR cases should cover all accidents and not only those which are reportable to the Railway Board/Hqrts as per revised guidelines.
(b) emphasis on relaying the prima-facie cause within 24 hours should be relevant to all type of accidents.
(c) monitoring of adequacy of punishment should be for all type of accidents.
(d) emphasis by the Divisional/Zonal offices in following the laid down schedules of accident inquiry, DAR cases and its finalisation, should be relevant for all types of cases.
(e) Statistical information regarding incidents not relayed to Board should be covered in monthly Safety MCDO's along with action taken.

The Railways were advised to follow above instructions without exception and be incorporated in Accident Manual of respective Railways.

5.2 Board's letter No.88/ Safety(A&R)/29/8 dated 18.4.1988

In supersession of instructions contained in Board's letter No.88/ Safety(A&R)/29/8 dated 18.4.1988 and letters of even number dated 10.8.2000 and 17.10.2000, Railway Board has issued fresh instructions for definition and Re-classification of Accidents on Indian Railways vide Railway Board letter no. 2000/Safety(A&R)/19/20, New Delhi dt. 31.10.2000. Following definitions are given as under:

Definition

5.2.1 Train

A train is a set of vehicles, empty or loaded, worked by locomotive, or any other self-propelled unit including light engine/engines or rail-motor vehicles or a single rail-motor vehicle, empty or conveying passengers, livestock, parcels, or goods, which cannot be readily lifted off the track and running under a particular number or a distinct name from fixed point of departure to a fixed destination. Part of a train shall also be treated as a train for the purpose of these definition, classification, and statistics. The train engine or any other vehicle once put on the train continues to be a part of the train until the station is reached beyond which it is not required to go on the same train. At such stations, the moment the train engine or any other vehicle is cut off the load, it ceases to be a part of the train.

5.2.2 Passenger Train

A train intended solely or partly for the carriage of passengers shall be treated as a passenger train. A workman's train or a ballast train or a material or an Accident Relief train or a Tower Wagon or such other train carrying workmen, or Cattle special/Military special carrying authorized escorts, or similar such train shall be treated as a passenger train.

5.2.3 Other Train

All other trains not covered under 1(ii) shall be termed as 'other trains.'

5.3 Accident

For the purpose of Railway working, accident is an occurrence in the course of working of Railway which does or may affect the safety of the Railway, its engine, rolling stock, permanent way and works, fixed installations, passengers or servant or which affect the safety of others, or which does or may cause delay to train or loss to the Railway. For statistical purposes accidents have been classified in categories from "A" to "R" excluding "I" and "O".

5.4 Injuries

Injuries are classified as

(a) Grievous
(b) Simple

5.4.1 Grievous injuries

'Grievous' injuries for purpose of these statistics should be taken as injuries as defined in Section 320 of Indian Penal Code reproduced below for ready reference. (Section 320, Indian Penal Code 45 of 1860). Following kinds of hurt only are designated as 'grievous': -

(A) Emasculation.
(B) Permanent privation of the sight of either eye.
(C) Permanent privation of the hearing of either ear.
(D) Privation of any member or joint.
(E) Destruction or permanent impairing of the powers of any member or joint.
(F) Fracture or dislocation of a bone or tooth.
(G) Any hurt which endangers life, or which causes the sufferer to be, during the space of twenty days, or in severe bodily pain or unable to follow his ordinary pursuits.

5.4.2 Simple Injuries –

(i) A person will be considered to have incurred simple injuries if these injuries incapacitate the injured person to follow his customary vocation during 48 hours after the occurrence of the accident.
(ii) A Railway servant is considered to have been injured if he/she is prevented from returning to work as a result of injuries for a period of 48 hours after the occurrence of the accident.

5.5 Threshold Value:

For the purpose of accident, threshold value is the minimum value beyond which the accident will be treated as having serious repercussion on the basis of loss to railway property or interruption to communication. It shall constitute two portions:

Threshold value of Railway property

Threshold value of Railway property, loss which is fixed at One lakh rupee.

or

Threshold value of interruption to communication either partial or total where duration of interruption is equal to, or more than Number of hours specified against each cell.

Interruption	BG- A, B, C or D Spl. (in hours)	BG- D, E, Spl. or MG- Q, R (in hours)	BG-E, MG-S or NG route (in hours)
Total	3	4	6
Or	Or	Or	Or
Total + Partial	6	8	12

Duration of Interruption is defined as duration from the time of accident till starting of first train on-line clear from adjacent station for movement over the affected line in that section.

5.6 The classification of the Railway accidents

Accident is classified under following heads: -

1. Train Accidents.
2. Yard Accidents,
3. Indicative Accidents.
4. Equipment Failures.
5. Unusual Incidents.

Detailed classification is given in 5.7

5.6.1 Train Accidents:

Train accident is an accident that involves a train. Train accidents are further divided as: -

(a) Consequential train accidents; and

(b) Other train accidents

(a) Consequential train accidents

Consequential train accidents include train accidents having serious repercussion in terms of loss of human life, human

injury, loss to Railway property or interruption to Rail traffic. Train accident under following classification will be termed as consequential train accidents: -

Collision: All cases under categories A-1 to A-4.
Fire: All cases under categories B-1 to B-4
Level Crossing: All cases under categories C-1 to C-4
Derailment: All cases under categories D-1 to D-4
Miscellaneous: All cases under category E-1

(b) Other train accidents

All other accidents which are not covered under the definition of consequential train accidents are to be treated as "other train accidents". These include accidents under categories B-5, B-6, C-5 to C-8, D-5, and E-2.

5.6.2 Yard Accidents:

All accidents that take place in a yard and does not involve a train are termed as Yard Accidents. These include accidents falling under categories A-5, B-7, C-9 and D-6.

5.6.3 Indicative Accidents:

In real term they are not accidents but are serious potential hazards and include all cases of train passing signal at danger, averted collision, breach of block rule coming under classification F, G and H.

5.6.4 Equipment Failure:

These include all failure of railway equipment i.e. failure of locomotive, rolling stock, permanent way, overhead wire, signalling and telecommunication equipment and include cases falling under classification J, K, L and M.

5.6.5 Unusual Incidents:

These include cases related to law and order but not resulting in train accidents and other incidents under classification N, P, Q and R.

In revised Accident Manual, consequential train accidents are classified as under and graded as per English alphabet with numerals. These

accidents have been classified under categories from **'A' to 'M'** except **"I" and 'O",** further these categories of the accidents are sub divided into numerical **'1' to '4'** depending upon severity of the accident. Such categorization of accidents into Alphabet and Numerical is quite helpful in keeping proper record for Statistical Purpose and Analysis.

The current classification of the Railway accidents is tabulated as under:

ACCIDENTS			
S.N.	**Class**	**Type of Accidents**	
1.	**A**	Collision	A 1 to A 5
2.	**B**	Fire	B 1 to B 4.
3.	**C**	Level Crossing	C 1 to C 4
4.	**D**	Derailment	D 1 to D 4
5.	**E**	Other train Accident	E 1
INDICATIVE ACCIDENTS			
S.N.	**Class**	**Type of Indicative Accidents**	
6.	**F**	Averted Collisions	F 1
7.	**G**	Breach of block rules	G 1
8.	**H**	Train passing signal at danger	H 1
EQUIPMENT FAILURES			
S.N.	**Class**	**Type of Equipment Failure**	
9.	**J**	Failure of engine and rolling stock	J 1
10.	**K**	Failure of Permanent Way	K 1
11.	**L**	Failure of Electrical equipment	L 1
12.	**M**	Failure of S & T Equipment	M 1
UNUSUAL INCIDENTS			
S.N.	**Class**	**Type of Unusual Incidents**	
1.	**N**	Train Wrecking or attempted train wrecking or Sabotage to a train	N 1 to N 3
2.	**P**	Casualties	P 1 to P 3
3.	**Q**	Other incidents	Q 1 to Q 6
4.	**R**	Miscellaneous	R 1 to R 5

The above classification is decided for proper logging of accidents in computerized program. The serial number of sub-classes of accident is placed on the basis of severity of accident, if it is sub-

class 1 then it is more serious than sub-class 2 or 3 or 4 or 5.

5.7 Accidents

5.7.1 Class 'A' -- Collisions

Sub-Class	Type of Accidents
A1	Collision involving a train carrying passengers, resulting in **i.** loss of human life and/or grievous hurt, and / or **ii.** damage to Railway property with value exceeding Rs. 2 crores, and/or **iii.** Interruption of running on any important through line for at least 24 hours.
A2	Collision involving a train not carrying passengers, resulting in **i.** loss of human life and/or grievous hurt, and/or **ii.** damage to Railway property with value exceeding 2 crores, and/or **iii.** interruption of running on any important through line for at least 24 hours.
A3	Collision involving a train carrying passengers, but not falling under A.1 above.
A4	Collision involving a train not carrying passengers, but not falling under A.2 above.
A5	Other collisions i.e., collisions occurring in shunting, marshalling yards, loco yards, and sidings etc., but not involving a train

5.7.2 Class 'B' -- Fire in trains

Sub-Class	Type of Accidents
B1	Fire in a train carrying passengers, resulting in **i.** loss of human life and/or grievous hurt, and/or **ii.** loss to Railway property with value exceeding2 crore, and/or **iii.** interruption of running on any important through line for at least 24 hours.
B2	Fire in a train not carrying passengers, resulting in **i.** loss of human life and/or grievous hurt, and/or **ii.** damage to Railway property with value exceeding 2 crores, and/or **iii.** interruption of running on any important through line for

	at least 24 hours.
B3	Fire in a train carrying passengers not falling under B1 above but resulting in **i.** damage to Railway property is 50,000 or above and up-to 2 crores, and/or **ii.** interruption to traffic is more than the—threshold Value, and/or detaching of coaching stock from the train.
B4	Fire in a train not carrying passengers and not falling under B.2 above, but resulting in **i.** damaged to Railway property is50,000 or above and up-to 2 crores, and/or **ii.** interruption to traffic is more than the threshold value, and/or **iii.** detaching of goods stock from the train.
B5	Fire in a train carrying passengers but not falling under B.1 or B.3 above.
B6	Fire in a train not carrying passengers but not falling under B.2 or B.4 above.
B7	Fire occurring in shunting, marshalling yards, loco yards, and sidings etc., involving rolling stock but not involving a train.
Note: I) in case of an inquiry by a committee into a fire accident in Railway premises or in a train leading to damage to railway property and/or booked consignments, a representative of the Railway Protection Force should also be included as a member of the committee.	

5.7.3 Class 'C' – Level Crossing

(Train running into road traffic, and/or road traffic running into trains at level crossings.)

Sub-Class	Type of Accidents
C1	Trains carrying passengers running into road traffic and/or road traffic running into such trains at manned level crossings resulting in **i.** loss of human life and/or grievous hurt, and/or **ii.** damage to railway property, which is more than the threshold value, and/or **iii.** interruption to traffic which is more than the threshold value.
C2	Trains not carrying passengers running into road traffic and/or

	road traffic running into such trains at manned level crossings resulting in **i.** loss of human life and/or grievous hurt, and/or **ii.** damage to railway property which is more than the threshold value and/or **iii.** interruption to traffic which is more than the threshold value.
C3	Trains carrying passengers running into road traffic and/or road traffic running into such trains at unmanned level crossings resulting in **i.** loss of human life and/or grievous hurt, and/or **ii.** damage to railway property which is more than the threshold value and/or **iii.** interruption to traffic is more than the threshold value.
C4	Trains not carrying passengers running into road traffic and/or road traffic running into such trains at unmanned level crossings resulting in **i.** loss of human life and/or grievous hurt and/or **ii.** damage to railway property and/or **iii.** interruption to traffic is more than the threshold value.
C5	Trains carrying passengers running into road traffic and/or road traffic running into such trains at manned level crossings but not falling under C.1.
C6	Trains not carrying passengers running into road traffic and/or road traffic running into such trains at manned level crossings but not falling under C.2.
C7	Trains carrying passengers running into road traffic and/or road traffic running into such trains at unmanned level crossings but not falling under C.3
C8	Trains not carrying passengers running into road traffic and/or road traffic running into such trains at unmanned level crossings but not falling under C.4.
C9	Shunting engine, with or without vehicles, or loose vehicles running into road traffic and/or road traffic running into shunting engine with or without vehicles or loose vehicles, at level crossings.
Note: If a road vehicle is not capable of being physically cleared off the track promptly by a single person operating it, it should be termed as road traffic	

for the purposes of classifying such an accident as a train accident irrespective of its mode of traction.

5.7.4 Class 'D' – Derailments

Sub-Class	Type of Accidents
D1	Derailment of a train carrying passengers and resulting in **i.** loss of human life and/or grievous hurt and / or **ii.** damage to railway property with value exceeding 2 crores, and / or **iii.** interruption of running on any important through line for at least 24 hours.
D2	Derailment of a train not carrying passengers and resulting in **i.** loss of human life and/or grievous hurt, and / or **ii.** damage to railway property with value exceeding2 crore, and / or **iii.** interruption of running on any important through line for at least 24 hours.
D3	Derailment of a train carrying passengers, but not falling under D.1 above.
D4	Derailment of a train not carrying passengers and not falling under D.2 above, but loss to railway property and/or interruption to traffic which is more than he threshold value.
D5	Derailment of a train not carrying passengers and not falling either under D.2or D.4 above.
D6	Other derailments, i.e., derailments occurring in shunting, marshalling yards, loco yards, and sidings etc., but not involving a train.

5.8 Indicative Accidents

5.8.1 Class 'F' - Averted collisions

Sub-Class	Type of Accidents
F1	Averted collision between trains, at least one of which is carrying passengers.
F2	Averted collision between a train carrying passengers and an obstruction.
F3	Averted collision between trains not carrying passengers.
F4	Averted collision between a train not carrying passengers and an obstruction.

5.8.2 Class 'G' - Breach of block rules

Sub-Class	Type of Accidents
G1	Trains carrying passengers entering a block section without any authority to proceed or without a proper 'Authority to proceed.'
G2	Trains not carrying passengers entering a block section without any authority to proceed or without a proper 'Authority to proceed.'
G3	Train received on a blocked line, but not constituting an averted collision.
G4	Train received on/or entering a wrong line at a station or catch siding or slip siding or sand hump etc.

5.8.3 Class 'H'– Train passing signal at danger.

Sub-Class	Type of Accidents
H1	Train carrying passengers running past a stop signal at danger without proper authority.
H2	Train not carrying passengers running past a stop signal at danger without proper authority.

5.9 Equipment Failure-

5.9.1 Class 'J'– Failure of engine and rolling stock.

Sub-Class	Type of Accidents
J1	Failure of engine hauling a train carrying passengers.
J2	Failure of engine hauling a train not carrying passengers, or failure of light engine.
J3	Parting of train carrying passengers.
J4	Parting of a train not carrying passengers.
J5	Failure of rolling stock, such as failure of tyres, wheels, axles, or braking apparatus etc., on a train carrying passengers and leading to detachment of rolling stock from the train.
J6	Failure of rolling stock, such as failure of tyres, wheels, axles, or braking apparatus etc., on a train not carrying passenger leading to detachment of rolling stock/stocks from the train.
J7	Failure of rolling stock, such as failure of tyres, wheels, axles, or braking apparatus etc., on a train carrying passengers and

	not leading to detachment of rolling stock from the train.
J8	Failure of rolling stock, such as failure of tyres, wheels, axles, or braking apparatus etc., on a train not carrying passengers, and not leading to detachment of rolling stock from the train.
J9	A train or a portion of a train running away or out of control.
J10	Poor brake power in a train but not covered in class J.9.

5.9.2 Class 'K'– Failure of Permanent Way

Sub-Class	Type of Accidents
K1	Buckling of track.
K2	Weld failure.
K3	Rail fracture.
K4	An unusually slack or rough running or heavy lurch experienced by Loco Pilots of running trains while passing over any length of permanent way leading to interruption in train running.
K5	Failure of railway tunnel, bridge, viaduct/ formation/ cutting, culvert, etc.
K6	Damage to track of such a nature other than those covered under Class K.1 to K.5 so as to render it temporarily unsafe for passage of trains or likely to cause delay to traffic for a period above threshold value.
K7	Damage to track of such a nature as to render it temporarily unsafe for the passage of trains or likely to cause delays to traffic not covered under class K.1 toK.6.
Note: In the above classification, those cases detected during regular maintenance and not affecting train movement will not be counted.	

5.9.3 Class L – Failure of Electrical equipment

Sub-Class	Type of Accidents
L1	Snapping of or any damage to OHE, requiring switching off of OHE for more than three minutes.
L2	No OHE for more than three minutes.
L3	Pantograph entanglement not covered under J.1 and J.2
L4	Defect in AC or other electrical equipment leading to detachment of rolling stock from a train.

5.9.4 Class M - Failure of Signalling and Telecommunication Equipment.

Sub-Class	Type of Accidents
M1	Failure of part or complete panel/RRI.
M2	Failure of interlocking, track circuit or axle counter.
M3	Failure of block instruments.
M4	Failure of point machine and related equipment.
M5	Failure of signal, point.
M6	Failure of control/station communication for more than fifteen minutes.
M7	Failure of station-to-station communication or station to level crossing gate communication for more than 15 minutes
Note: Signalling and telecommunication failures which were not informed to S&T department will not be considered for failure.	

5.10 Unusual Incidents

5.10.1 Class 'N'- Train Wrecking or attempted train wrecking or Sabotage to a train

Sub-Class	Type of Accidents
N1	Train wrecking or attempted wrecking or Bomb Blast or Explosion or Hijacking or sabotage to a train carrying passengers with or without loss of human life and / or grievous hurt and / or damage to Railway property.
N2	Train wrecking or attempted wrecking or Bomb Blast or Explosion or Hijacking or sabotage to a train not carrying passengers with or without loss of human life and / or grievous hurt and / or damage to Railway property.
N3	Train wrecking or attempted wrecking or Bomb Blast or Explosion Or sabotage to signalling and track or forceful confinement of train running staff on duty and / or passengers but not involving a train.

5.10.2 Class 'P'– Casualties

Sub-Class	Type of Accidents
P1	Person or persons falling out of a running train resulting in loss of human life or grievous hurt.

P2	Person or persons run over or knocked down by a train resulting in loss of human life or grievous hurt.
P3	Person or persons falling out of a running train or knocked down by a train or engine or railway vehicle but not resulting in loss of human life or grievous hurt.

5.10.3 Class 'Q'– Other incidents

Sub-Class	Type of Accidents
Q1	Accidental or natural death or grievous hurt to any person, whether passenger/railway employee/ trespasser (or any other person), within railway premises (excluding railway quarters).
Q2	Murder or suicide in a train or within railway premises.
Q3	Robbery, attempted robbery, theft, or attempted theft in railway premises, including trains.
Q4	Fire or explosion within railway premises but not involving trains.
Q5	Fire or explosion resulting in damage to railway bridge and viaduct etc.
Q6	Blockade to train services due to agitation.

5.10.4 Class 'R'– Miscellaneous

Sub-Class	Type of Accidents
R1	Vehicle or vehicles running away.
R2	Train running over cattle.
R3	Floods, breaches, and landslides etc., resulting in interruption of traffic in an important through line for more than the threshold value.
R4	Other cases of floods, breaches, landslides etc., resulting in interruption to traffic.
R5	Any accident not included in foregoing classifications.
Note: **1.** The term 'cattle' does not include sheep, goats, pigs, dogs, donkeys, rams, ewe, and lambs.	
Note: **2.** A train includes a trolley, lorry, motor trolley, when worked under the rules for working of trains.	

5.11 Reportable Train Accidents:

All accidents falling under the purview of Section 113 of the Railway Act 1989 are termed as reportable train accidents and include following: -

(a) any accident attended with loss of any human life, or with grievous hurt.
(b) any collision between trains of which one is a train carrying passengers.

Or

(c) the derailment of any train carrying passengers, or of any part of such train; or
(d) accidents which are attended with loss of human life in passenger trains involving train wrecking, or attempted train wrecking, cases of running over obstructions placed on the line, of passengers falling out of train or of fires in trains, or grievous hurt as defined in the Indian Penal Code, or serious damage to railway property of the value exceeding rupees twenty five lakhs which have not actually occurred but which by the nature of the accident might reasonably have been expected to occur and also cases of landslides or of breach by rain or flood which cause the interruption of any important through line of communication for at least 24 hours.

5.12 Serious Accident:

Accident to a train carrying passengers which is attended with loss of life or with grievous hurt to a passenger or passengers in the train, or with serious damage to railway property of the value exceeding Rs.25,00,000 and any other accident which in the opinion of the Chief Commissioner of Railway Safety or Commissioner of Railway Safety requires the holding of an inquiry by the Commissioner of Railway Safety shall also be deemed to be a serious accident. However, the following shall be excluded: -

(a) cases of trespassers run over and injured or killed through their own carelessness or of passengers injured or killed through their own carelessness.

(b) cases involving persons being Railway servant or holding valid passes/tickets or otherwise who are killed or grievously injured while travelling outside the rolling stock of a passenger train such as on foot board or roof or buffer but excluding the inside of vestibules between coaches, or run over at a Level Crossing or elsewhere on the Railway track by a train; and

(c) Level crossing accident where no passenger or Railway Servant is killed or grievously hurt unless the Chief Commissioner of Railway Safety or Commissioner of Railway Safety is of the opinion that the accident requires the holding of an inquiry by the Commissioner of Railway Safety.

5.13 Reporting of Accident:

(a) To Railway Board: A telephonic advice should be relayed to nominated officer in Railway Board's Office immediately after the accident in case of following categories of accidents: -

(i) All consequential train accidents.

(ii) Any yard accident having serious repercussion on movement of traffic on through/main line resulting in dislocation of traffic more than the threshold value as indicated above.

(iii) Landslides, breaches, OHE breakdown etc. which result in dislocation of traffic more than the threshold value as indicated above.

In addition to this, periodic(monthly) statement of Accidents in all categories shall be submitted to Railway Board in prescribed proforma.

(b) To Zonal Railway: A telephonic advice should be relayed to nominated officer in Zonal HQ immediately after the accident in case of following categories of accidents: -

(i) All train accidents.

(ii) Any yard accident having serious repercussion on movement of traffic on through line resulting in dislocation of traffic more than the threshold value as

indicated above.

(iii) Landslides, breaches, OHE breakdown etc. which result in dislocation of traffic more than the threshold value as indicated above.

In addition to this periodic (monthly) statement of Accidents in all categories shall be submitted to Zonal Headquarter in prescribed proforma.

5.14 Level of Enquiry:

(i) All serious accident shall be inquired into by the Commissioner Railway safety.

(ii) In case of Commissioner of Railway Safety or Chief Commissioner of Railway Safety is not in a position to inquire into the serious accident cases the Inquiry shall be done by JA Grade Inquiry Committee.

(iii) All other consequential train accidents except Unmanned Level Crossing Accidents shall be inquired into by a committee of JA grade officers and in its absence by Branch officers. Consequential Unmanned Level Crossing Accidents shall be inquired into by a Committee of Junior Scale Officers.

(iv) All other train accidents shall be inquired by a committee of Senior scale or Junior Scale Officers as decided by respective DRMs.

(v) All yard accidents shall be inquired into by a Committee of Senior Supervisors

(vi) Safety Officer shall be one of the members of all Departmental Accident Inquiry Committee. In case Safety Officer in same grade as of the inquiry committee is not available in the Division, Safety Officer of one grade below may be nominated for the Inquiry Committee.

(vii) All cases of indicative Accidents shall be inquired into by a Committee of Junior Scale Officers.

(viii) All cases of equipment failure shall be inquired into

by a Senior Supervisors/Supervisors of respective departments.

5.15 Rules for the preparation of accident returns:

(i) Accidents to trains shall be accounted for by the Railway which exercises jurisdiction over the site of accident. Engine failures shall be accounted for by the Railway owning the engines.

(ii) A train intended solely or partly for the carriage of passengers shall be treated as passenger train. All other trains will come under the category of other trains.

(iii) Statistical returns in the prescribed proforma showing cumulative data till the end of the month should be submitted so as to reach Board's Office not later than 7th Day of the next month.

(iv) Only those accidents which have occurred during the period to which the returns relate shall be included in the relevant returns. With regard to the accidents where details are not available at the time of forwarding the returns for any reason, such accidents are to be included in the statement with a clear indication that further details would follow.

(v) Each accident must be shown only once and in the event of an accident falling in more than one category, it should be treated as an accident in the higher category.

(vi) Derailments or bumping during reversing or shunting operations etc. on an incoming, outgoing or any other load, including a sectional carriage, etc. shall be deemed to be a 'train accident' only when the train engine or a vehicle still forming a part of the train derails or as a result of bumping casualty (including injuries) or loss to Railway property takes place, irrespective of whether the shunting was being done by the train engine or by a shunting engine.

(vii) Interruption is defined as duration from the time of accident till starting of first train on-line clear from adjacent station for movement over the affected line in that section.

(viii) Statistics of fire should include all cases of physical fire or smoke emission resulting in death or injury or damage to property amount to Rupees 5000 and above.

(ix) Equipment failure shall include all failures irrespective of date of last schedule or examination and shall be subsequently classified under avoidable or unavoidable category.

(x) Details and Statistics for accident cases falling under unusual incident categories "N", "P" and "Q" shall be maintained and provided by Security (RPF) Branch.

(xi) DRM at the Divisional level and the General Manager at the Zonal Headquarters level will ensure the correct reporting of accidents to Zonal Headquarters and the Railway Board respectively.

5.16 Collection, Compilation and Monthly statement of Accident Statistics: -

(a) Information about train accidents, yard accidents and indicative accidents falling under classification A, B, C, D, E, F, G and H will be compiled by the Safety Branch at Divisional and Zonal Railways.

(b) Equipment failure falling under classification J, K, L and M will be compiled by the Divisional control on daily basis and shall be handed over to Safety Branch. Every equipment failure shall be classified under the category of avoidable and unavoidable by the Branch Officers concerned and summary shall be handed over to Safety Department of the Division. It is further clarified that all equipment failures should be taken into account irrespective of the date of last schedule or examination and shall be subsequently

classified under avoidable or unavoidable category as the case may be. The Safety Branch shall forward the monthly summary to Chief Safety Officers of respective Zonal Railways. Chief Safety Officers after compilation of statement shall forward monthly statement to the Safety Directorate of Railway Board.

(c) Unusual incidents falling under classification N, P and Q shall be collected and compiled by the Security (RPF) Branch at Divisional level and they shall take subsequent follow up action. Daily position will be given to the Safety Branch of the Division who after compilation of statistics shall forward monthly statement to Chief Safety Officers of the Zonal Railways concerned. Chief Safety Officers after compilation of statement shall forward monthly statement to the Safety Directorate of Railway Board.

Following system will be followed for reporting of accident to Railway Board: -

(a) Information regarding consequential train accident and any yard accident leading to serious repercussion shall be reported by Divisional Control to Headquarters Central Control of Zonal Railway Headquarters. Central Control shall in turn inform all concerned at Headquarters office including GM, PHODs etc.

(b) In case of accidents as in para (a) above, Chief Safety Officer/Dy COM(Safety) should thereafter inform nominated officer of Safety Directorate of Railway Board. At Board level Safety Directorate shall issue the message and take follow up action.

(c) In case of land slide, breaches, OHE break down etc. which result in dislocation of more than threshold value and also cases due to public agitation shall be reported by Headquarters Control Office to

Punctuality Cell of Railway Board and dealt with by the Coaching Directorate.

(d) Cases falling under N, P and Q except Q-6 i.e. blockade of train services due to public agitation; shall be dealt with by Security Directorate.

SAFETY AUDIT: INTERNAL AND EXTERNAL

6

Industries that handle large hazardous equipments and substances need to locate, design, operate and maintain facilities to the standards acceptable by the public and government for the safety of people. For this, the management and managers need to critically review and evaluate the practices and policies of the organization. Among the various tools available for the managers to check and analyze the capability and efficiency of the procedures and methods followed on safety, safety audit is the most useful tool in this concern. It is an element of safety management system which investigates and examines the activities and facilities of an organization from the concern of safety. This type of audit helps in minimizing the injuries and illnesses, lower workers compensation, empower employees by making them involved in the activities affecting their own health and safety, enhances job satisfaction and make the organization more competitive. Further, they assess the current prevention level, emergency and protection management. Based on these, they prepare a plan of action to enhance safety inputs and to avoid adverse situations.

6.1 Safety Audit

Before understanding the motives, philosophies and process of safety audit, it is necessary to look in general what an audit is? Audit is a systematic, multidisciplinary assessment of a process, system or a facility. This normally involves a regular periodic review of the facility and whether its operations conform or comply with expected standards of operation. Further, the auditor will gather the evidence to support their findings and conclusions in regard to the level of compliance and overall result of the audit. An audit can be done on a product, process, system, program or a service. It can be applied to the entire organization or may be confined to a particular production unit or a function. Audits serve various purposes such as auditing documents in an organization, performance or following up remediate actions. An audit can be carried out internally by the people employed by the organization or externally by a consultancy.

6.2 Characteristics of an Audit

1. **Unbiased**
   Same results will yield for different team of auditors. Audit will not encourage favouritism and individual concern.
2. **Independent**
   It forms the basis for equitability and objectivity. Further, it results in unbiased decisions during an audit process.
3. **Periodic**
   Regular and periodic schedule is maintained by the auditors
4. **Systematic**
   All the parties will be systematic as per the audit protocols, evaluation rules, schedule, documenting and reporting. It also means that the auditors get the same results when auditing is done by any team at the same place.
5. **Documented**
   The audited program collected facts during an audit and action plans are written and documented.

6. **Efficient**
   The audit goals are reached as per scheduled time and within a planned budget.
7. **Qualified team**
   The lead auditor and his team have the required knowledge and experience for making correct judgments.

6.3 Audit Vs Inspection

In most of the cases people will get confused between the terms inspection and audit. Both the terms have a same central theme but differ in some aspects. An inspection is an examination to verify compliance on equipment integrity, maintenance, equipment safety etc., with a specified frequency (monthly, weekly or daily). On the other hand, an audit assesses compliance against an established standard, management systems or process to verify their effectiveness and level of implementation. The difference between audit and inspection is given in Table 6.1.

Table 6.1

S.N.	Audit	Inspection
1	Audit allows deeper investigation and cause analysis to identify issues in a system or a process	Inspections allows for the identification and correction of hazards on a case-by-case basis
2	Audit focuses on management systems	Inspection focuses on work area, activities or equipment
3	Apart from having visual and observational method, audit also collects the evidence from the documents and staff interviews	Inspection has visual and observations methods only
4	Audits are less frequent	Inspections are frequent and repeating
5	Audit is more formalized process I	Inspection may not be a formalized one
6	Larger scale and scope	Focused and specific
7	Audits evaluate the effectiveness in the elements of management system	Inspection looks for unsafe acts and conditions
8	Audits are constructive and	Inspections are mostly

	structured, and also allow for further investigation	checklist based and often more rigid.
9	Managersandsupervisors may not be required during auditing	Managers and supervisors are involved during inspection.

6.4 Audit Basic Definitions

1. **Audit plan:** It defines the arrangements and activities of an audit.
2. **Audit criteria:** It is the set of procedures, policies or requirements.
3. **Audit evidence:** Statements of fact, records or any other information pertaining to audit criteria considered as audit evidence.
4. **Audit findings:** These are the results and conclusions of the evaluation of the collected audit evidence against audit criteria
5. **Audit scope:** It is the extent and boundaries of an audit.
6. **Audited:** An area which is being audited
7. **Auditor:** A person with the competence to conduct an audit
8. **Verification Audit:** Systematic, independent and documented process for obtaining audit evidence and evaluating it objectively to determine the extent to which the audit criteria are fulfilled conducted by WHS Unit
9. **Internal auditor:** A trained and qualified employee of the organization who is intended to perform audit in order to report non-conformances.
10. **Lead auditor:** Lead auditor is one who is authorized to schedule, formulate and direct the audit of an organization
11. **Noncompliance:** Evidence that indicate that the company is not acting in accordance with the rules, regulations or law.
12. **Nonconformance:** Evidence that indicate that the actions and information do not confirm to established standards.

6.5 Classification of Audits

Audits can be classified into several types based on its application, type of approach, type of function and the nature of audit. A

detailed classification and explanation are discussed below.

Classification based on the type of Audit application

- Product audit
- Process audit
- System audit

Classification based on the type of approach

- First party audit
- Second party audit
- Third party audit

Classification based on the type of function

- Financial audits
- Operational audit
- Compliance audit
- Information Systems audit
- Quality Audit
- Safety Audit

Classification based on the Nature of Audit

- External audit
- Internal audit

6.6 Classification based on the type of Audit application

6.6.1 Product Audit

Product audit examines a particular product or service, such as an engine block, a newly developed material or software. Further, it evaluates whether the products or services conforms to the specifications, standards and customer requirements. It assures a careful investigation of a final product before conveyance to a provider or a client. By thorough inspection, product audit aims at enhancing quality, profitability, customer loyalty and satisfaction. It is important for a product to undergo this process so as to determine whether it meets specifications or not. The product audit ultimately serves as an advantage to the customers and suppliers by guaranteeing quality which results in higher consumer loyalty.

6.6.2 Process Audit

Process audit verifies that the organizational processes are functioning as per the established standards. It assesses the method or an operation against predetermined standards or instructions. The idea of process audits is to restrict the assessment focus to specific procedures, specifications or routines used in a departments, units or business areas. A process audit may also verify the materials, equipments and people that are involved in transforming input raw material to an output product.

6.6.3 System Audit

System audit is defined as "A systematic, independent and documented process for obtaining audit evidence and evaluating it objectively to determine the extent to which audit criteria are fulfilled". It is an audit performed on a management system which is used to improve and evaluate the performance of a system. System audit also provides evidence concerning the need for reducing, eliminating and preventing non-conformities.

- A Quality Management System (QMS) audit evaluates the current quality management program to check its conformance with the company policies and regulations. In the similar fashion, environmental and food safety system audits are also used to examine the environmental and food safety management systems respectively.

6.7 Classification based on the Nature of Audit

1. **External audit**
   External audit is performed by an external team or a third party with which the company has entered into contract for sale of goods or services.
2. **Internal audit**
   Internal audit is performed by the company itself on its own systems. The purpose is to provide assurance to the management that its quality system is efficiently and effectively achieving the quality objectives planned.

Difference between Internal and External Audit

S.N.	Internal Audit	External Audit
1	Internal Audit is a continual audit function carried out within an organization by an individual internal auditing department.	External Audit is carried out by the autonomous body which is not an integral part of the company.
2	Internal audit reviews the regular activities and provide suggestions for the development.	External audit analyses and verifies the financial statements of the company.
3	Auditors are generally appointed by the management	Members usually appoint the auditors
4	Internal audit is conducted by the employees	External audit is conducted by a third party
5	Internal audit reports are adopted by the management	Stakeholders (creditors, lenders and investors) uses the reports of external audit
6	It is a continuous process	External audits are conducted once in a year
7	Assessment is provided on the efficiency of the operational activities of the organization.	Assessment is provided on the truthfulness and fairness of the financial statement of the company.
8	This audit helps in providing advice and assistance to the employees	Auditors in external audit are restricted from supporting an organizational staff
9	It checks and analyses operational efficiency	In this, accuracy and validity of financial statements are analysed.
10	Specified qualification is not compulsion for internal auditor	Specified qualification is compulsory

6.8 The Four phases of a safety audit

1. Audit Preparation

Prior to auditing there are some basic preparations required for smooth conduction of an audit. Audit preparation is a phase that actually exists before initiating an audit. This phase commences when the management arrives to a decision to conduct an audit and ends when the actual audit begins. The audit preparation includes, scope of the audit, organization's structure,

questionnaire etc.,

2. **Audit Performance**
   This phase is also called as onsite activity. This phase is the physical inspection, communication and data gathering part of the audit which includes the time slot from the arrival of the audit committee to the work area up to the closing meeting. This phase consists of multiple events and activities which includes opening meeting, interviewing, field visits, verifying and inspecting the process, communicating with the auditee.
3. **Audit Reporting**
   In this phase, the audit results are communicated with the management and managers of an organization. The audit repost should produce a clear and accurate data so that the management can address the significant organizational issues. Mostly the audit process will end when the audit report is submitted by the lead auditor. In some cases, it ends after the follow-up actions are finished.
4. **Audit follow-up and closure**
   During follow up, the audit team verifies and determines the effectiveness, adequacy and actions taken by the management to correct the reported recommendations and issues.

6.9 The Safety Audit process

1. **Pre-audit**
   It is the initial step in the process of an audit. In this phase, all the documents are evaluated and required information is collected before a company undergoes an audit. This phase may be conducted by the employees of the organization or may be performed by independent organization. Pre-audit helps in describing the single instance review as well as continuous monitoring of performance.
   The following are the sequence and events that followed in the pre-audit.
   1. Schedule the audit.

2. Communicate with the management for example concerned Railway Zone and Division.
3. Decide the number of SAG officers and others who need to be accompanied with audit party.
4. Regulation and safety policies review.

2. **Audit**

This is the actual part of the audit. This part begins when the auditor begins their opening conference and ends with the closing conference. On-site visits, employee interviews, document review etc., are involved in this part.

The following are the events that take place during an audit.

1. Opening conference
2. Facility tour
3. Documentation review
4. Facility inspection
5. Employee interviews
6. Management updates
7. Data entry
8. Training
9. Closing conference

3. **Post audit**

In this, the outcome of an audit is analyzed. Post audit begins after a company discloses its data that includes auditors' recommendations, findings etc.,

The following event occur during post audit.

1. Complete the audit document
2. Proofread the audit document
3. Distribute the audit report
4. Follow-up

6.10 Principles of a Safety Audit

There are some fundamental principles which are necessary to be followed for ensuring effective auditing. These principles form a support for auditing results and allow the auditor to perform

auditing independently from one another to ultimately reach the same conclusions under similar situations. There are five principles are as under:

1. Ethical conduct
2. Fair Presentation
3. Due Professional Care
4. Independence
5. Evidence Based Approach

1. Ethical Conduct

Ethical conduct forms the foundation of professionalism which must be practiced by the auditor in all situations of audit.

a) Trust
b) Integrity
c) Confidentiality
d) Discretion

2. Fair presentation

Fair presentation is necessary to report the conclusions accurately and reliably. This task is being a challenging one for the auditors since the audit happens in a busy schedule, under employee and teammates' interaction. The auditor may overcome this problem by remaining truthful to the requirements and working on specific finding to gain the consensus.

3. Due professional care

It is necessary for an auditor to uphold due professional care in the matter of their duties. This involves the application of sound judgment & diligence and maintaining a standard of professional and personal competencies. These competencies include the following:

a) Training
b) Knowledge
c) Science
d) Experience

e) Regulation
f) Sectors

4. **Independence**
   It forms the basis for equitability and objectivity. This leads to unbiased decisions during an audit process and also all the outcomes and findings of an audit will reflect the requirements. In any circumstance there should not be any conflict of interest and if such situations arise it must be intimated to the relevant staff prior to the commencement of an audit.
5. **Evidence-based approach**
   This approach is the appropriate method for getting reliable, valid and accurate conclusions. Generally, all evidence is to be verified during an audit, but due to the limited time and resources, auditor has to go for sample based. Therefore, audit confidence is associated to the degree of sampling.

6.11 Safety Audit

A safety audit is a constructive process which examines the safety policies, programs and practices within a work area. The practices are further evaluated based on its effectiveness and how they comply with the safety standards. Safety audit plays a vital role in developing hazard control system of an organization. It serves as one of the efficient methods to find those activities which require improvements from the safety concern. Safety audit has following five elements are as under:

1. Identification
2. Assessment
3. Selection
4. Implementation
5. Monitoring

For example, safety audit in railway may consist of following elements:

1. Whether safe practices in railway operation are being followed?

2. Railway track is maintained as per standard given in manual?
3. Whether rolling stock i.e., coaches, wagons, and locomotives are maintained especially with safety fitment?
4. Are signal gears functioning all right and relay room are maintained properly and there is no shortcut method is involved?
5. Whether all staff is having sufficient knowledge about the safety rules?
6. Other aspect of train operation and maintenance are in order?
7. Any other issues which may affect train safety must be brought out in report?

6.12 Safety Inspection Vs Safety Audit Safety Audit

Although safety inspection and safety audit have common central theme, but both these approaches have different angles. The initial one looks into the hazards and risk whereas the later one examines the practices and strategies in the matter of safety. Both are essential elements of safety in workplace. The differences between safety inspection and safety audit are presented in the following table.

S.N.	Safety Inspection	Safety Audit
1	A safety inspection looks into unsafe practices and safety hazards throughout the organization.	A safety audit evaluates safe practices and programs within an organization.
2	Safety inspection examines current approaches and the actions of the employees	Safety audit reviews safety policies and strategies
3	Safety inspection will determine whether the company uses proper equipment safety guards & PPE, and also examines whether the equipments lead to any hazards.	An auditor conducting a safety audit will measure and collect the information pertaining to safety programs and analyze whether they meet the organization's established goals.
4	Safety inspection observes the work practices to identify unsafe actions. Any hazards present can	Safety audit examines safety training programs and its output.

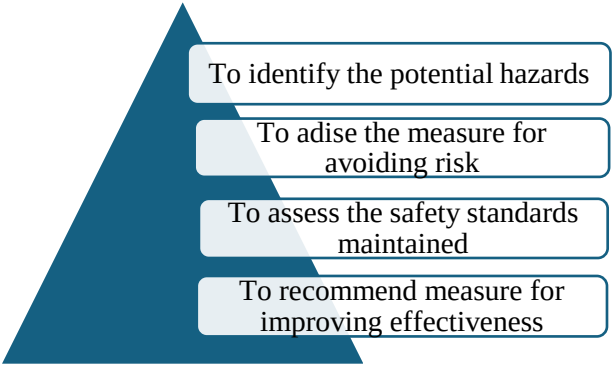
	be redressed, eradicated, or accounted for.	
5	Safety inspections are carried out by those people who are familiar with the workplace.	Safety audit is conducted by the independent employees whether from outside organization or separate department.

6.13 Safety Inspection and Safety Audit

Similarities There are some similarities between safety inspections and safety audits. Both aim for safer and healthier workplace that adheres with all standards and regulations. Both use a checklist that includes OSHA standards.

6.14 Objectives of Safety Audit

1. To identify and assess all potential hazards involving plant, personnel, services and operations.
2. To check whether the organization is in compliance with safety regulations and also with those of the organization's stated safety objectives, policies and progress.
3. To analyze weaknesses in their regular safety programs and practices.
4. To judge the safety standards maintained in the organization
5. To guide for drafting safety plans.
6. To identify remedial actions that needs to be undertaken.
7. To propose the measures for enhancing the effectiveness in existing safety methods.



Main Objectives of Safety Audit

Once the objectives are accepted, next task would be the gathering of information. The audit team will analyze the collected information and then prepares an audit schedule. Separate time slot is arranged for on-site observation by team members during which the team will identify the events that lead to hazards. After completing the site study, a preliminary report is prepared and submitted prior to the submission of the final report.

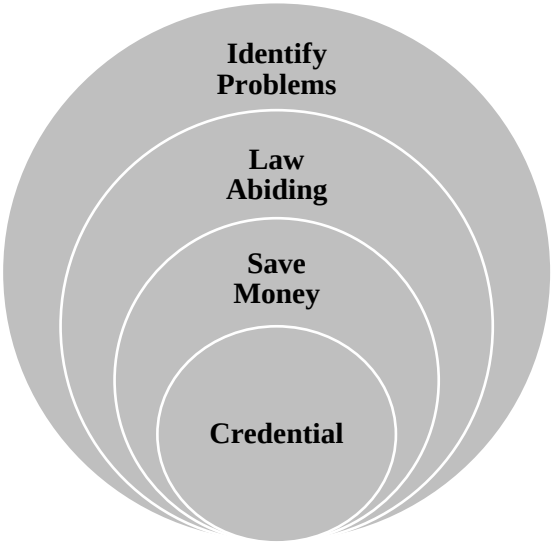
6.15 Limitations of Safety Audit

Safety audit may fail if

1. The safety audit gives a wrong implication of pass score.
2. The safety audit cannot identify the deficiencies and flaws.
3. Companies aim only at improving audit score rather that enhancing the safety.
4. Inadequate or non-existent system of audit.

6.16 Benefits of Safety Audit

1. Ensures that management and staff follow predetermined methods, guidelines and procedures.
2. Enhances the safety awareness.
3. Identifies the methods and procedures where they are insufficient.
4. Discloses the weaknesses in the safety program.
5. Estimates the potential losses that are associated with the risk.
6. Inspire the employees by producing the conclusions of their safety effort.
7. Determines the effectiveness of safety education.
8. Identifies remedial actions to minimize the losses.
9. Examines whether previously suggested corrective action is addressed or not.



Safety Audit Intended benefits

6.17 Types of Safety Audits

1. **Industrial/Workplace Safety Audit**
   Industrial safety audits are performed in the industries where hazardous equipments and substances are involved. It is a methodical examination which reviews procedures and practices of industries in order to verify whether they comply with legal requirements and internal policies. Further, necessary improvements and corrective actions are taken based on the audit results.
2. **Fire Safety Audit**
   It is the inspection of work area and the surroundings of an organization to verify how it is being maintained in the matter of fire safety. Fire safety audit is generally performed by fire safety inspector (in some cases it may vary). This audit also includes the interview with the staff in order to know how far they are aware about fire safety procedures. This audit provides the plan of action which helps in fire prevention and emergency preparedness. In order to confirm the implementation of

regulations which have been formulated previously, the auditors will walk through the premise which concludes the audit.

3. **Road Safety Audit**
   Road Safety Audit (RSA) is a formal examination of planning, designing and construction of road projects. It is used to identify unsafe features or arrangements of roads that may affect adversely on road user safety. It assesses and reports on the issues concerning road safety and also analyses the opportunities for enhancing safety for the road users. The main motive of RSA is to minimize the road accidents.
4. **Construction Safety Audit**
   Construction Safety Audits helps in identifying the potential losses through a constructive assessment and examination process at a construction site supported by an industry expertise and resources.
5. **Electrical Safety Audit Safety Audit**
   Electrical safety audit can be applied to the power sectors, IT parks, industries, service sectors and hotels. Electrical safety audit is carried out to minimize or eliminate the faults in electric circuits and connections. There is lot of risk associated with the electrical system towards the safety of the people in terms of shocks, fire, burns, and explosions. Over forty percent of accidents relating to fire occur only due to the faults occurred in electrical circuits and connections.
6. **Food safety audit**
   A Food Safety Audit (FSA) focuses on the specified requirements which were established in the food safety standards. It primarily focuses on the activities, procedures, criteria and the data pertaining to the safe production and distribution of food products. FSA is an efficient and reliable tool in the backdrop of food safety management policies and controls.

6.18 Significance of Performing a Safety Audit

Organizations perform safety audits to verify whether the methods and practices are in accordance with the laws and regulations or not. Safety audit ensures continuous health and safety of employees in an organization through a systematic assessment of on-site processes and procedures. It determines various levels of risk associated with work area. Safety audit will find out the areas in which changes are required for making work area better in the matter of safety. Organization can focus on particular areas which are based on the results of the safety audit. An audit results includes the remedial actions that how the organization can overcome the threats for safeguarding the people. There will be minimized possibility of injuries, illnesses and deaths if an organization focus on the outcomes of safety audit results. A safety audit is essential as it will help to:

1. Minimize the risk of personal injury.
2. Ensure customer confidence.
3. Avoid material loss from a business.
4. Promote employee morale

Following is some of the elements to make safety audit more effective.

1. Develop an audit checklist. Rigorous study and research will help the auditor in refining the checklist.
2. Have minimum safety standards for each work area and possible safety issues.
3. Plan for a preliminary verification of all work areas. Note down the unsafe conditions, equipments that need replacement and the places in which employees require better Personal Protective Equipment (PPE)
4. Review safety records of every program and area.
5. Go through the safety procedure and policies, meeting agendas, data sheets of material safety, inspection reports of previous audit and reports of injuries and accidents.

6. Arrange a formal inspection by going through all work areas once again.
7. Note down if a workplace is not in accordance with the checklist
8. Ask questions to the managers and employees for the information which will be required to prepare an audit report.
9. Prepare an official version of the formal inspection that summarizes the audit's findings.
10. Produce a copy of the safety audit to management. Program managers need the auditor's contact information if they have questions about how to correct problems summarized in your report.

6.19 What an auditor looks for during an audit?

The following elements are to be observed by an auditor during the process of an audit

1. Position of employees
2. Reaction of employees
3. Procedures
4. Personal Protective Equipment (PPE)
5. Tools and equipment
6. Housekeeping

1. Positions of people
   - Observer whether the employees are in safe position or in a danger of injuring themselves by lifting overload objects.
   - Look whether the employees are in a position of trapping, falling or colliding with other others.
2. Reaction of people
   - See whether any employee adjust protective equipment, rearrange their job or change their position when auditor appears
   - Does any employee abruptly stop work?
3. Procedures
   - Are they sufficient?

- Do they prevent all unnecessary risks?
- Are they followed?

4. Personal protective equipment (PPE)
   - Are the employees using the proper PPE?
   - Are they being in proper conditions?
5. Tools and equipment
   - Are they being utilized properly?
   - Are they in good working and safe conditions?
   - Are any improperly designed tools being used?
6. Housekeeping
   - Is everything arranged properly?
   - Is the workplace neat?
   - Are there any unnecessary risks?

6.20 If you observe when an employee is working unsafely; then

1. Observe for a while and then get the employees attention
2. Explain what the employee has been doing
3. Discuss with the employee regarding the repercussions of unsafe act.
4. Motivate the employee and get his consent of doing the job safely
5. Confer other safety issues and rules
6. Ask the opinion of the employee regarding how the supervisor can help in making the jobs safer.
7. Finally thank him.

Elements of an effective safety audit system

1. Management leadership and employee involvement.
2. Worksite analysis.
3. Hazard prevention and control.
4. Safety and health training.

6.21 Conducting Safety Audit

Audit must be conducted efficiently, consistently and comprehensively by competent auditors who must elicit the

cooperation of plant managers and staff.

There are three major phases of safety audit. They are

1. Pre-audit activities
2. Audit(on-site activities)
3. Post audit activities

1. Pre-Audit Activities Audits will fail if it doesn't have proper preparation. This will be more in case of companies which depend on the part-time auditors from organizations. Usually, they are the busiest persons who often start their audit preparation just before a day of audit. Various activities need to be finished before an audit team initiates its actual auditing process. These activities are given below:
    a) Selection and formation of team
    b) Preparing pre-audit questionnaire
    c) Review of relevant regulations
    d) Defining audit scope and establishing team responsibilities
    e) Review of audit protocols
    f) Development of an agenda

The manager of audit program identifies the team leader of audit, and they together chose the remaining team members to form an audit team. The team members should possess overlapping and complementary skills. If any situation arises or requires a wide technical knowledge at the auditing facilities or during the formation of team, the organizations allot their subject expertise to the audit team. Some organizations allot their safety coordinator to the audit team to give a better idea of the process and methods which will help them to prepare well for the upcoming visit. It is also important to consider language when forming an audit team. After the finalization of the team, it is always advised to arrange team meetings before initiating an audit process. This can be handled in a variety of ways. Generally, face to face interactions are preferred, if not possible, video conference can be arranged.

Preparing Pre-audit Questionnaire Preparing pre-audit questionnaire serves two purposes. First it facilitates the audit team to become familiarize with the safety related operations and activities prior to arriving on site. Second, it alerts the audit manager and his team to prepare well for the audit. A questionnaire should not be prepared in bulk of pages; it should be as concise as possible as. Generally, 15 to 25 pages are sufficient in making a questionnaire. The questionnaire should include the questions asking the general information pertaining to the facilities. Its prime motive is to create awareness regarding organization's safe practices so that the relevant requirements and regulations can be reviewed by the audit team. After completion, the questionnaire should be circulated to the site four weeks before an audit. Reviewing the questionnaire prior to the on-site visit by the audit team member is also important. Generally, the company related information and safety related information as shown in table are very much useful for prepare of pre-audit questionnaire.

6.22 On-Site Activities

On-site activities during an Environment, Health, and Safety (EH&S) audit will include the following primary functions

1. Opening conference
2. Orientation tour
3. Overview of organization and management systems
4. Review of Records and documents
5. Staff interviews
6. Physical inspection of facilities
7. Closing conference
8. Development of the audit report

6.23 Opening Conference

Every audit should start with an opening conference where audit team, site operational and safety management are involved. Plant manager takes the initiation and begins the conference by a welcome address. The responsibility of this conference will be on

team leader who fix the agenda and looks that everything run in time. Arriving on time is the simple and crucial element for the team members. Much time is wasted if the audit time arrives late, and this may lead to delayed audit process.

6.24 Orientation Tour

Once the opening conference has completed, the audit team will be taken to an orientation tour. This ensures the team to review and observe the on-site operations and facilities. Following are some tips while conduction orientation tour.

1. Provide the time limit for the site escort and inform him regarding the locations that you are willing to see.
2. It is better to use pre-audit questionnaire for focus and help.
3. Do not spend much time in the production areas. As this observation does not provide required performance information. It will only give an idea of machine guarding and Personal Protective Equipment (PPE)
4. If the size of the organization is too large, it is preferable to split the audit team into two or three.
5. Manage the orientations depending on areas of interest.
6. Remember and note the work areas where you are willing to revisit again.

6.25 Overview of Organization and Management Systems

After completing the orientation tour, it is beneficial to have a quite discussion with the safety manager to confer how safety compliance is managed at the site. Also, policies, responsibilities, organizational structure and management procedures are considered during a discussion. These interactions may help the audit team in understanding how the works are done at site.

6.26 Review of Records and Documents

Generally, records and documents are reviewed just before the inspections and interviewees. It is also preferable to review the documents at the time when the interview is being conducted or a process is being inspected. This may depend on the auditor style, or

the area being audited. As the records contain many compliance requirements, the auditor need to check specifically for the applicable terms, requirements or conditions and need to verify whether these requirements have been met or not. While performing an audit, a bunch of files and papers will develop which is not uncommon and the team may leave the work area with large files of reports and documentation. It is important to note that the audit team should prepare the copies of those documents if they want to conduct a complete evaluation of facility's compliance status. Following are some activities that helps in developing an effective review of documents.

1. First review the records.
2. Do not get devastated with the tasks.
3. Ask for time if you require.
4. Create a list of verifiable requirements.

6.27 Staff Interviews

Interview is the significant aspect of the safety audit process. There are some numerous interviewing skills, if equipped will definitely improve the audit outcome.

6.28 Schedule Interviews Ahead

An interview should be planned and scheduled well in advance so that the employee being interviewed will be prepared and get ready for the auditor. The interviewee should be informed, if possible, regarding the purpose of audit, form of questions which may be asked, and types of documents that the auditor want to review. If necessary, one day prior intimation should be given regarding interview schedule. In some cases, the auditor may walk to the production area and ask the technician and operators some questions regarding safety.

6.29 Conduct Interviews at the Workplace

It is always advisable to conduct interviews at the workplace of the interviewee. This serves various purposes. First, the employee being interviewed gets relaxed and will not feel nervous. Second,

the documents and files are readily available if the interview is conducted in the workplace, as they maintained and preserved in the work area. Third, the auditor can have a look over the actual conditions of the workplace, the behaviour of staff. However, interruptions and distractions may occur if the interviews are conducted within the work area. Also, most of the workplaces are noisy which makes difficult to communicate.

6.30 Make Interviewee Relaxed and be Sensitive

Some of the employees assume that the audit interview is a threat to their job security. The responsibility of the interviewer is to be sensitive towards an interviewee and questions should be asked in a respectful manner. If an interviewee facing problem in answering, the auditor should shift to the next topic rather than going deep into the question. Auditors have to remember that the interviews are the part of audit; it is not the audit of interviewees. The auditor should remember to the interviewees that the need of the audit is to eliminate the barriers which require more resources, training and attention.

6.31 Avert Yes or No Questions

Always go for the open-ended questions i.e., the questions should be aimed at making the interviewee to speak out openly and communicate the compliance issues. Do not go for closed-ended questions i.e., its response will be either yes or no.

6.32 Explore for the Deserving Staff

There are chances that an auditor starts interviewing the facility staff and he may end up by interviewing two or three members to collect the required information. To avoid such circumstance, an interviewer always needs to explore for a deserving staff who may be able to give responses for the questions immediately without any ambiguity. In some cases, contacting the retired or resigned staff who have relieved from the organization is also advisable if they able to provide required information. Interviewing is an interactive process where every auditor may have his own style and attitude.

6.33 Physical inspection of Facilities

6.33.1 Inspect the Remote Areas

Most of the organizations have obscure areas, which may be presently used as storing hazardous materials. It is the duty of the auditor to review those areas thoroughly, because the employees will not realize that they create potential problems. It is the auditor's job to carefully inspect those places to know if any potential problems exist. Observe Emergency Response Plans in Action Emergency response plans are developed and maintained by the organizations to act immediately in the event of unplanned activities like fires, discharges. Auditor should perform a keen examination of emergency response plans. Based on the availability of time, drills must be conducted during an audit where an auditor can observe directly the reactions of staff.

6.33.2 Closing Meeting

Once the on-site activities of auditing have finished, there will be a closing meeting to discuss the preliminary observations and findings. Most important findings and observations should be drafted and given to the management. If any immediate remedial actions are required, then the audit leader should intimate the management personnel about the situations. If any matter of clarifications required, it is to be listed for the discussion with concerned staff.

6.33.3 Preparation of Report

An audit report should recap the information collected during the audit. Also, the audit checklists can also be attached. An audit report should include the following:

1. General information pertaining to the audit,
2. A description of the criteria and factual information used to select the source for an audit.
3. Findings, conclusions & recommendations.

6.33.4 Post Audit Activities

1. Feedback response from the site
2. Final Report submission
3. Audit follow-up and closure

1. **Feedback Response from the Site**
   As a part of audit process, the facility manager can respond to the suggestions and findings given by the audit team. They have a right to reject the findings and should give an appropriate explanation in support of it.
2. **Final Report Submission**
   Auditor may finally submit the audit report which contains the conclusions and recommendations for implementation. In some cases, the report may contain a time frame for implementation. In addition, the audit report should include the explanations for any rejected findings.
3. **Audit follow-up and Closure**
   During follow up, the audit team verifies and determines the effectiveness, adequacy and actions taken by the management to correct the reported recommendations and issues.

SAFETY DRIVES, CIRCULARS, POSTERS, BULLETINS AND PAMPHLETS

7

As we know that most safety breaches occur due to human factors and to address the human factor safety drives are launched to make them aware of safe working practices. The safety drives are being launched on the basis of recent safety breaches or probable cause of accidents, which could occur in future. Safety drives basically aim for continuous improvement of safety culture and encourage the moto of zero accident. The reasons to launch safety drives are as under:

1. Ensuring that accountability is built right through the organization.
2. Workshops to engage teams in the processes of safety and build workforce positivity.
3. Leadership having a passion and commitment to the momentum gained in safety.
4. Sensible metrics to reinforce compliance and to understand the need for consistency.
5. A willingness to listen and make use of worker's past experiences and knowledge.
6. A willingness to spend appropriately to ensure the process works.

The leadership of any organization decide how to build the culture of safety in organizations. The safety is basically supreme in all of the processes. Following diagram shows that how leadership drive safety culture excellence in their organization.

How Leadership Drives Safety Couture Excellence		
	Leadership	• Act as role models and coaches to crate a culture of habit
	Employee Engagement	• Ensure safety becomes the key topic of conversation
	Conditions & Behaviour	• Put in place the conditions for safety
	Systems & Process	• Support and nurture the tools to enable improvement
	Safety Culture Excellence	• Continue to challenge the status quo

7.1 Safety Drives in Indian Railways

Safety Drives are being launched by Ministry of Railway or Zonal Railway or Divisional Safety Organization to motivate the officers and supervisors to focus about the subjects given in those safety drives. All concerned officers are to focus on these safety drives and do the inspection accordingly. The safety drives are for certain time periods and cannot be continued for a longer period. If a safety drive is run for a longer period, then it will loose the desired impact. Some of the examples of safety drives in railways are as under:

1. Prevention of Rolling down of Locos to avoid derailments.
2. The Working condition of HS Lamps/Tri coloured torches.
3. Prevention of Derailments.
4. Rule for Working of Push Trolleys, Cycle Trolleys and Moped Trolleys (Light Motor Trolleys) and Motor Trolleys.
5. Fire Prevention.
6. Prevention of Accidents at Unmanned Level Crossings.
7. Non-functioning and Malfunctioning of Detonators.
8. Prevention of Accidents at Manned / Unmanned Level Crossings.
9. SPAD Prevention.
10. Joint Inspection of Points and Crossings.

11. Prevention Carrying of Inflammable Materials / Articles.
12. SPAD Prevention of Light Engine.
13. “Prohibition of Steel tapes/metallic levelling staff for measurement in OHE Territory”.
14. “Prohibition to be taken for working of Trains during Foggy Weather”.
15. Safety Drive On “Improving the Road Surface at Un Manned Level Crossings.
16. Safety Drive on Stabled Coaching Rakes to Ensure Closure of Windows Doors.
17. Ensuring safety while executing works adjacent to running lines.
18. Safety in the prevailing situation.
19. Prevention of Yard derailments.
20. Ensuring safety while executing works adjacent to running lines.
21. Maintenance of points and crossing.
22. Safety of works sites for various works done adjacent to running lines.
23. "Short cut methods".
24. Proper closing of doors of OHE Tower wagon while on run.
25. Maintenance of assets
26. Maintenance of track and points & crossing in yards as well as strict observance of rules in shunting
27. "Stabling and securing precautions"
28. Proper closing doors of Engg. track machine/packing machine
29. Single car test of a Coach
30. Safety issues related to storage and handling of Ammonium Nitrate
31. Exchange of all right signals
32. Safety drive to ensure safe train operations
33. Safety drive on S&T disconnection and reconnection
34. Safety drive on safety while operating track machines regarding
35. Safety drive on safety at work sites adjacent to the running lines
36. Divisional safety drive for checking the availability of TRD jumper cable
37. Working on running lines and safety at worksites
38. Divisional Safety Drive Census for requirement of Buffer ends
39. Special safety drive on cab changing procedure and to prevent

rolling down of Locomotives
40. Safety Drive for the month of Jan Ensuring safety, while executing works adjacent to running lines-reg
41. Safety Drive on Winter season precaution
42. Safety Drive to ensure ERCJ Clips properly driven at all fishplates joints.
43. Safety Drive all manned LC (Interlocked & Non interlocked gates)
44. Safety Drive month of FEB, Maintenance of Points and Crossings.
45. R.B Special safety drive on Maintenance of Track and Points and Crossings
46. Prevention of LC Gate open cases
47. Frist Aid Box
48. Ensuring the availability of thick web switches register
49. Dry vegetation & Railway installations
50. Safety drive on Rolling down Locomotives/Trains
51. Prevention to be taken while backing the train'
52. Massive Drive against smoking and carriage on inflammable material through rail
53. Precaution to prevent unusual incidents due to festival gathering near railway track
54. Railway Board Safety drive on summer weather precautions
55. Safety drive on “Precaution of YARD derailments
56. Hon’ble Prime Minister’s 10 points Agenda on disaster related issues
57. Safety drive on Prevention of Derailments of Freight Train entering / leaving Stations and Yards
58. Safety drive on “Safe Securing & Packing of Goods rake”

7.2 Safety Circulars

Before we discuss about safety circulars, we must understand about the circular. A circular, a letter or a notice is a very important communication tool. The importance of these communication tools cannot be underestimated as they enable you to disseminate critical information to the employee, people to provide relevant and latest information regarding the business and other aspects of working.

These tools can be used to invite the potential consumers, clients, suppliers, and partners for any upcoming events or conferences. Apart from this, circulars also make for a great tool to reach the target audience. These circulars can also be used to spread the information about the safety.

Circulars - a Crucial in Official Communication

Irrespective of the size, work, duties, and services of any organization, communication is one of the most crucial aspects of its working. Official communication plays a vital role in the efficient and smooth working of an organization. Effective communication between employees, authorities, departments, and clients takes the organization ahead on the path of success. Circular is the most important tool of official communication.

What is a Circular?

A circular is the official communication medium which a business organization communicates. As the name itself tells, it is a letter which is given to the audience. Circulars have four components: head, opening, text, and signature. If you receive a circular from an organization or its team of employees, then it means that the organization is planning to inform you about something. The term circular comes from the fact that it was written on a circular piece of paper. Although circulars can be written on any kind of paper, the most frequently used type is the "letterhead". Circulars are generally used in the context of businesses and public service organizations.

In a general sense, a circular is a statement about a business or about a company which is issued by the firm. A circular can be addressed to customers, suppliers, customers, employees or to any other business group. These documents are used for many different purposes in the context of businesses.

The Structure of a Circular

As a circular is a letter, it must have a heading and a body, which contains the required information about the sender. The head will include the information about the recipient, addressee or readers and it is considered the important part of the circular. The opening is a section where the sender introduces himself or herself. In this section, the sender provides the information about his business, his name, the title, etc.

The body will contain information regarding the purpose, content or information conveyed by the circular, so it must be relevant to the recipients. The closing is used for ending the letter or for the sender's signature.

The use of circulars in organizations is very common because they are direct and to the point. In circulars, organizations want to inform their customers about the company, about the services offered or to explain the new developments within the organization. They might notify you about the business, the goods that are being sold, a new promotion or a new product release. Circulars can also be written

to employees to inform them about the plans of the organization, or they can be written to the partners or suppliers for the purposes of advertising.

In the corporate world, different heads may be present in a circular. The most important one is the head that is present at the beginning of the letter. In this head, the sender will be introduced and will mention his/her title or name. After that, a brief introduction will be presented.

The name of the organization may be mentioned, followed by the location and the format of the letter, like business letter format. Also, it can be written that the letter is circular. This is the official form of the letter and if it is written correctly, it might be easily spotted. Other important heads are the subject head and the closing.

The content of a circular should be concise and should include all the details that should be included in the letter. In short, it is not a good idea to include lots of information in the letter. Also, the letter should have a professional presentation. It is better if it has the signature of the person who wrote it. This will help to add credibility to the letter. A good way to do it is to print the company name and then sign the letter.

7.3 Advantages of Safety Circulars

Safety Circulars, if designed and distributed productively, play an important role in the awareness of safety in Indian Railways. The advantages of safety circulars are as under:

1. **The Easiest Method for Conveying Information**
   It is a straightforward and most convenient method of conveying important information to a large group of people. Circulars play an important role in the growth, development, and smooth working of any business. The information can be conveyed at a greater level at cheap rates. It is also useful in producing prompt feedback from the respondents.
2. **Achieving Economy**
   In broader terms, circulars can also be used for wide publicity. To convey the news related to product, service, or customers, circulars are used as they help to expand the business and market base of a company. As a result, the large amount of money that would have been used in sending separate letters can be saved.
3. **Time-Saving Method**
   With the efficient use of circulars, any important information can be transmitted to a large section of people at the same time. Hence, it saves you a lot of time that the company officials might spend on conveying the information separately to different people. Circulars

can be displayed on the notice board of the workplace, and people can read the relevant information. This time-saving method becomes very convenient for companies.

4. **Cost-Effective**
   Circulars are a cost-effective method of spreading information. Since with the help of just one circular information can be given to a hundred people. It thereby reduces the printing cost as well as the distribution cost of information per reader. With this method of passing information, an organization can save a lot of money for better purposes.
5. **Fewer Efforts**
   Circulating information separately to all the concerned individuals requires a lot of work and effort. It becomes both time-consuming and difficult. With the use of circular letters, an organization can effectively overcome this problem with an efficient solution. Circular letters help to communicate with a large number of people with minimum effort.
6. **Increasing the Confidence of Consumers**
   Rightly designed, convincing, and attractive circular letters can easily convince a reader about the importance and benefits of the data mentioned in the circular. It thereby enhances a consumer's trust and confidence in the company's products.
7. **Develop Public Consciousness**
   One must design the circulars very carefully. If the correct information about the price, utility, and place of availability of the product is mentioned in the circular letter, the general public reading that particular circular becomes more conscious about the product. These letters also help to inform the customers about social welfare activities, quality of the product, and services, thus engaging them more with the company.

Some of the Safety Circulars issued in railway are as under:

1. Action to be taken in any unusual seen in run through trains.
2. Safety at worksite.
3. Precaution taken for stabling of Load/Loco/Train at station /yard.
4. Procedure for preventing admission of rolling stock into power block section or over section of track with dead overhead lines.

5. Protection of track during Block.
6. Summer precaution for LWR/CWR/SWR Territory.
7. Action to be taken on Brake Binding & prevention of Flat Tyre on passenger carrying train & Locomotives.
8. Action to be taken after abnormal jerk message given by Loco Pilot, Motorman & Train Managers.
9. Running of loaded trains (more than 3000T) BOXNHL & similar rakes with BMBS.
10. provision of Train Manager (TM) for loaded Freight Trains with Bogie Mounted Brake System (BMBS) like BOXNHL, BCNHL, BTPGLN, BCCW etc.
11. Action to be taken in Hot axle.
12. Cab changing procedure in Multiple Loco (Conventional Locomotive).
13. Winter Precaution and Train working during thick & Foggy weather.
14. Regarding GLP Check. (GR 4.31).
15. Non-interlocked working (Appendix-III).
16. Station working rules (GR 5.06 and APP.-XIV).
17. Precautions to avoid Yard Derailments.
18. Prevention of Fire in Passenger Carrying Trains.
19. Prevention of SPAD.
20. Train operation in case of Loco pilot and/or Guard experiencing any abnormal-Condition in the track, information sabotage or likely sabotage to the Track/Bridge/fixed installation and obstruction on adjacent line(s).
21. Monsoon precautions.
22. Prevention of Roll back of train during power interception/ loco reversal.
23. Shunting Precautions.
24. Knowledge of rules for Gateman – need for intensive counselling.
25. Duty for securing safety.
26. Disconnection and Reconnection (SR 3.51.6 & App. XIII).
27. Detaching Engine.
28. Lurch/Conditions likely to affect running of trains (S.R. 6.07).
29. Summer precautions for C&W officials.
30. Precautions to avoid Yard Derailments

7.4 Safety Posters

Maintaining workplace safety is a constant challenge. New employees, new safety rules and new equipment are just a few of the many issues that must be addressed in any safety program. But the key to a successful safety culture is worker motivation. Without worker engagement, even the best-laid plans will fail.

So how can you motivate and engage workers to take safety seriously? There is a simple and cost-effective tool that can be used to help improve workplace safety in nearly any situation. Safety posters. Safety posters are powerful visual communication tools that can help you create or maintain a successful safety culture - and a successful business. Here's how to use them most effectively:

1. **Reinforce Your Safety Messages with Safety Posters**

   To effectively communicate your safety program, you need to do more than hold regular meetings and post mandatory safety signs. You need to educate and engage employees to keep safety top-of-mind. Safety posters can help by removing barriers to learning and levelling the playing field for diverse learners.

   Engage Employees-

   People are naturally drawn to images. They attract and hold attention, stimulate curiosity and illustrate messages. Safety posters with interesting images are especially effective at grabbing employee attention.

   Educate-

   Now that your safety posters have employees' attention, you have a good opportunity to reinforce training messages and bring attention to new ones:

   1. Address issues specific to specific types of work
   2. Promote special topics, such as falls or eye injuries
   3. Advertise targeted safety themes for weeks or months
   4. Complement your safety culture

Increase Consistency-

Safety posters are one of the easiest and most effective ways to increase communications consistency, while reinforcing your key safety messages. They help improve retention of those messages - and also raise awareness of your commitment to safety.

2. Choose the Right Safety Posters

Just like eye-catching billboards, safety posters are intended to engage people. But with the wrong placement, message or colours, they could still be ineffective. Consider the following to find the right posters for your audience.

Purpose –

What is the purpose of your safety poster? Are you targeting real problems or setting a tone for your safety culture? Posters should reinforce safety topics and motivate positive action.

A Clear Message –

Sometimes posters are a bit too artistic, resulting in unclear messages. Make sure the safety posters you select have images and text that are easy to read and understand. Avoid inside jokes, unless they complement the culture in your workplace.

Audience –

Consider the knowledge level, age and other characteristics of the people you want to reach. Don't talk down to experienced employees, but don't talk over-the-head of new hires. Humorous posters can be effective in many situations because they're memorable.

Readability –

If people can't read your poster from a distance, you're missing an opportunity. Poster designs should include a variety of text sizes. The headline should pull in the reader. Avoid too much fine print, tight character spacing and low-contrast colours so your posters can be read from a distance. Think of reading a highway sign vs. a roadmap. Sometimes less is more.

Originality –

The safety message on your poster has one chance to grab the attention of your audience. Eye-catching posters with original images, colours and themes will make employees stop and take notice.

3. **Make Sure People Read Your Posters**

You take the time to craft safety protocols, find posters that meet your needs and hang them throughout your workplace. But how can you be sure people will pay attention to them? Here are three tried-and-true tactics to ensure people read your posters.

Shuffle Locations-

You can ensure more people see your safety posters by moving them around frequently and testing where they're most effective. You might assume the break room is the best spot to catch people's attention - but if people are engaging with colleagues your message may be missed. On the other hand, a hallway might be a surprisingly good spot to catch some eyeballs as people pass by with nothing else to look at. Once you find the spots that seem to gain the most attention, rotate your posters between the hot spots. It's a simple and inexpensive way to surprise people with fresh messages.

Update Frequently-

Three out of four safety professionals believe changing safety posters often increases their effectiveness, so keep them fresh. Although your basic topics (PPE, spills, handwashing, etc.) may stay the same, new posters with different colours, images and slogans will attract attention.

Make People Laugh-

Several studies show that humour boosts retention, so a humorous poster will not only catch attention, but it may also help people remember your message.

4. Use Safety Posters as Motivational Tools

Inspirational and motivational posters help you create an environment where people feel valued, empowered and respected. Productivity and safety improve when workers feel valued by their employers. Motivational messages that align with your company values will encourage your employees. Here's how to do it:

Be Positive-

Most safety signs focus on the negative, giving orders of what NOT to do. Posting safety posters with attractive images, positive messages, lively colours and humour creates a lively atmosphere the encourages workers.

Promote Teamwork-

Employees who feel there's a low level of respect between colleagues are 26% more likely to quit their jobs. Happy employees stick around, so messages that promote teamwork are important.

Encourage Ownership-

Businesses find the most success when they treat employees like adults. That includes encouraging them to take ownership of their work and their actions. Empower your employees with inspirational posters.

Acknowledge Hard Work-

Studies have shown that employees whose managers consistently acknowledge their excellent work are 5-times more likely to stay at the company. So let your team know you don't expect perfection, you expect progress.

Motivate Success-

Encourage employees to think big, take calculated risks and follow their passions to keep them engaged. Committed and engaged employees are 87 percent less likely to leave.

5. Inspire a Safety Commitment

Words are incredibly powerful. They can inspire, motivate and persuade - or discourage, dismiss and create negative attitudes. So, it's important to choose your words wisely, because they indicate the key element of success: attitude.

Employee engagement empowers an organization to create a successful safety culture. When employees are committed to the organization and its goals, they're engaged to make safer choices because they actually care about what they're doing. The messages you send, whether spoken or posted around your building on safety posters, can motivate the change you need to create a safer, more successful workplace.

1. **Safety Posters Provide a Safety Message Quickly**

   Annual safety training, weekly toolbox talks, refresher courses and on-the-job training are all crucial elements of your workplace safety and health program, but reinforcement is critical to maintaining a safe work environment throughout the year. Hanging safety posters or signs in key places at eye level emphasize your most important safety messages quickly, when needed, every workday. Sharing safety concepts and best practices that workers have already heard, or been exposed to, is the best way to reinforce great safety habits on the job.

2. **Safety Posters Prevent On-the-Job Incidents**

   Location is important when you are considering where to place a safety poster. Hanging an easy-to-read safety poster that emphasizes a hazard or safety tip in critical work areas gives workers easy reminders of vital information at the exact moment they need it. Informational safety posters should repeat ideas that employees have already been exposed to during safety training or a weekly safety meeting. When the work environment has a tendency to get

hectic or overwhelming, then safety posters become even more necessary.

3. **Safety Posters Demonstrate the Organization's Commitment to Safety**

   Every organization should have a written safety policy that is communicated to all employees and reinforced throughout the year. On-boarding and annual safety training are great, but finding innovative ways for management to demonstrate their continual commitment to safety is also necessary. Cultivating a safety-minded workforce can be accomplished by investing in high-quality artwork like safety posters, motivational safety prints or elegant canvas art with a workplace safety message. Doing this reinforces safety as a company value throughout the year.

4. **Safety Posters Carry the Message Outside of Work**

   When safety is an organizational value, it becomes absorbed into the fabric of the workplace culture. The significance of safety doesn't just stop when employees head home for the day. If safety is reinforced throughout the workday, with the help of safety posters, then employees are more likely to continue safe habits when working offsite, on the road and even after they go home at the end of the workday. We all want our people to get home safely, but we also want them back the next day adding value to our organizations!



7.5 Safety Bulletins

Safety Bulletins are guidelines recommended by the Safety Organizations. These bulletins are generally issued for informing the targeted group of some important message. In Railways, safety bulletins are generally followed by some serious accidents to avoid any recurrence of the same.

The Safety Bulletins are representative of the commitment of both safety organization and management to ensure safe practices in train operation. These bulletins convey the message directly and save a great deal of time and effort. By definition, the bulletins are a short official statement or broadcast summary of news, or a regular newsletter or report issued by an organization.

Most of the Zonal Railways publish quarterly safety bulletins to spread the message of safe running of trains. Sometime, these

bulletins are thematic. The cover photographs of some bulletins are as under:



7.6 Safety Pamphlet

A pamphlet is a small, unbound booklet focused on a single subject, often educational in nature. A safety pamphlet is an unbound book (that is, without a hard cover or binding). Pamphlets may consist of a single sheet of paper that is printed on both sides and folded in half, in thirds, or in fourths, called a leaflet or it may consist of a few pages that are folded in half and saddle stapled at the crease to make a simple book.

Pamphlets functioned in place of magazine articles in the pre-magazine era, which ended in the mid-nineteenth century. There are hundreds of such pamphlets in railways giving various aspects of safety.

7.6.1 Pamphlets vs. brochures

While they might seem similar in size and layout, pamphlets and brochures are not the same thing. While brochures are used to

advertise something (like a brand or an event) pamphlets are made to inform, not sell. Most often, pamphlets are distributed as educational tools.

For certain organizations, like nonprofits or community-based groups, pamphlets can be a valuable way to spread information and awareness on various issues. In industries like healthcare, pamphlets can also be a cost-effective way to educate people on things like medical procedures, different illnesses, and mental health.

The pamphlet has been widely adopted in commerce, particularly as a format for marketing communications. There are numerous purposes for pamphlets, such as product descriptions or instructions, corporate information, events promotions or tourism guides and they are often used in the same way as leaflets or brochures.

7.6.2 How to make a pamphlet in 5 steps

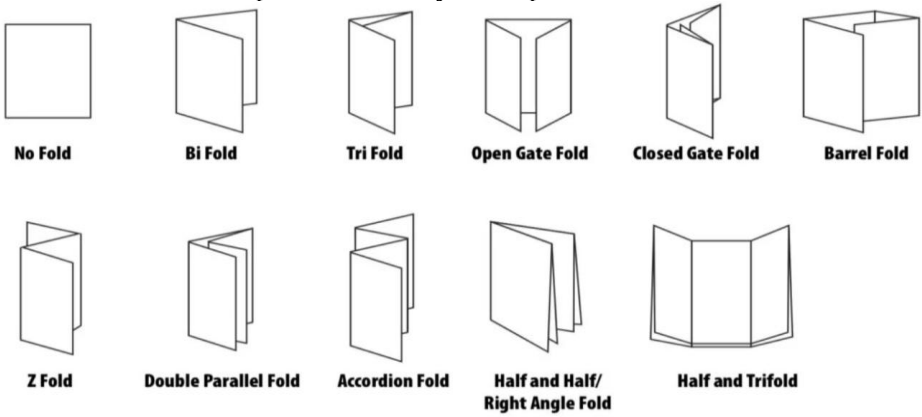
Think a pamphlet would be a good tool for your organization or group? Making one is pretty simple, so let's dive right in.

The process of creating a pamphlet is very similar to making a brochure. The key difference is intention. Instead of putting emphasis on making a sale, put your emphasis on providing valuable and accurate information about a subject.

First up: deciding on what size to make your pamphlet.

1. **Consider your layout/size.**
   Before you can start designing, decide how big or small you want your pamphlet to be, and how it should be folded.
   There are tons of different fold options to choose from – just remember that you don't want your pamphlet to be too complicated to open and read.
2. **Write compelling but understandable copy.**
   Pamphlets don't offer a lot of space, so each sentence should be purposeful and valuable. Use simple language that's easy to read and easy to understand.

3. **Provide visual interest.**
   Illustrate your pamphlet with helpful visual elements—like photos, tables and charts—that make it more interesting to the reader.
4. **Choose your colours.**
   Colour is closely tied to emotion. Using colours wisely in your pamphlet will help communicate your message on a deeper level.
5. **Test-run the print version.**
   Before you print and order hundreds of copies, test-run it first. Verify that the finished product meets your expectations.



7.7 Safety Camps

Sub: Usefulness of Safety Camps; combined Refresher Courses with Safety Camp.

Ref: (i) Board's letter No. 2001/Safety-I/13/8 dated 26.02.2002 (ii) Board's letter No. 2000/Safety(A&R)/19/40 dated 19.12.2000.

Doubts have been raised from time to time by the Zonal Railways on the need and usefulness of holding of Safety Camp. Enclosed find in Annexure a copy of the Background Note on Safety Camp and Refresher Courses.

1. In order to overcome shortage of staff some of the Zonal Railways had been recommending discontinuance of the Safety Camp; or at least reduce its duration. The matter has been considered in the Board and there appears no apparent need to review the existing system. However, if any Railway feels that the period/duration for which the staff is sent to the Safety Camp should be reduced, or if any category of staff may be exempted from the Safety Camp, they may send their recommendation to the Board.
2. Some Railways had expressed doubts on whether it is mandatory to have a combined Refresher Course followed thereafter by a Safety Camp for all

the Safety staff including Loco Pilots. Some, Railways had recommended this system so as to avoid difficulties in sparing of staff twice. Eastern Railway has sought clarification as to the policy of holding Safety Camp at Dhanbad subsequent to the Refresher Course at ZRTI/Bhuli. (Eastern Railway may link their reference No. M/RL/P/42/RgStaff/Trg./Pt.IX dated 10.05.09; and No. TG-593/S. Camp dated 10.09.09 and 29.04.09).

Based on the views of the Zonal Railways, the subject has been reviewed afresh in the Board. It is now advised that the Zonal Railways are at liberty to decide whether they would like to hold the Refresher course and the Safety Camp in continuation, for all the staff (including Loco Pilot). Alternatively, they may decide to conduct these courses separately.

3. In the recent COM's Conference held at Kodaikanal, the reluctance of the Zonal Railways to spare Controllers to attend the Refresher Course and the Safety Camp was highlighted. Many of the COM's questioned the need for providing Refresher Course (and Safety Camp) training to the Control Staff. The Zonal Railway may, now send their recommendation on whether the Safety Camp training for Section Controllers can be done away with or reduced. Further, the duration of the Refresher course of two weeks for the Section Controllers seems to be too long. We could consider curtailing this to six working days and keep its periodicity to once in three years. Suggestions on the above may be sent to Railway Board.

With best wishes

Reference: D.O. No. 2001/Safety-I/13/8 dated 28.05.09 is issued and signed by Kamlesh Gupta, Adviser Safety and is given to COMs, All Indian Railways.

ANNEXURE

BACKGROUND NOTE ON SAFETY CAMP AND REFRESHER COURSE

A Study of the historical background of having Safety Camps has revealed the following:-

Safety Camp - Background:-

1. 1962: GM/WRly recommended a scheme, drawn up by that railway, for setting up Safety Camps in order to instill safety consciousness amongst the staff – the scheme envisaged running of accident prevention courses of one week's duration. Board accepted the scheme and desired its implementation on all the other Railways subject to their own local requirement.
2. 1963: The then MT in his address to the TS's (Safety) in a meeting held on 21.09.1963 in Boards Office laid special stress on the organization of Safety Camps and desired that the process of staff being put through the Safety Camps should be accelerated.
3. 1965: Board issued policy directives to all Zonal Railways that the Safety Camps should be opened on all the Railways to give training to Guards, Drivers, SM's, ASM's, Shunters and Block Signallers. This training was further to be extended to other categories like TXR, C&W Fitters, First Fire men, Shunting Jamadars, Cabin man, Leverman, Points man etc. The recommendation of the Kunzru Committee which had recommended holding of Safety Camps on the Railways, was accepted and advised to the Railways for implementation.
4. 1966: The Standing Safety Committee recommended continuation of the Safety Camps.
5. 1967: In the TS's (Safety) Conference held in November 1967 the continuation of Safety Camps was again discussed. It was decided that the Safety Camps may be wound up after all the staff in the prescribed category have undergone training at least once. Instructions were, accordingly, issued in December 1967 to all the railways asking them to progressively wind up the Safety Camps. It was further decided that Safety Seminars should be conducted during the Refresher courses.
6. 1970: The subject was discussed in an extraordinary meeting of the GMs with the Board in November 1970 by the then MR. Orders were issued to the Railways in March 1971 in response to the discussions held in the GM's meeting with the Board (November 1970) for restarting of the Safety Camps.

Purpose of the Safety Camp:-

The Safety Camp is of a short duration (3 to 6 days at the discretion of the Zonal Railway) and should not be mixed up with the training imparted during Refresher courses. Staff of different categories and from different Divisions are expected, in a Safety Camp, to meet and exchange their experience and views. The intermingling of ideas in a group discussion under the guidance of the Instructor In-charge of the Safety Camp generates a healthy outlook and tends to instill greater safety consciousness amongst the staff.

In order to overcome shortage of staff some of the Zonal Railways had been recommending discontinuance of the Safety Camp. This cannot be accepted by the Board. If any Railway feels that the period/duration for which the staff is sent to the Safety Camp should be reduced, or if any category of staff may be exempted from the Safety Camp, they may send their recommendation to the Board.

Syllabus for the Safety Camp:-

There is no uniform syllabus for the Safety Camp. As mentioned above the Safety Camp is not for the purpose of theoretical training, it is more to concentrate on the practical working during interaction amongst different staff, and to share and exchange their experience and views. Recent accidents which had occurred on the Zonal Railways need to be thrown open for discussion in the Safety Camp so as to develop a higher safety consciousness amongst the staff.

Refresher Course and Safety Camp:-

Consequent to acceptance of RSRC's Report, 1998, the periodicity of the Refresher course has been made three years as advised by the Safety Directorate vide letter No. 2000/Safety (A&R)/19/40 dated 19.12.2000.

In this letter, the categories of staff have been identified for attending the Refresher courses. In addition, periodicity and duration of each Refresher course has been specified. It is pertinent to note that the duration of the Refresher course for ASM/SM, Switchman, Controllers and Guards is 12 working days (total two weeks); on the other hand, the duration of the Refresher course is three weeks for Drivers and Assistant Drivers.

Based on recommendation from Eastern Railway for merging the Refresher course with the Safety Camp, Board gave clearance to the Zonal Railways vide letter No. 2001/Safety-I/13/8 dt. 26.02.2002 for a 3-day Safety Camp to be combined in continuation with two weeks of Refresher course, i.e. in a total duration of 2 ½ weeks both Refresher/Safety Camp could be held. This system was to be made applicable only for ASM/SM, Switchman, Guards, Controllers. An option was, however, left to the Railways that they could continue to follow

the existing system of two weeks of Refresher course and separately 3 days of Safety Camp.

Possibility of Combined Refresher course and Safety Camp for LP's: -

The Refresher Course consists of 6 working days training in the ZRTI's and another 12 working days training in loco shed for LP's.

The total duration of the Refresher Course is, therefore, 3 weeks. Board's letter of 26 February 2002 quoted above, specifically mentions combination of the Refresher course and Safety Camp of staff for two and half weeks. It is, therefore, not applicable for the category of Drivers or Assistant Drivers as the duration of their Refresher course is itself three weeks. It is due to this; the category of Drivers or Assistant Drivers is not mentioned for holding of a combined Refresher Course and Safety Camp in the letter of 26 February 2002. The references received by the Zonal Railways indicate their interpretation that holding of combined Refresher course and Safety Camp is permitted for the Loco Pilots and ALPs on the basis of Board's circular of 26 February 2002, is, therefore, not correct. This is, however, being reconsidered in the Board and the Zonal Railways would be given the freedom to decide whether they would like to hold the Refresher course and the Safety Camp in continuation for all the staff (including Loco Pilot) due to attend both these courses. Alternatively, they may decide to conduct these courses separately.

Review of Categories of Staff to attend Safety Camps:-

As mentioned above, the Zonal Railways may review the need of each category of staff for attending the Safety Camp as also its duration, i.e. around 3 days. The view of the Board is that we should continue to hold the Safety Camp for the staff for whom this is mandatory at present. Attending of the Safety Camp should be compulsory for SM's/ASM's, Loco Pilots, ALP's, Guard's etc.

HUMAN FACTORS IN SAFETY AND SAFETY COUNSELLING IN INDIAN RAILWAYS

8

Manpower is the most valuable asset of railway operations. Indian Railways has a total staff strength of over 12 lacs (1.2 million) out of which there are about 600,000 operating & maintenance staff, which play an important role in safety of Railways. Undoubtedly, the entire safety edifice of Indian Railways rests on the human element.

Railway staff are performing numerous functions every day. When an accident occurs, the probability is that in 65% of such cases, it is on account of staff failures and 35% on account of other factors. This is inspite of the fact that railway men are considered to be one of the finest groups of loyal, dedicated and hard-working persons who try to perform well their duty with best intentions and sincerity. This ratio has not been changing with time, training or technological input. However, overall, the number of accidents has reduced and can be reduced further through skill, knowledge and technological upgradations. The number of accidents caused by staff failure has come down from 514 in 1982-83 to 248 in 2001-02 reflecting about 52% improvement.

8.1 Human side of the human element

1. As human beings are responsible for a large number of accidents directly or indirectly, a question arises as to how to improve the situation and for this the basic cause of human failure has to be carefully examined. In this context, the importance of psycho-technology in the

field of railway operations cannot be over emphasized. It is essential that the traits of human character are studied to identify factors which lead to their committing errors, and then channelize the energies to the best advantage.

2. The 'human side' of the human element has to be closely seen and retrospection is required whether the present system of 'action taken on erring staff' is correct or needs to be modified.
3. For a long time there has been a stress on the philosophy of punishments as a means to improve. Normally punishments are given to the staff held responsible. However, the continuous increase in the number of accidents due to human element leads one to believe that resorting to punishment is not the solution. What is needed is a fresh approach, in reversing the current thinking by dealing with the problem by a psychological approach and getting to the root cause of these accidents to find a solution for this universal phenomenon of the failure of the human element.
4. To err is human; Errors of omission and commission on the part of station staff to some extent, could be understood, as they are not personally affected in an accident; on the contrary, in the case of the train crew like drivers etc. such errors are beyond comprehension as, during any accident, their own lives are at stake. There can be no greater deterrent than the fear of losing one's own life. Inspite of this, if he still causes an accident due to some failure, it must be on account of factors not entirely within his control.
5. Human failure can be due to absent mindedness, forgetfulness or drowsiness caused by audio-monotony of the sounds of running trains or any other similar factors. At other times, it may be momentary mental blankness or fatigue due to inadequate rest or worry of some kind. Even the best man can commit an occasional error.
6. In view of the above considerations, if a driver happens to be negligent or careless, perhaps punishment may lead to correction, but even there, a psychological study before resorting to punishment would lead to better results. It is, therefore, necessary that the human side of human element is studied in detail before imposing a penalty on the erring staff.

8.2 Human Failures

Technical check and automation to reduce human failures: Under optimum field conditions and with the best of intentions, a human being is likely to commit a mistake from time to time, In order to reduce

accidents, there are set operating rules which involve number of checks and systems; By adopting these systems, the mistakes are likely to be reduced from one in hundred to one in thousand. In an effort to reduce accidents further, automation as well as technical innovations arc resorted to, which may reduce chances of likely mistake from one in thousand to one in million.

8.3 Factors contributing to quality of human resources

To enhance the quality of human resources, a multi-pronged strategy is required to be adopted.

1. **Recruitment**
   a) Improving the quality of recruitment by focusing on appropriate aptitude tests.
   b) Reorganizing Railway Recruitment Board (RRBs) for enhancing the quality of recruitment.
   c) Improving the quality of recruitment of safety category staff; For this the job eligibility standards should be raised; Many experts feel that minimum qualification for such staff should be high school pass.
2. **Training**
   a) Modernization and Upgradation of Training Centers to improve the quality of training (initial courses as well as refresher courses)
   b) Competency-based training to be given to maintenance staff working in workshops and in open line.
   c) Training Modules: A central training cell, composed of a multi-disciplinary team of specially selected staff and officers, should be started. It should be assigned the responsibility of designing training courses and preparing quality training material.
3. **Strength of Staff & Vacancies**
   a) Staff requirement should be worked out afresh for zero-based assessment of manpower. Based on the exercise, sanctioned strength of staff may be revised and made uniform. The concept of multi-skilling should be adopted.
   b) All Safety category vacancies should be filled on an urgent basis.
4. **Simplification of Rules**
   With the changes in operating system and pattern of working, modernization and technology upgradation, rule books and manuals should be taken up for re-assessment to make them simpler for compliance.

a) A comprehensive accident manual universally applicable to all the Zonal Railways should be framed and circulated. Separate modules should be drawn up, category-wise, containing dos and don'ts for ensuring safety and preventing failures and accidents.
b) Handbooks containing relevant rules, framed in simple language, for different categories of staff should be issued.

5. Proper Environment

a) Congenial Climate

Full use of Ergonomics, which is a developing science, should be taken for creating congenial climate for the men to work with machine and thus increase his efficiency by creating a suitable climate.

b) Loco Cab Design

An ergonomic design of loco cab should be developed to make it a crew friendly cab so as to provide easy approach to various control handles/ buttons, so as to ensure fatigue-free driving for long hours.

c) Running Rooms

The upgradation of the Running Rooms should be done by providing certain basic amenities like proper hygienic toilet facilities, clean drinking water, proper ventilation, desert coolers, subsidized meals, etc. All the new running rooms should be built with improved layout and proper amenities. The running rooms should be able to provide a good rest to the running staff.

d) Crew lobbies

Should be upgraded by providing basic amenities, facility for proper display of various instructions, computer and software package for proper booking of crew and ensuring adequate rest for running staff.

e) Guard-friendly brake Van

Should be developed with several novel features to make them convenient and stress-free for goods train guards.

6. Fatigue & loss of mental faculties

a) Situations causing fatigue

Should be carefully analyzed. Diseases like diabetes and hypertension can also cause sudden unconsciousness and mental blankness, though they do not disqualify drivers. Research on the effects of aging has brought out that aging has definite effect on speed reaction and form perception, and these showed marked deterioration after 45 years of age.

b) Duty Rosters

Have also some effects on the efficiency of men. It takes 2 to 3 days for a person to adjust himself with the diurnal cycle of sleep. It was found that Drivers spending idle time or waiting for duty develop symptoms of fatigue and exhaustion on runs more quickly than those who start the trains on time. Long hours on duty also cause fatigue. An eye should be kept on these factors and while allotting duties to running staff, these factors should be considered.

7. Mental Worries

The staff connected with the running of the train should not have mental worries because of domestic problems particularly related to housing. It is desirable that such people are **provided with quarters** liberally so that their families are looked after well, they are readily available for duties and are housed in healthy surroundings.

8. Discipline & Punitive action

a) Discipline is the soul of an organization for its efficient functioning. Lack of discipline undermines productivity and endangers safety. No indiscipline should be tolerated, and appropriate remedial measures should be taken to ensure that discipline is maintained.

b) Supervisor-staff and Officer-staff ratios

Should be maintained at an equitable level so that Supervisors and Officers may be in regular touch with the staff working under them and command their respect and loyalty by redressing their grievances.

c) Appropriate disciplinary action

Should be taken immediately with swiftness on staff who cause accidents due to laziness, carelessness, lack of knowledge of rules and due to some similar other reasons.

d) Imposition of Penalty

While imposing penalty on the erring staff, consideration and weightage should also be given about intention of the erring staff, his limitations at that time, his truthfulness in accepting the mistake, his past record about safety aspects, general reputation about sincerity and loyalty to work and such other factors.

The spirit of punishing the right man and rewarding a sincere person sets a good example for the staff and boosts their morale.

e) Fear of punishments

Many psychologists and management experts feel that punishing conscientious staff for having a long and clear accident-free record just because they failed once is questionable, especially when their failure was beyond their conscious control.

Unfortunately, this has been happening in many cases on the Railways. The safety organizations conduct their inquiries in a usual, routine and mechanical manner and feel satisfied by fixing responsibility and awarding standardized punishments, without attempting to determine the circumstances that caused such failures. This has a very adverse and negative effect on the psychology of employees. If instead of closing the case with the imposition of penalties, the matter was probed deeper to identify the causes, it would be a much more rewarding, and indeed a useful study.

This point is required to be considered while giving punishment to staff.

9. Driver passing signals at danger—Factors responsible

a) Drivers' expectation or hypothesis when he finds most of the signals always in favour and occasionally one is against.

b) Taking cognizance of wrong signal

The driver might meet a display of several signals and respond to one, which did not apply to his train. Such an error might be due to a fault in the display or to poor visibility or to inadequate knowledge on the part of the driver or due to negligence.

c) Glare due to sunshine resulting in blurred vision of the driver and thus possibly making a mistake of responding to wrong aspect of the signal.

d) Signal showing wrong aspect (Phantom signals) It has been noticed that sometimes signals give wrong indications to the driver on account of cracked red lens showing orange or sunlight reflection. There have been cases when lens gets covered with moisture or greeze & gives wrong indication. Such cases come under the category of Thantom Signals' & mislead the driver leading to unsafe conditions.

e) Pre-occupation and distraction

Due to some serious domestic problems as a result of which he misses a signal.

f) Momentary Mental Blankness

Due to some worries or other causes

g) Wrong Practices
The driver and Assistant Driver should repeat the aspects of signals to each other as per rules, but do not do so in practice. No checks are exercised by supervisory officials from time to time. Education and proper drill are very important in such cases.

h) Lack of Vigilance
The Driving crew may be careless, including sleeping or being drunk on duty.

i) Short cut methods
With a notion to save time.

j) Incompetency
Due to his lack of knowledge and adequate qualifications.

10. Betterment of human factor

a) Psycho-technical methods
Are adopted to assess the suitability of staff connected with train working like drivers, station masters, points men, etc. A person's accident proneness is determined, based on a series of tests like reaction time, depth perception and concentration. Persons who fail to measure up to the standards are given alternative jobs unconnected with train working. Thus, the general level of staff connected with train running is elevated.

b) Seminars and training courses
Should be organized to clarify the rules and interpretations.

c) Close supervision, rigid inspections and friendly counselling go a long way to improving the human element on the positive side. Motivation is essentially an attitude of leadership.

11. Inspections

To improve quality of inspections, detailed checklist of various types of inspections should be made out and circulated. The quality and compliance of inspections should be made an important plank of the management tools.

As the element of surprise and the opportunity to observe the performance of staff under actual working conditions, surprise inspections should be intensified, especially between 0 hrs. and 4 hrs. at night.

12. Safety audits are suggested to identify system failures and generic shortcomings. Periodic safety audits should be undertaken at various levels for making an in-depth assessment of safety systems.

8.4 Action plan for improving the efficiency of human resources

1) **Careful recruitment** of suitable personnel in the initial stages.
2) **Training and educating** them throughout their career both on the job and in the schools; Special training of drivers on Loco simulator. (Para 8.5)
3) **Creating proper environment** to discharge their duties efficiently.
4) Keeping them **free from fatigue** and mental worries.
5) **Maintaining discipline** is the big strength of an organization.
6) **Punishing** the erring staff for negligence after arriving at real cause of his mistake.
7) **Minimizing accidents due to human factors** by providing technical aids as far as possible consistent with economy and smooth working.
8) **Betterment of human factors** by adopting phycho technical studies.
9) **Improvement of morale** of Railway Staff to meet the new challenges.

8.5 Special Training of drivers on 'Loco Simulator'

(a) Introduction

1. Loco Simulator is a new equipment by which loco drivers can be given training in workshops in environment and surroundings, which are almost similar to actual field conditions.
2. The use of loco drivers as a training aid was first started in the USA in 1968. Indian Railways procured the equipment in 1992 for training the drivers. 'Loco. Simulator' as a training aid to train drivers (fresh recruits as well as serving staff). There are four simulators already in operation for training Diesel & Electric drivers and 12 more are being procured by Railways.

(b) Details of Loco Simulator

The simulator is housed in a railway carriage to provide mobility and comprises of five major sub systems:

1. **Cabin:** The cab is an exact duplicate of the locomotive including all controls-the (hiolllc, the gauges, brake gear and all other functional units exactly at the same places, where they are to be found on the actual unit.
2. **The Data processing system:** A digital computer controls the simulator system. It coordinates the activity of the trainee and the instructor, the programmed information and the visual film cues.
3. **The visual system:** This enables the trainee to look out of the window at a motion picture view of what a driver would see during the actual run.

4. **The Motion system:** A realistic hydraulic motion system provides lateral, longitudinal and roll motion effects.
5. **The sound system:** Complementing all other systems in creating a realistic environment are the related cab sounds reproduced stereophonically. All types of sounds, & track noise, passing trains, the air whistling and other expected sounds are faithfully reproduced.

(c) Use by a trainee driver

When ready to make his first simulated run, while seated in the cab s right hand seat, a trainee driver gets the feel that his movement of the throttle starts everything in motion. Simultaneously the engines churn louder, the cab begins to vibrate and maybe lurch a bit, the indicator needles in up-close gauges shudder and begin to move slowly up and through the cab window ahead the scene begins to move and gradually picks up speed. A glance out of the window also shows that it is beginning to blur as speed is picked up. With all the activity going on at once, the simulator ceases to be a simulator and becomes an actual locomotive running on the track.

(d) Advantages of Loco Simulator

1. **Simulation of track experience** without any risk to the trainee, equipment, loss of line capacity or reduction in availability of locomotive.
2. **Alertness and troubleshooting** skill of the drivers can be judged by simulating different malfunctions such as Hot Engine, Ground relay, low lube oil, wheel slip, faulty traction motor, tripping of circuit breakers, low water and other unsafe conditions. Thus, correct assessment of safety-related weaknesses of loco drivers can be made.
3. **Aptitude testing** by observing the behaviour at the controls on the simulator and studying the aptitude of a person whether he is alert and careful or casual and careless in his approach. It can easily be determined whether he reacts quickly to the problems or is slow and dull.
4. **Safety category gradation** of drivers based on computerized assessment of responses on a simulator to minimize subjectivity.
5. **Sharp reduction in timeframe** for change of category of drivers from one type of locos to another and for introduction of drivers

to new sections. There are many other advantages such as driving confidence building driving efficiency & reduction of training time for drivers etc.

Loco simulator is likely to be of immerse use for giving practical training to drivers in real-time situations. This is bound to improve the safety alertness of the drivers.

8.6 Safety Counselling

Safety Counselling plays an important and essential role in day to-day safe functioning of Indian railway. The need for Safety Counselling has been elaborately commented on by the Sikri committee. Sikri committee says that safety Counsellors should be drawn from amongst railway man of probed ability and dynamism for a minimum for 3 years to guide the staff in every aspect of safe running of staff. Most of the railways have sanction post of highest grade to the safety Counsellors. The Counsellors are selected by divisional safety organization and sometime in Headquarters to select the best candidate in the aptitude of Counselling and knowledge sharing and guiding. These safety Counsellors are given appropriate theoretical training and on the job training in safety Counselling.

The Wanchoo committee has define the role of safety and stated that every department in railway are responsible for safety in their areas for example engineering department responsible for safety of track, mechanical department safety coach, wagon and loco and similarly operating department is responsible for safe movement of traffic. At present the safety Counselling team is headed by Senior Divisional Safety Officer (Sr. DSO) in the division and at zonal railway principal chief safety officer. Safety Counsellor are drawn from all major discipline and posted as safety Counsellor (traffic) to look railway working as traffic, engineering, loco, C&W and S&T.

8.7 Human Factors in Railway Accidents

Accidents, wherever they have occurred, have been caused either due to mechanical/signal failures or due to human error. In the ultimate analysis, a man's hand will always be identified in its occurrence. Apart from sabotage, certain lapses on the part of the workers in other accidents may be the causative factors.

The Railway Accidents Inquiry Committees had gone into the causes of accidents from time to time and brought to light various factors which cause death and misery to so many persons: In 1962 the Kunzru Committee submitted its report. The Committee has defined an accident as "any occurrence which does or may affect the safety of the Railway - its engines, rolling stock, permanent way or works, passengers or railway staff on duty is treated as an accident.

Writing about the accidents, the Committee further noted that “The lapse of the Railway's operating staff was responsible for 77 percent of the collisions, 56 percent of the derailments, about 85 percent of averted collisions and block irregularities and for cent percent cases of trains passing signals at danger. Even in respect of the accidents at level crossings, 27 percent of them resulted from the failure of the Railway Staff.

The Wanchoo Committee (1968) has written, "the primary responsibility for collisions ordinarily lies on staff in the categories of Station Masters, ASMs, Switchmen, Levermen, Cabinmen, Pointsmen, Shunting and Yard staff or the Loco Running staff. It will be seen that 80 percent of the staff responsible for collisions belonged to these categories".

The Railway Accidents Inquiry Committee 1978 in its Pt. I report submitted in 1979 wrote "Failure of railway staff or human element was responsible for the largest number of serious accidents. The proportion of accidents attributable to human element has remained almost static, around 43 percent during the last three periods. Failure of equipment, i.e., locomotives, rolling stock and track takes the next place after failure of railway staff in the last three quinquennia and the proportion of serious accidents due to these causes has steadily increased from 7.6 to 18.4 percent."

All the three committees have agreed on the role of human factor as the most Prominent factor causing the accidents. However perfect a machine may be, it cannot be solely relied upon unless it is handled by a safe worker. Hence, the saying that the 'best safety device is a careful man', proves its merit, more so under present Indian context. Mechanical safeguards are useful to the extent the rules of operation are followed meticulously. They become ineffective in proportion to the short cuts applied. Persons with no aptitude for work and also untrained people are

found to adopt short-cut methods and hence invite trouble or accidents. Unless such irregularities are checked by a firm hand these may form a potential source of impending disasters.

If we compare the number of accidents per Million Train Kilometers (M.T.K), we will find that performance of Indian Railways is not worse than any advanced country in the world. Human nature being almost alike everywhere and, the mistakes committed by the staff in regulating the rail traffic are almost of the same nature, barring a few advanced countries where advanced technology has reduced sole dependence on man's performance.

Sometimes emotionally charged situations make a person forget things. It becomes quite difficult to concentrate on any work unless the emotional impact gets released. It will not be unusual for a driver to lose his concentration while driving if his mind is wandering over his wife's or son's serious illness. This lack, of concentration, while on the run, may cost him not only his own life but may endanger the lives of hundreds of innocent passengers travelling by his train. Liquor too has an important role to play in shaping the mental state of a driver, it has been observed that an addict generally has weak nerves and gets easily irritated and excited at the slightest provocation. Besides difficulty in thinking. failure of memory, loss of concentration and difficulty in taking decisions follow suit in an addicted person.

Sometimes peculiar behaviour has been noticed in otherwise sane drivers. They form some preconceived notions regarding the position of signals and assuming them to be clear try to run through a signal instead of verifying its aspect. This is truer of Mail/Express drivers for whom signals are generally cleared much in advance. This was revealed in an interview with one of the Mail/Express train drivers who was fortunate enough not to get involved in an accident even after passing a signal at danger as there was no train ahead. Not only do such drivers anticipate position of signals but sometimes form such mental associations with objects in their environment which help them remember the location of particular signal, but which may be deceptive at times, as was the case with one driver who had associated the sound of a mill with the aspect of a particular signal. Were the mill to be closed one day he would pass that

particular signal unnoticed. This was disclosed during a routine check of the signals while driving with the particular motorman.

Keeping bad health, especially poor digestive system, or a feeling of exhaustion too easily etc., are diseases which not only create fatigue in people but may also be an underlying cause of depression in them. Depression coupled with monotony of the job may play havoc with their life by distracting their attention from the track. Cases of momentary blankness have been noticed in such drivers. There is an unfortunate case of an ace driver who was undertaking his last trip before retirement. He had the distinction of having accident-free service till that date and he was to be interviewed by one of the members of the Railway Board about his accident-free service. But on that very day he fell prey to momentary blankness while driving, which resulted in a derailment. His clean record got a blot on the last day of his service.

Nervousness is another cause of accidents. Some people who are nervous by temperament are more likely to take a wrong step while facing emergency situations. Such people are a potential danger to railways and consequently to commuters.

Constant driving work will naturally result in fatigue, both physical and mental, in the driver. If his body does not get proper rest after work, this is likely to influence his efficiency adversely. It has been noticed that some drivers do not take sufficient rest during the rest period. This accumulated fatigue may be a cause strong enough to disturb his attention, thus indirectly leading to causation of accidents.

Sometimes avoidable haste on the part of the drivers makes them susceptible to accidents. This has been especially noticed at the end of the journey when the driver wants to reach home after finishing his work early. A slight inattention at this period on the part of the driver may unduly involve him in an accident.

Besides these psychological factors certain physical and environmental factors also contribute to the share of the accidents, e.g., dusty atmosphere, dense fog, or mist, and placing of colour light signals against improper background creating a confusion in the mind of the driver regarding the aspect of the signal.

There is a growing need for intensive research in this field which may help solve such problems which disturb the crew. These factors seem to

be easy to handle but they are not so. Eliminating even one of these problems entails a lot of effort and requires enrolment of additional manpower which entails meticulous care in selecting the personnel, stricter supervision, providing comforts to the driving crew for their stay at out stations, introduction of sophisticated equipment etc. All these require additional funds.

Even if all this is achieved, there is no way of changing the nature and temperament of a highly susceptible person. Sermons on the drawbacks of such a temperament are not going to change him. It needs concentrated efforts to change his behaviour through intensive counselling.

Fortunately, our government is fully seized of this problem and the lead given in this direction by the Psycho-technical Directorate of Research Organization of Ministry of Railways is worthy of appreciation.

Long back, the RDSO, Lucknow started periodical testing of drivers over 45 years of age, on psycho-motor and other equipment. This gives a fairly good idea about the psycho- physical fitness of the driver for the job. These drivers and other staff held responsible for the accident are given a group of psycho-metric, psycho-diagnostic and psycho-motor tests for probing deep into their psychic and psycho-physical working. Those found deficient in such abilities are identified and recommended counselling and/or psychotherapy for treatment. Many have already benefitted substantially from such measures.

Research on these and other allied problems is continuing to take care of the vital problem i.e., human factors in accidents. With zeal and enthusiasm, it will not be difficult to overcome such problems.

8.8 Rationale of Safety Counselling and Suggested Method

Railway Accidents Committee 1962 in Chapter VI part 1 of their report recommended that institution of Safety Counsellors should be created to carry out the campaign of man-to-man contact with the specified categories of Staff, viz, Drivers, Assistant Station Masters, Cabin men/Levermen, Permanent way staff and Gatemen, etc., to explain to them the specific lapses which result in serious accidents, educate them about the correct methods of working and impress upon them the need for adhering to correct working procedures, duly stressing the consequences that follow their lapses.

In so doing they were expected to take note of minor grievances of staff contacted by them and take initiatives to remedy these in association with welfare supervisors. Safety Counsellors were also required to take note of unsafe practices followed by the staff and bring these to the notice of regular supervisors and officers for corrective action. In spirit, their functioning was to culminate in creating a spirit of emulation amongst the staff for giving a better record of safety performance.

8.9 Why Safety Counselling?

The fact that the institution of Safety Counsellors has not been as effective as visualized brings us to the basic question whether our accident abatement programs offer them adequate scope to play a useful role. Conceptually, accidents caused by failure of human elements could be attributed to four main factors which are indicated below together with appropriate preventive measures.

Causative factors	Type of Intervention
a) Lack of abilities, attributes, and personality characteristics	Scientifically designed selection programmes: redeployment to non-safety jobs
b) Deficiencies in skills, competencies and attitudes, work habits	Training, education, and counselling
c) Socio-economic and organisational stresses	Motivational inputs (Incentives) and supervisory effectiveness
d) Inadequately designed and stressful working conditions and equipment.	Rationalisation of work procedures, redesigning of equipment/tools, provision of technical aids to counter stresses, etc.

It would emerge from the above that counselling has a distinct role in Improvement of safety standards, but its application has a specific context. However, in order to ensure that this aid is made an effective tool in fulfilling the objectives, it is necessary that the tasks to be carried out are clearly spelt out and the persons assigned these tasks, have the requisite professional and temperamental qualities to play the role set for them.

8.10 Duties of Safety Counsellors

Each Division has a complement of four or five Safety Counsellors representing Mechanical (Loco and C & W), P. Way, Traffic and Signals

departments. These safety counsellors' function under the administrative control of Sr. DSOs/DSOs. Notwithstanding the roles envisaged by RAC-1962, their present duties mainly center around.

1. going on line and carrying out checks on the working of staff.
2. making notes of shortcomings and reporting these to Sr. DSO's/DSO's for initiating corrective action including disciplinary action.
3. Occasionally addressing groups of staff at stations, loco sheds, etc. about the correct working procedures/methods.
4. Assisting Sr. DSO's in carrying out surprise checks, night inspections and accident inquires.
5. Taking measurements of track, rolling stock parameters, etc. in connection with accident inquiries.

The responsibilities which are not generally executed as under:

1. Diagnostic assessment of the deficiencies and shortcomings of staff in regard to their knowledge of work procedures.
2. Assessment of deficiencies in systems and working procedures and reporting these too concerned executive departments for appropriate intervention (including complaints of staff about system deficiencies such as poor brake power etc.)
3. Individualised attention to staff to help them in overcoming their deficiencies regarding working procedures and explaining the rationale of correct working procedures.
4. Taking stock of the pressing personal problems/grievances of the staff which hamper working and make staff antagonistic in association with Welfare Inspectors/ Supervisors.
5. Booking of staff for refresher courses out-of-turn in the event of their being found deficient in basics of working procedures.
6. Educating staff about quality maintenance in sick lines/P. Way and S&T gears which result in poor reliability of assets and also jeopardise safety.

It would be apparent from the above documentation that there is considerable gap between what is being done and what is required to be done and Safety Counsellors are not serving as an effective instrument either in the area of improving the job-related knowledge of staff or the human relations which may bring about significant improvement in motivation and attitudes of staff. More or less safety Counsellors are working as another set of Inspectors duplicating the job performed by the incumbents of the concerned disciplines. Their effectiveness even in this area is seriously handicapped for want of adequate authority to take action

against erring staff, ordinarily enjoyed by their counter parts in inspectorial cadres.

Organizationally, Safety Counsellors do not enjoy the wholehearted support of their own parent departments, and their observations/suggestions are not taken very seriously. Although, instructions are there that competent and experienced persons should be deputed to work as Safety Counsellors. In actual practice the concerned executive departments generally do not adhere to these guidelines and instead spare persons who have not proved effective and efficient in their parent departments. Most of the Safety Counsellors have been found deficient in regard to-

1. intellectual make-up
2. knowledge,
3. temperamental qualities, and
4. communication skills.

The realization that counselling is a skilled and pain-taking job does not seem to be weighing adequately in making choice of Safety Counsellors. The problem gets further confounded due to absence of institutionalized arrangement for training of safety Counsellors in handling the assigned responsibilities. The type of management control envisaged for them and the arrangement to regulate their functioning are also not explicitly defined. No arrangements have been formalized to have feedback on the performance of Safety Counsellors to evaluate the outcome of their endeavours, with the result that all that they do is either according to their own initiatives or dictated by the day-to-day needs of Safety Officers.

8.11 Rationalizing the Role of Safety Counsellors

A Safety Counsellor in some way integrates in himself the role of a keen 'observer' of the shortcomings of the staff and that of an educator' to assist the employees in understanding the correct work methods and practices. These are, however, implicit aspects of his job. As distinct from an Inspector, a Safety Counsellor aims at diagnosing the deficiencies in staff and the genesis thereof rather than display of authority through chastisement, reprimand, and punishments. Similarly, his role as an educator is different from that of an instructor and his efforts do not end merely by imparting instructions. His efforts are focused on making the employees understand the correct procedures, realize their shortcomings,

and integrate factual knowledge with day-to-day performance. Implied in this is a process of positive attitudinal change on the part of the employees, which could be triggered only if the Safety Counsellor is perceived more as a genuine and trustworthy guide. The functions of Safety Counsellor would have to be defined in a manner that these do not overlap with those of Inspectors and Supervisors. If some common functions are considered inescapable or desirable, the context of such functions should be explicitly brought out.

The duties and responsibilities of Safety Counsellors need to be defined, keeping in view the possibilities and limitations which are relevant to their endeavours. In the first place, it has to be realized that if an employee is not able to perform well and is continuing to be safety risk due to limitations imposed by natural/innate dispositions, there is little which a Safety Counsellor can do except to recommending redeployment or alternative placement. If there is something grossly wrong with work procedures or the work environment creating stress on employees, he has to serve as an intermediary to bring these to the notice of management for timely intervention. Safety Counsellors have a more focal and direct role in the following areas:

a) Spotting the employees showing aberration in their working, identifying their shortcomings, weaknesses in regard to rules, work procedures, motivation, attitudes, etc. and making diagnostic assessment of the genesis of various shortcomings.
b) Categorising staff, based on their own assessment and those of Inspectors and Supervisors, into sub-groups
    1. requiring general group sessions to areas of ignorance wrong interpretation of rules and incorrect application
    2. to identify employees displaying indifferent working due to behavioural aberrations/ personal problems and take action for their rehabilitation.
    3. booking employees showing pronounced deficiencies in knowledge of work procedures for out-of-turn training.

The Safety Counsellor should maintain detailed records of the staff in order to understand their problems in totality and correct perspective. The remarks on individual cases should indicate the reasons why a given staff is not able to adjust to his job. His strengths and shortcomings will require detailed enumeration and changes noticed after counselling sessions duly

taken note of and recorded together with improvement in performance outcomes. It is through this process that a Safety Counsellor can follow up his cases. Use of computers for this purpose would greatly facilitate his work.

In the process of counselling, there may be occasions when the Safety Counsellor will be faced with situations in which contradictions in management goals may be projected by the employees or some rules may come to notice, the observance of which is found to be an impediment in meeting the objectives of both safety and operation. The cardinal principle in dealing with such situations should be to emphasize that goals of safety and operation are not contradictory, but complimentary and that if the operation is executed efficiently the safety will take care of itself.

In the present organizational set-up, there is only one Safety Counsellor in a Division from one discipline. It is rather difficult if not impossible for one person to be in touch with the staff spread over the entire division and fully understand their problems. On the other hand, there are a number of Inspectors and senior Supervisors on a division in different disciplines who should as a part of their responsibility exercise close supervision over the staff and identify such persons who are not responsive to routine educative and supervisory inputs and are potential safety risks. Arrangements may be formalized under which lists of such staff may be forwarded by the Supervisors to the Safety Counsellors for specialized attention. This will enable the Safety Counsellors to establish their professional status and devote more time to needy cases.

Safety Counsellors also have a role to play in spreading the message of safety amongst the staff through periodically organized lecture sessions at work sites, illustration of typical cases where violation of rules has led to accidents and the new features in working which the management may introduce from time to time as part of its modernization programme.

8.12 Motivating Safety Counselling

The work of safety counselling has been in practice for the past more than 40 years. The individuals who are doing this job in the safety department are known as safety counsellors. The jobs of the safety counsellors are manifold. It includes less counselling and more miscellaneous jobs. Their main job is to inspect and observe the errors, omissions and shortcomings in the functioning of the staff connected with safe running of trains e.g.,

ASMs, drivers etc. and to tell them to improve their working and failures are reported to the respective departmental officers for punitive or corrective measures. There is no regular post of safety counsellors with the Safety Department. The incumbents are chosen from the operating, mechanical, civil engineering, carriage and wagon and signal and telecommunication departments on the basis of seniority.

Railway Board vide their D.O. letter No.69/Safety/68/12 dated 9/6/69 issued instructions for working of Safety counsellors on the following lines:

> "Their main function is to inculcate on the one hand safety mindedness among the various categories of staff through Intensive personalized campaign and on the other hand to bring out and remove the lacunae that may exist in the actual day to day working of the staff through informal and personalized contacts with the staff in the field. This they must do by carrying out a safety-oriented drive among the staff, by contacting them individually and educating them, by exhorting them and listening to their difficulties and, in so far as they are genuine, in removing them otherwise explaining the correct position to them so that they are satisfied that their voice is also heard, and action taken on what they say to the extent possible. Thus, the safety counsellor has to be something of a friend, philosopher and guide to the staff on-line."

Wanchoo committee (1968)" (RAIC 1968) in their report has written about the functions of the safety counsellors as under:

> "The main function of safety counsellors visualized by the KUNZRU committee was to make personalized contacts with and educate the staff of the various departments in the observance of the safety rules. They were required to give talks on safety matters and to hold meetings of the staff in their respective jurisdiction,
>
> In addition, they were also required to carry out Inspections of an intensive nature from a safety angle".

The duties of the safety counsellor's Inter-alia Include Inspections of the Railway stations, testing of the drivers and other crew members, in their knowledge of rules and regulations, their vigilance and mental agility, to check the attendance and readiness in their work, and to see that the orders given by various divisional officers from time to time are carried out properly.

For carrying out these tasks they have to go to various stations of their division both during day and night to check the vigilance of the staff, prepare a report of their inspections and also complete various sundry jobs within a specified period. Now when they are given one more job which requires scientific steps for compliance, they are not easily motivated to take up this serious job. Besides, there are factors other than this too, for their not accepting this job easily. Prominent amongst them are:

1. Their low educational qualifications.
2. Personal, health and family problems.
3. Human tendency to avoid any new innovations.

It is not that they do not realize the advantages arising out of this new procedure, but they simply show resistance to accepting any change in their routine traditional working, however useful the new technique may prove to be.

I have conducted about half a dozen courses on "Techniques of counselling" in the two zonal training schools at Bhusawal and Udaipur. It is from my personal experience, after conducting these courses in the zonal training schools, that the safety counsellors have felt very happy to have learnt very useful techniques. A few safety counsellors who were highly motivated after the courses came to the author to express their grateful thanks for having enlightened them on very useful aspects of human personality and behaviour. When they came to know the scientific meaning of the term "counselling" (the job that they had been doing so far in the name of counselling was simply to find fault with the working of staff) and learnt other concepts like empathy, patience, art of questioning, confrontation etc. they took a pledge before the author that from that day onwards they would try to improve their personality, manner of dealing with staff, improve their quality of inspections and also improve their work and family environment gradually. One safety counsellor has made an alcoholic Railway driver a sober one through continuous many sittings and now he feels that he has been able to achieve something in life through scientific counselling.

There are certain things which the Railway Administration can do to help the supervisors, safety counsellors and inspectors (who are quite energetic and enthusiastic) to do their jobs more effectively,

1. The number of Inspections to be conducted by them should be limited to a certain reasonable number with emphasis on the qualitative aspect of Inspections. Certain clerical Jobs can be given to other staff and their minds should be given training in more productive pursuits. They should be trained in utilising their powers for effective counselling.
2. The safety counsellor's job is a very responsible and laborious one which requires meticulous attention on his part to the finer details of each job to be completed. Therefore, while selecting persons for such an important job personality tests and other psychological tests like psychometric tests etc. should be applied and due weight given to the results of these tests. RDSO had already developed a suitable Test Battery for this purpose.
3. Such persons, who have been thoroughly screened and selected after these rigorous tests, should be exposed to an especially tailored training programme which will aim at making them good and effective safety counsellors.
4. Their course, inter-alia should include practical counselling sessions which will give them more confidence and they will be able to counsel more effectively.
5. Their syllabus should include topics dealing with human behaviour, causes and types of behaviour, cognitive, conative, and affective aspects of the personality, their interdependence, psycho dynamics of Normal and Abnormal behaviour and modern methods of understanding human behaviour.
6. Counselling, and related concepts, Techniques of counselling, steps of counselling, evaluation of counselling programme etc. should also be included.
7. If the administration wants to get effective counselling from them then they should be given financial incentives for carrying out the counselling work which will be in addition to their already loaded schedule of work.
8. The staff should also be made aware of the type of assistance and guidance they can receive from the trained safety counsellors. Then only the desired results of the scheme can be obtained.
9. An optimum ratio between the posts of the safety counsellors and the number of staff to be counselled per month will have to be fixed.
10. The faculty members of the zonal training school should be well versed not only in their respective subjects, but they should also have mastery in the language through which they express themselves. Without effective power of expression, they will not be able to motivate their students.

11. The Divisional safety officers and other Senior Divisional Officers should themselves be given thorough grounding in the field of counselling so that they are able to judge the efficacy of a safety counsellor effectively. It has been observed that most of the senior officers do not understand its importance and are very reluctant to relieve the safety counsellors for attending such courses.
12. Refresher courses in the art of Man Management I should also be run for such staff who have been exposed to the techniques of safety counselling and allied topics so that in their routine day-to-day working they may not forget the tenets of the counselling.
13. To impress upon their receptive minds about the various aspects of the scientific counselling experts from the fields of counselling may also be associated so that the technical problems faced by them in their counselling sessions may be properly answered to their satisfaction and enough light could be thrown on their problems by the authorities.
14. A good library may also be gradually built up in each divisional Railway headquarter which may supply them books on Human Psychology, Management Techniques, Counselling techniques, Industrial relations etc.
15. Exemplary cases of Effective counselling should be rewarded and given wide publicity, by the Divisional railway managers office and its report published in the Gazette as well, so that the safety counsellor feels motivated and honoured.

A perusal of direction, of the present prospectus-cum-syllabus for the management course for the senior supervisors of the Zonal Training Schools placed below indicates a very appreciable trend in the same direction which can be further enriched by the foregoing suggestions.

8.13 Procedure for Selection of Safety Counsellors

In pursuance of the decisions taken in the meeting of the Chief Safety Superintendents with Minister of Railways in the Railway Board on 17th Oct 1977, psycho technical cell has been organizing integrated training programs for Safety Counsellors of the Zonal Railways in psychological testing and counselling which earlier extended coverage only to techniques of psychological test administration. Based on the analysis of the feedback from the participants of the programs it was felt that most of the safety counsellors, though reasonably suited to the technical requirements of the job and related supervisory roles, lacked temperament and abilities to meet the demands of the enlarged scope of

safety counselling, which includes effective communication, understanding of the inter personal problems and bringing out the positive attitudinal change in the safety category of staff for efficient and safe discharge of duties. This view was also shared by the Chief Safety Superintendents of Zonal Railways at the meeting held in RDSO on 28th & 29thApril, 1978.

8.14 Personality Profile of a Successful Safety Counsellor

The skills that Safety Counsellors are required to learn can more effectively be mastered by them if they possess a particular constellation of personality traits. A need was, therefore, felt to recognize such personality traits as a prelude to the development of a screening procedure for their selection.

On the basis of interaction of the faculty members with safety counsellors during a series of integrated training programs and after a review of the related literature Lewis 1970; Fullmer and Bernard 1964), a set of personality traits have been identified as desirable for a successful counsellor. These are:

1. Warm hearted, easy going, participating.
2. Intelligent, bright.
3. Emotionally stable, mature, calm.
4. Controlled, socially precise.
5. Practical.
6. Natural, sentimental.
7. Tolerant of traditional difficulties.
8. Group dependent.
9. Relaxed, Un-frustrate.
10. Good adjustment.
11. Interest in helping people.
12. High ego strength.

In addition to these qualities, counsellor should also be in a position to demonstrate that he is a person who encourages free communication who does not appear to be trying to satisfy his neurotic needs for power or manipulation and who does not need to promote and maintain the dependency of others.

8.15 Selection of Tools

In the development of the screening device for safety counsellors two aspects were considered important. First, the tools used should be able to give a fairly complete coverage of relevant personality traits in a reasonably short time and secondly, these should also give an indication about the manner or style in which the person could behave in practical life situations. With these aims in view, a scanning of the available personality tests was made, and Cattell's 16 personality Factor Questionnaire (Cattell, 1962) was considered appropriate for the purpose. Apart from a fairly valid diagnostic test of personality, 16 PF has got three added advantages in that it is an objectively scorable test, takes comparatively less time in administration and is suitable for group administration. Moreover, this test is available in many equivalent forms both in English and Hindi and some of the forms of these tests have been specially developed for less educated persons. These characteristics of the 16 PF test eminently suited the typical requirement of the railways.

For assessing the skill of listening, group interaction, verbal fluency etc., of the prospective safety counsellors, "a group observation session" was designed to supplement the personality test. This provides for the ratings of participants being made on various aspects of social interaction over a structured observation schedule.

The assessment offered by the above two test/techniques was expected to be highly effective in selection of safety counsellors with natural disposition and temperament for the job.

8.16 Workability of The Screening Procedure

A try-out of the testing procedure was made to see its workability in field conditions. Seven safety counsellors of Moradabad and Allahabad divisions of Northern Rly and Lucknow division of North-Eastern Rly formed the subjects of the try-out.

The experience with the test has been highly satisfactory. The 16 PF test, though a bit lengthy, works well with the safety counsellors. The test items and the instructions for taking the test are easily understood, both in English and Hindi versions of the test. It takes about 60 minutes on average to complete the test.

Some difficulty was faced in organizing group discussion sessions during the try-out. At no instance more than three safety counsellors could be made available at a time. Therefore, in most cases the discussion was confined to mere one-to-one conversation. This problem, however, is not expected to arise at the time of selection when a good number of candidates would be available.

8.17 Suggestions for Safety Counselling in Railways

1. The psychological screening procedure developed and pretested is expected to make available such safety counsellors who would have natural disposition to render counselling service to the needy staff on the railways.
2. The results of the try-out indicate that the personality test and group discussion ratings are independent of each other and complimentary in nature. Hence, both these cases will require to be used in the selection of safety counsellors.
3. The personality test will yield a profile of the prospective candidates to be matched with the standard profile on identified characteristics. These characteristics are more a function of hereditary endowments and interaction of the same with various socio-psychological factors of the environment. These are, more or less, stable in nature and do not change unless significant and critical experiences are encountered in life. The possession of identified characteristics in the required measure is to ensure that the individual has got natural disposition and inclination for taking counselling work and is more apt to benefit from specialised training. The second criterion seeks to gauge "learned disposition" in regard to the social interactions. The profiles of the candidates on this criterion will show the particular areas of weakness in interpersonal communication so that during the training programmes, particular attention could be bestowed by way of group exercises and role plays on the selected candidates in order to improve their skills further.
4. An abridged version of the personality test, prepared in the light of experience gained during pretesting, would be more suitable and less time consuming.
5. The procedure to be followed in application of the screening procedure is enumerated in following pages.

8.18 Psychology of Safety in Supervision

Every job, plant or industry needs men for its functioning. Without men there is no production. There exist differences between the individuals

who man a particular industry. Some men are safe, while some others accident repeaters. Some are safety conscious and others safety unconscious. Some people are sensible, others create problems. It is the 'supervisor' who has to bring out the best in these workers. He is the man who has to perform his responsibilities in a manner that the workers around him have the incentive to cooperate, take initiative and do their work to the entire satisfaction of the supervisor.

The supervisor has to understand human nature thoroughly as he understands the working of the machine before it is acquired. Before a machine is purchased, we have a thorough accounting of its qualities and limitations made. We talk about it in terms of specifications because we know that if we operate the machine beyond specifications something is sure to go wrong. When a machine goes wrong, we do not say that the machine is uncooperative or lacks initiative. We stop it and try to see why it does not work properly, correct what is wrong and put it back to work as quickly as possible. But, when a man does not come up to our expectations, we tend to call him lazy, insubordinate, or non-cooperative. We discipline him. We forget that just like machines, men often have no control over the things that happen to them which prevent them from being as good men on the job.

For a supervisor it is necessary to understand the nature of workers, their expectations, desires, and feelings. Men are very much unlike machines which people operate. But men can be taught, directed, and controlled. Men differ from one another in certain respects and at the same time they are alike in other respects. A good supervisor should know these facts thoroughly so that he is accepted by those working under his guidance. Everyman wants recognition from his supervisor. A good supervisor always speaks well of his men and builds them up. He is always for them, and he watches for the chance to push a deserving man into a better job. A little praise from the supervisor makes workers feel elevated. Sometimes he has to question men who deliberately step out of line but still when he does it, he winds up his criticism with a word of encouragement.

While assigning the work to the workers, the supervisor has to bear in mind that nobody is perfect at all times and on all jobs. He has to

understand the physical, mental and emotional inadequacies of people and then assign jobs suiting their characteristics.

As all people are not gifted with foresight, they sometime disregard safety rules. The responsibility of the supervisor lies in making the workers safety conscious at all the time so as to reduce the accidents to a minimum.

People do not easily accept new ways of doing things because:

1. they feel that they are getting along comfortably in the old ways.
2. the new ways mean breaking up old habits. They mean extra exertion and also the possibility of doing things wrong and consequently being subject to criticism.

Once people have faith in a man, they follow him often to their own harm. Faith and trust make people blind to the faults of a man in whom they have confidence, and they can easily be led or misled by him. Generally speaking, people are led by faith.

People are just basically drifters on the sea of life and need a rudder and a guide. Only a few of them have initiative or are self-starters of change. They rarely think plan fully beyond today even though they have a lifetime to live. This indicates that human nature is nearsighted.

People want to feel important. This is a universal human tendency. People are suspicious and apprehensive about things, people and ideas they do not understand. That is why they want to be in and feel as though they are participating in the making of plans which will affect them. People want to know the reasons for changes that affect them, and they do want a chance to be heard when they disagree.

People sometime have trouble bothering their heads. They want to confide in somebody who would listen to them patiently. The good supervisor, therefore, should learn to listen patiently, do something to straighten out the difficulties whether they be departmental or personal. He should try to make the people feel happy and always keep them in high spirits.

The supervisor has to own his men who work under him. He should feel proud of them. This adds to the efficiency of the people. There are individual differences among the workers. Though they are alike in certain respects such as money problems, minor ailments, family problems, etc. They all want security, recognition, attention, and

friendship. But still people are different too. They have different abilities, different personalities, different backgrounds and different ways of going after the things they want. The supervisor has to understand the individual differences among men and handle each of them in a different way.

8.19 Teaching safety on the job

The supervisor has to teach safety on the job. Safety training can best be imparted with the job training. The steps that could be followed are:

1. Prepare (make ready)
2. Present (teach)
3. Apply (use)
4. Test (check and recheck)

1. Prepare

Preparing means getting the learner ready to learn, it also means supervisors getting ready to teach. The person is told about the job so that he gets an idea of what he is to learn and why it is important. 'Prepare also means that the supervisor himself is prepared to do the job. It implies that he has organized in his mind exactly what and how he is going to teach.

Whether a man learns properly what he wanted him to learn will depend on whether he has prepared himself and the man properly for giving and receiving training.

2. Present

Presenting operation requires four major conditions:

i) The entire operation must be described carefully and simply from beginning to end so that the new man is not confused. That is, it should be ensured that the person has followed every step carefully.

ii) After the complete story has been run through, the entire operation should then be repeated:
   1. Very slowly
   2. Step by step
   3. In small doses
   4. One step at a time
   5. If necessary, the supervisor may have to repeat each step until he is sure that the man has followed.

iii) The training is to be given at the machine, at the work bench, on the job and at the place of work.

iv) The man should observe from the proper angle because most of the persons learn best by imitating someone else.

3. Apply

Applying means that the man does what he has been shown, exactly as shown. This step in the training process consists of having the man try it himself while the supervisor observes and stops the man and corrects him when he goes wrong, regardless of how slightly he goes wrong.

This step gives practice and prevents a man from picking up the man goes over the operation several times, until the supervisor is convinced that he has learned the operation well enough to continue alone. wrong habits.

4. Test

"Testing" means letting the man go ahead on the job by himself. The supervisor is supposed to check frequently to make sure that he is doing exactly what he has taught him to do.

The supervisor should see to it that the work is done perfectly. A man who can do a job slowly and perfectly every time can learn to do it quickly and perfectly every time. Since a job done right is a job done safely, this kind of training will result in low spoilage, low accident rate and low cost of production.

Job training should be considered job safety training. To assure safe production, the supervisor must do the following:

1. He should make a study of the job and prepare a list of things to be done, stepwise. He must do it in minute detail.
2. For every step of the job, he should jot down the following three points:
    1. The hazard or danger in that step.
    2. The remedy for the hazard or danger.
    3. The safe practice to be followed.

For example, the job step is- feeding stock into a machine. The hazard is getting hands caught in the feed rolls. The remedy is providing and teaching the use of tongs for feeding stock into the machines.

The safe practice is—always use tongs-never use fingers. Actually, there may be hazards at every step of the job. They may be found in the work area, in machine operation, in using tools and in handling materials. Each

of these must be thoroughly checked and planned by the supervisor if he really wants safety on the job. That is, the supervisor should have knowledge of the hazards in a particular job. He should discover the hazards in a job by studying the reports of the accidents that have already happened. He can further learn about accidents by talking to people who have worked or are working on the job and by hearing about their experience-experience which might have but perhaps did not result in reportable accidents.

8.20 Emphasis on safety records

Many supervisors are concerned too much with accident records. They really should be concerned more with safety records than with accident records as safety records are for the present and future and are based on men. The point of view should not be against accidents but for safety.

The mere start of a 'safety campaign whenever accidents occur would not do. It has often been noted that some departments go on month after month, even year after year without a lost-time accident because they continually work for and maintain interest in safe practice, safe performance, and safe thinking on the part of everybody.

Safety problems are a concern both for the supervisor as well as the workers. The supervisor should talk to his men about safety rather than accidents. Cooperation can be sought, when he asks his men for help in planning the strategies of safety. The people feel elevated when they are consulted by the supervisor.

Safety meetings can be important as the problems discussed are of importance to everybody. The supervisor must be on his guard not to talk alone. He has also to teach his men how to take active part in the meeting. He should make it clear that participation by every member in the proceedings is necessary. To bring variety in such meetings, sometimes a speaker from outside can be invited or sometimes a man from amongst themselves may be chosen to participate in the proceedings.

Mere talking about safety is not as effective as correcting unsafe practices and conditions in the department. One must practice safety oneself and teach specific safety on the job individually to each man. Suggestions should be made by the workers while discussing the matter and good suggestions must be acted on immediately and put to work.

Because people have tendency to forget without reminders, one should plan a program of reminders. Bulletins, board notices, posters and displays of all kinds are as necessary to the selling of safety as they are to the selling of anything. Advertising helps in promoting safety amongst workers. Different sorts of exhibitions can be put on show, e.g., an exhibit of safety equipment which must be in possession of staff while they are on duty; posters of serious accidents depicting the causes that led to it and the safeguards which could have prevented the occurrence of the mishap; posters depicting the cardinal principles of safety, and the man who averted a serious mishap by following these principles, are all reminders. The supervisor to be successful must develop good sense in him, base his actions and decisions on considering all the facts and pros and cons of the situation. He must think of the things that are likely to occur. This will help him lessen the mistakes and improve the chances of doing the right things.

Though circumstances are beyond control, but still, he can do something about his own attributes which will serve as guides to him.

1. He should, as much as possible, try to delegate responsibilities to his subordinates after ascertaining their good points and limitations.
2. He should use the services of the following five honest servants to give him exact information regarding any work, and they are 'what' 'when' 'why' 'who' and 'how. He should get all these facts, build the decision on them, and he will find that he is right.
3. A good commending expression is also an aid to success. This will prove to be an asset to him.
4. Using common sense supervision technique will help him go a long way. He should realise that human psychology is the same everywhere and hence the desires, aspirations, likings, and disliking's are almost the same.

Once he realizes these objectives, he can turn himself into a successful supervisor.

DUTIES AND RESPONSIBILITIES OF OPERATING STAFF AT RAILWAY STATIONS

9

The duties to be performed by different categories of staff in connection with movement of trains are detailed in this chapter. These duties must be read in conjunction with the Station Working Rules of the station, General & Subsidiary Rule Book, Chapter II of Operating Manual dealing with "Working of Stations" and Block Working Manual as amended from time to time.

9.1 Responsibilities of Traffic Inspector of the Section

Traffic Inspector is one of the most important functionaries of operating department and is responsible for a section. His geographical jurisdiction is well defined and mostly given in the working timetable. He has following function:

1. He is in-charge of the section and looks after the leave and General Management of the staff.
2. He is in-charge of the safety store and responsible for distribution of the store at railway stations under his charge.
3. He is responsible for conducting night inspections, surprise inspections and regular inspections of the station.
4. He is the link between station and divisional management.

5. He conducts accident enquiry at supervisory grade and is responsible for preparation and signature of joint note and accident diagram when any major accident happens.
6. He has certain protocol duties and accompanies the senior officer during their inspection.
7. He also undertakes enquiries of DAR, if entrusted to him.
8. In case of abnormal working or major yard remodeling or non-interlock working he is in-charge from operating side.
9. Any other work assigned by Senior DOM/other Senior officers.

9.2 Responsibility of Station Master (supervisory)/Station Manager

1. Station Master is responsible for the efficient discharge of duties by different members of staff at his Station. (General Rules 5.01)
2. Ensuring that the general working of the Station is being carried out in strict accordance with the current rules, procedures and instructions.
3. Providing prompt and courteous service with utmost safety and security of passengers and employees.
4. Availability, helpfulness and good conduct of station porters.
5. He shall be responsible for general up-keep of the station.
6. He shall be responsible for keeping the safety and operating literature including circulars, pamphlets, gazettes etc. up to date and these must be explained to the staff working under him and noted by them.
7. He shall be responsible for maintaining the Accident register and Accident charts and keeping these up to date.
8. He shall maintain figures in respect of the stock and get them relayed to the control in time.
9. He shall investigate all public complaints and send the extracts of the complaint with an explanation of the staff and his own remarks to the Divisional Office in time. In case of complaints concerning the other department, intimation may be given to

the subordinate In-Charge of that department immediately so that action may be taken to avoid recurrence.

10. He shall promptly attend to all accidents, assume charge of the site too and assist in relief measures ensuring prompt evacuation of injured & stranded passengers. He shall take note of all the information available and protect the clues/evidence, which may be helpful in the enquiry. He shall intimate the control office at regular intervals for current information and ask for the required assistance i.e., Relief Train, Medical van etc. He shall investigate yard accidents, obtain statements from the staff responsible and submit his report with conclusions and joint note to the Divisional office.
11. He shall ensure that firefighting equipment at the station such as fire extinguisher, fire buckets etc. are in fine fettle and ready for use.
12. The Station Master should regularly test and record in the charge book, the working of Points, Signals and Track Circuit to ensure that:
    1. The Signals are back to 'ON' position when the relevant slide/button/ lever is put back or intended train movement has been completed.
    2. it is not possible to take 'OFF' conflicting signals at the same time.
    3. Signals are not taken 'OFF' until all points are correctly set and facing points locked.
    4. Any other manner of testing prescribed by the Authorized Officer.
    5. Panel testing: Normal/Abnormal by Station Master.
    6. At stations provided with continuous track circuits or at stations having solid state interlocking the method of testing shall be prescribed jointly by Signalling and Operating Branch which shall be described in the Station Working Rules to be followed by station masters.
13. He must ensure that the essential Safety equipment at his station is the same, complete and, if there is any deficiency, should be made good without delay.
14. He shall conduct night and surprise inspections to check the

alertness of staff and working of signals, and points and visibility of the signals.

15. The Station Master in charge at a station shall inspect his station daily with a view to ensure efficient working of-
    1. All public facilities including, fans, lights, lifts, escalators,
    2. All equipment being in efficient working order. Deficiencies must be promptly rectified or recorded in Petty Repairs Book
    3. Safe and efficient working of trains
    4. Cabins, Assistant Station Manager's office, yards, goods sheds and level crossing gates under his charge.
    5. Reservation Enquiry, Public Address system, Public Information Display System, booking offices, Ticket Checking, catering and vending stalls etc.
    6. Drinking Water availability.
16. He shall see that the train signal register, station Diary, Inspection Notebook, reference books and other station record is property maintained and preserved for a minimum period as prescribed later in this chapter.
17. At the bigger stations the Health Inspector is in-charge of sanitation. The Station Manager along with himself shall conduct daily inspections and find deficiencies.
18. He shall conduct daily inspections of waiting rooms, bathrooms, lavatories, refreshment rooms and catering trollies, platforms, tracks and other station premises from sanitation point of view and ensure that arrangements in this regard are adequate and effective.
19. Availability of safe drinking water to passengers & employees is joint responsibility of JE/SE (works) and health department. He should check that same is available.
20. He shall ensure that sufficient coaching stock is available for the requirements of the day in case of bigger station. He shall keep in touch with the running of trains so that, in case of late running of connecting train, scratch rake can be turned out, if necessary. He shall also keep a check - on reserved stock available/allotted to his station.
21. He shall take personal interest in arranging quick clearance of

reserved carriages of troops, public, prisoners, treasuries etc.

22. Whenever special trains are arranged to run from his station, he shall ensure that stock for the same is secured and certified placed on the proper line in time.
23. He shall fix up responsibility in case of detention to trains outside or at the station and submit full report to DRM office.
24. He shall be responsible for ensuring that all the operating staff working under him are relieved in time for their periodical NVT/ Competency/ Safety camp and special competency programmes. No one, overdue NVT/Competency shall be allowed to perform his normal duties.

9.3 Panel Assistant Station Master (ASM)

1. When on duty or when called upon to do so, in case of emergency, he shall be responsible for obtaining and granting line clear to trains or for shunting movements as per SWR & GR.
2. He shall handle the control panel himself when on duty and shall not permit any unauthorized person to manipulate panel.
3. He shall keep the SM's control keys of control panel in his personal custody whenever he is required to leave his office even for a short duration.
4. While coming on duty, he shall ensure that all points and signals are in good working order and all the registers, records, pertaining to train passage are completed in all respect before taking over the charge.
5. He shall personally ensure that conditions for taking 'off' the reception signals are fulfilled and the clearance of line is verified as per SWRs before actually pressing the relevant button for taking off the signals.
6. He shall ensure from indications available on the panel that the signals are burning 'brightly' and are giving correct indications.
7. He shall maintain complete and up to date record of the Engg. Restrictions.
8. He shall be responsible for bringing forward the caution order

register every Monday and displaying the restrictions on notice board as well.

9. He shall be responsible for ensuring delivery of proper caution orders to all trains.
10. He shall ensure that all Shunting operations are carried out as per extant orders and GR 5.19 and SRs thereof.
11. He shall inform the ESM/MSM in writing or through a written message, of any failure of track/signals/ points/keys or panels etc. and shall invariably enter these failures in the signal failure register.
12. He shall allow shunting in between the arrival/departure of trains or during slack period as frequently as possible to the maximum extent.
13. He shall come on duty after taking complete rest and shall not perform his duty under the influence of drugs, or intoxicants.
14. He shall keep his reference books up-to date, posted with the latest correction slips and shall keep himself fully conversant with the extant rules. He shall keep his books readily available for inspection when asked to do so.
15. He shall not absent himself from duty without prior permission of his superiors. He shall not leave his duty unless properly relieved by his relief and shall not exchange his duty without prior permission from his superiors.
16. He shall not consider himself relieved of duty unless he has completed transactions of trains for which he has given/obtained line clear till the complete arrival of such trains.
17. He shall always obey the lawful orders of his superiors so long as they do not contravene any of the extant rules in force.
18. He shall ensure that proper indications of points, signals, track, circuits, crank handle, level crossing gate etc., are displayed at their proper places.
19. He shall be responsible for issuing required papers to trains entering/leaving the yard under the instructions of log ASM.
20. He shall issue shunting order for shunting operations as per extant rules.
21. He shall keep a watch on the working of shunting staff.

22. He shall ensure clearance of running lines in case of failure of their track circuits.
23. He shall maintain logbook regarding train and shunting movement.
24. He shall be responsible for giving complete arrival of all trains to log ASM supported by a private No.
25. In case of abnormal working, he shall be responsible for cranking pad locking of points and piloting of trains in absence of Deputy Station Manager/outdoor.

9.4 Deputy Station Master/Manager (Deputy SM)(Outdoor)

1. The Deputy Station Manager shall be responsible for general up-keep and proper working of the station as under-
2. He shall maintain safety literature, rule books, safety records. He shall counsel staff regarding rules and safety- systems.
3. He shall deal with public complaints and counsel commercial staff on courteous behaviour.
4. He shall ensure right time placement and removal of terminating/originating trains and keep records in this regard and also keep a watch on Shunting operations.
5. He shall inspect gates, panels, station, regularly during his shift.
6. He shall maintain close contact and co-ordination with Panel ASM and Log ASM for smooth running of trains and for better planning of operational work and will assist in case of any abnormal working.
7. He shall promptly attend to any incident or accident and assist in relief measures during his duty. He shall collect all the information and inform the Control office for required assistance, i.e., Relief Train, Medical Van etc. He shall also inform the local civil authorities as required and safeguard the clues or evidence which may be helpful in enquiry.
8. In case of abnormal working, he shall be responsible for manual operation (Hand Cranking) of Points and piloting of trains.
9. He shall ensure that all coaching trains scheduled to stop at the

station start within their allowed time.

10. Whenever Special trains are arranged to run from his station, during his duty, he shall ensure that stock for the same is secured and placed on the proper line in time. He shall keep close supervision on sanitation. He shall inspect the platforms, waiting halls, waiting rooms & the track and see that some are cleaned properly by the sanitary staff.
11. He shall keep close watch on passenger amenities provided at the station and their upkeep.
12. He shall look after any other work assigned to him by the Station Manager, from time to time.
13. In case of emergency, he shall also perform duty on Panel/Log.
14. All instructions received from superiors shall be recorded in an Order Book. Senior officers should confirm these through a control order to avoid ambiguity. All such instructions shall be implemented, provided these do not violate safety rules & procedures.
15. He will perform all the duties of SS in his absence.

1. Pointsman/Shuntman

1. He shall obey all lawful orders of the ASM on duty or official in-charge supervising the shunting during the course of shunting operations including coupling or uncoupling of vehicles of wagons. Fixing rubber washers, closing wagon doors, displaying hand signals etc.
2. He shall exhibit danger signal to the official supervising the shunting should the crossing be fouled during the shunting operation.
3. He shall pilot the trains in case of abnormal working and when ordered by the SM on duty.
4. He shall be in a proper neat and clean uniform while on duty.
5. He shall come on duty after taking complete rest and shall not perform duty under the influence of liquor, drugs, or intoxicants.
6. Neither should he absent himself from duty nor should he exchange his duty without prior permission of his superiors.
7. He shall not leave his duty unless properly relieved or

authorized by his superiors.

8. He shall set the points properly in non-interlocked yard and man them for all shunting movements and shall not interfere with the points while the vehicles are standing and or passing over them.
9. He shall be responsible for seeing that foul marks are kept clear after completion of shunting.
10. He shall always commence his duty equipped with hand signal lamps during night and flags during day.
11. He shall verify the correct setting of route before delivering required papers to the loco pilot either through taking 'OFF' the relevant shunt signal or by personal observation.
12. In case of track failure, he shall assist the SM to ascertain the clearance of line.
13. He shall be responsible for lighting up of the indicators in the evening and putting them out in the morning time fixed by DRM office and ensuring that these are burn brightly at night.
14. He shall be responsible for cleaning and oiling the burners and trimming wicks during daytime under the supervision of the Station Manager/Deputy Station Manager.

2. **Gateman**

1. He shall be responsible for proper operation of the gate as per SWRs for the passage of trains.
2. He shall ensure that no train suffers any detention on account of the late closing of the gate.
3. He shall keep the channels of check-rails clean and shall clean the road within the railway limits and water the area regularly.
4. He shall clean the gate lamps and hand signal lamps daily. He shall ensure that the wicks of the burners are trimmed so that these are lighted properly and kept burning continuously from sun set to sunrise.
5. He shall keep the surroundings of his gate lodge clean, tidy and neatly planted with shrubs, plants etc.
6. He shall remain alert on duty till properly relieved. If he is required to leave the gate in an emergency, he shall close and lock the gate booms against the road traffic before leaving the

gate.

7. He shall ensure that the equipment at L-xing is complete and in working order.
8. He shall produce the public complaint book when required by the public for lodging complaints and to the railway officials for inspection.
9. He shall ensure that road traffic is not unnecessarily held up at the gate.
10. He shall stand in attention near the gate lodge facing the track and be prepared to repeat any signal which the guard may intend to convey to the loco pilot or show caution or danger signal should anything appear to be wrong with the train itself as it passes.
11. He shall be polite and courteous in his behaviour towards the public.
12. He shall report any defect in the gate to the ASM on duty without delay.
13. He shall close the gate on sighting a train or when ordered by the ASM on panel duty.
14. He shall attract the attention of the loco pilots and guards by shouting and gesticulating instead of showing danger signal in case of tram parting.
15. He shall obey all lawful orders of the SM on duty.
16. In case of any obstruction, accident or damage to the gates, he shall protect the gate/obstruction as per instructions and rules in force.

9.5 Duty list and hours of duty at Railway Stations

Sr. DPO/DPO shall fix the duty hours for the staff at stations in accordance with the (Hours of employment regulations in consultation with Sr. DOM/DOM/ Sr. DCM/DCM). Copies of these duty hours (roaster) must be displayed at each station.

1. Station staff shall handover charge at the end of their hours of duty as prescribed at the station only when properly relieved.
2. Such duty hours shall not be exchanged without the permission of the Station Master.

3. Daily Mustering of Staff: The Station Master or the person authorized in this behalf shall fill in the attendance of staff at his station in Attendance Register.

9.6 SM's responsibility for assurance

Station Master's responsibility before allowing employees to take independent charge-

1. The Station Master must not allow any employee to take independent charge of a post connected with train working without satisfying himself after detailed oral examination about the knowledge of concerned staff. He must satisfy that the employee –
   (a) Possesses the requisite Certificate of Competency.
   (b) Has understood the working rules of the Station and is fully conversant with the duties he has to perform.
2. Before an employee takes independent charge of a post connected with train working for the first time, the pickup period is generally laid down by the DRM(Safety). However, following guidelines can be observed on first posting or when there is change of system/means of working of trains –

(a)	Junction stations with marshalling yard and lobby	10 days
(b)	Terminal stations with marshalling yard and lobby	8 days
(c)	Large stations or junction stations	5 days
(d)	Medium stations & Roadside stations	3 days
(e)	Roadside stations	2 days

   If an employee fails to give a declaration in a fixed period, he must be directed for Refresher Training at his expense.
3. It must cover pickups in all the shifts. (Minimum one day for each shift.)

He must read station-working rules and must witness the actual performance of these duties for the time specified as 'pick up' time. In emergencies, however and in cases where the duties are of a simple character and similar to those already performed by an employee at stations where he has worked before, this pick-up period may be reduced by the Sr. DOM.

9.7 Home Address Register:

1. Every Station Master must maintain a Register containing the name and up-to-date address including telephone /mobile phone no. of each member of the staff employed at his station.
2. A separate Register containing list of all shopkeepers, licensed vendors, licensed coolies, contractors' coolies or any other persons working at station other than railway employees must be maintained along with their up-to-date address and telephone nos., blood group if available and office copy of their Photo Identity cards. Entry of such people into the station area will be permitted only after checking the I Card.

9.8 Public and Staff notices for exhibition

The following Notices and Publications, besides those, which may be ordered from time to time, shall be exhibited at each station in conspicuous places.

1. Notice Board showing current running of trains in the waiting hall, or at the entrance.
2. Notices regarding hours of business of goods, luggage and parcels – outside the respective offices.
3. Notices regarding restrictions on Goods Booking.
4. Notices regarding Allotment of Wagons.
5. Rules regarding occupation/use of Waiting Rooms – Inside the waiting rooms.
6. Notice regarding date of payment of staff.
7. Duty Rosters and Classification lists of staff employed at stations.
8. Extract of Railways Act (24 of 1989) and payment of wages act.
9. A list of nearest Doctors and Hospitals, with telephone nos.
10. Rules for the occupation of Rest Houses and Rest Rooms.
11. A list of home addresses with telephone nos. of staff in Station Master's office.
12. List of people with telephone nos. from whom conveyance can be requisitioned in emergency, list of tent houses.
13. List of nearest Fire Stations, Bus depots, Airports, OIL companies etc. with telephone numbers.
14. List of telephone numbers of Civil, Police, Military and Railway officials.
15. Other prescribed notices.

16. The List of Staff qualified in First Aid.
17. Blood groups of staff.

The Station Manager must be careful to see that outdated timetables and notices are removed and replaced with current ones. He should also ensure that the telephone nos. are updated from time to time.

9.9 Exhibition of public advertisements

1. Public advertisements in the form of Boards, Posters, Showcases, Models, Neon-signs, or in any other form should not be allowed to be exhibited at any place within the station limit or premises without the written permission of the competent officer of commercial publicity branch etc. The Station Master will maintain a register showing full particulars of each advertisement exhibited at the station in the prescribed form.
2. Station Masters and other railway staff including Guards and Loco pilots of any train must not permit the display of advertisement matters on engines, passenger coaches and other rolling stock, unless the prior permission of the Divisional Railway Manager concerned has been obtained.

9.10 Rule Books, Manuals etc. at Stations

1. The Station Master is personally responsible for seeing those rules books. are kept up-to-date and are available for staff for reference. (G&SR 2.01, 5.02 and 5.03.)
2. Station Master is also responsible for seeing that all registers, forms and charts are properly and neatly maintained and that they are not used for purposes other than those for which they are printed and supplied.
3. Station Masters are responsible for the general accuracy of all periodical returns and for their submission in time.
4. Destructions of obsolete records shall be recorded in a register.

Station Records:

1. Each book/Register, when completed must be stocked in a bundle with a cover showing dates of commencement and completion.
2. Records must be placed on shelves and almirahs in dry and secure places, where they shall be safe from irregular handling or removal

by any unauthorized person.

3. Periods for which Station records must be kept at Stations are given at the end of this chapter. Any records pertaining to court cases/enquiries must not be destroyed until the DRM's permission is obtained.

9.11 Books and Notices at Level Crossing Gates

The following books and notices are maintained at a level crossing gate provided with Gate-lodge. Where Gate-lodges are not provided, the books shall be maintained in the Station Master's office.

1. A Book showing the list of equipment.
2. Duty Rosters.
3. A copy of duty list with translation in regional language.
4. Level crossing working instructions, which should appear as separate appendix to SWR.

9.12 Handbook for gateman

1. Extract of the Station Working Rules.
2. Public Complaint Book.
3. Vision test and Competency Certificate of the Gateman.
4. Results of last Traffic Census.
5. Inspection Books.

9.13 Filing of Operating Circulars

1. Every Station must maintain files of circulars etc. subject-wise.
2. Each circular must be noted by members of the staff concerned. In the case of Group 'D' moderately literate staff, Station Master must record that circulars etc. have been correctly explained.

9.14 Instructions for Train Managers

Instructions for Train Managers issued from time to time must be kept in one file at Train Managers Headquarter stations. Train Managers must make themselves thoroughly acquainted with these instructions and should sign the circulars and assurance register of safety literature file, while "signing on" for duty.

9.15 Correspondence

1. All official correspondence must be attended to by the Station Master, who must open all covers and see that all letters are replied to without delay.
2. All inward letters must be registered in the inward letters register showing the dates & letter no. of reply with a copy placed in a file.
3. Station Masters are responsible for the accuracy of the information contained in all outgoing letters, which they must sign personally.
4. The Station's name must be stamped on all returns and letters and on envelopes in which they are despatched.
5. Every outward letter must be numbered, dated and must also bear reference no. of the subject. This must be adhered to in all subsequent correspondence when replying to correspondence; reference must be made to the letter number under reply.
6. Letters from the public asking for information must be replied to as promptly as possible. If there is any difficulty in supplying the required information, the receipt of the letter must be acknowledged and matter referred to the DRM,
7. SR.DOM shall provide model draft of letters, which are frequently received at stations, using a model draft will ensure that language used is polite, respectful and courteous. It should be written legibly at stations not having computers
8. When forwarding letters or complaints from staff working under them, Station Masters must submit their own remarks, while forwarding such letters.
9. Letters received by the Station Master, pertaining to departments under him e.g. Goods Shed, Booking/Parcel offices etc. may be marked by the Station Master for the in charge concerned, but the Station Master shall be personally responsible for the early compliance of such letters.

9.16 Playing of Bands and presentation of Guards of Honour etc. on Station platform

The playing of bands and presentation of Guard of Honour etc., on the Station Platform is prohibited, except with the prior permission of the DRM.

9.17 Prohibition against Photography/Film shooting on railway premises

Such Photography/Film shooting is strictly prohibited within Station limits and on the railway lines, except with the permission of the officers authorised by railway administration.

9.18 Religious Edifices within the railway limits

Employees are forbidden to occupy any place in station area for praying holding religious functions speeches, discourses etc., to erect religious structures, either permanent or temporary, or to add or alter any existing religious structures on railway land, without the sanction of the General Manager.

Station Masters will keep close watch and promptly report any violation of this instruction.

9.19 Normal period for which Station Operating Registers and Records are required to be preserved

S.N.	Description of the Book/Form	Period of preservation from the date of completion
1	Train passing registers/Books/Forms	1 year
2	Muster Roll	Permanent record
3	Caution order register and Caution Order books	1 year
4	Wagon Exchange Book/Wagon Exchange Register	3 years
5	Sick Wagon and Transhipment Register	3 years
6	Guard's Signature Book	3 years
7	Wagon Demand/Priority Register	3 years
8	Indent and Loading Register	3 years
9	Wagon Transfer Register	3 years
10	Damaged Stock Register/ Sick Wagon Register	3 years
11	Siding Voucher Book/Record of Time Wagon Handing over	3 years
12	Control Order Book/Conference Book	3 years
13	HQ Leaving Permission Register	1 year
14	Uniform Register	Permanent Record
15	Record of Station Equipment sent for repairs	Permanent Record
16	Register of Inward and Outward Letters	3 years
17	Register of Important Circulars	Permanent Record

18	Station Order Book	Permanent Record
19	Station Inspection Register	Permanent Record
20	Transportation Bio-data Register of Home Addresses of staff etc	Permanent Record
21	Spectacles Register	1 year
22	Station Diary and Charge Book	1 year
23	Unconnected Wagon Register	3 years
24	Load Report Register	3 years
25	Register showing Analysis of Late starts To Goods Trains at important Yards	3 years
26	Watering Register	3 years
27	Summary of Daily receipt and despatch of wagons and Work Done	Local Orders to be issued by DRM
28	Special Stock Register	Local Orders to be issued by DRM
29	Detention to Wagon at Train Marshalling stations	Local Orders to be issued by DRM
30	Register of occupation of reception lines	3 years
31	Detention to Trains outside signals and at adjacent stations	3 years
32	Marshalling Register for Inward and Outward trains	Local Orders to be issued by DRM
35	Register showing detailed Arrival, Placement, Despatch and Detention particulars of PU, Repack wagons, etc.	Local Orders to be issued by DRM
36	Register of Long-Distance Goods Train run	Local Orders to be issued by DRM
37	Guard's and Assistant Guard Arrival Register	3 years
38	Register showing Detention to wagons at Break of Gauge Transhipment point`	3 years
39	Number Taker Book	3 years
40	Yard Wagon Balance Register	1 years
41	Guard's Duty Register	3 years
42	Guard's Rough Journal	3 years
43	Register of Train Advice	6 months
44	Form of Train Examination advice	1 years
45	Register showing load of Goods Trains and Goods trains run under load	3 years
46	Statement of running of Passenger Trains	3 years
47	Diary of Yard Supervisor.	Permanent Record

	Unusual Register, other registers and Records maintained in control offices and at specified stations	Local Orders to be issued by DRM

Note: -

(i) In calculating the one year or the three years period, the year to which the books and documents relate, and the year in which they are to be destroyed should be excluded.

(ii) Record pertaining to Court Cases, departmental enquiries should not be destroyed till three years from the date the case is decided.

(iii) Records pertaining to public claims etc., or those under reference from Home or other railways, should not be destroyed without permission from DRM concerned. Most of these registers can be computerized, clubbed & some can be eliminated.

PART B:
BASICS OF RAILWAY ASSETS AND ITS PROBABLE CAUSE OF FAILURE

UNDERSTANDING BASIC ENGINEERING

10

10.1 Science

It is the study of and knowledge about the physical world and natural laws obtained and tested through scientific methods which can be experimentally verified.

10.2 Engineering

Engineering is the application of knowledge of science for the use of mass consumption/ utilization.

10.3 Fundamental Units

There are 3 systems of fundamental units for engineering purposes. Other units are derived from these fundamental units of space, mass and time.

a) Foot, Pound, second system, known as F.P.S. system.
b) Meter, Kilogram, second system, known as Metric or M.K.S. system.
c) S.I. UNITS: In order to have a uniform system of units all over the world, **System International,** abbreviated as S.I. units, was evolved, The S.I. System rationalizes the available units and streamlines them into a coherent logical system, using minimum possible basic units. The basic S.I. units' area is as follows.

	Items	Name of S.I. Unit
1.	Length	Meter
2.	Mass	Kilogram
3.	Time	Second
4.	Electrical current	Ampere
5.	Temperature	Kelvin
6.	Luminous intensity	Candela

Other units are derived from the above.

Distance, Displacement, Speed, Velocity, Acceleration, Relative Velocity & angular Velocity

Distance:

It is the length of the actual path traveled by a particle in motion. Unit of distance is Meter in SI system of the unit. It is a scalar quantity.

Displacement:

It is the shortest distance between the initial and final position of a body. It is a vector quantity. Unit of displacement is Meter in SI system of the units.

Speed:

It is defined as the rate at which a particle covers a distance along a given path. It is given by the ratio of distance traveled to the time taken. It is a scalar quantity. Unit of displacement is Meter/ second in SI system of the units.

Velocity:

It is the displacement of the body in unit time or rate of displacement. It is a vector quantity. Unit of velocity is Meter/ Sec in SI system of the unit.

Acceleration:

A particle moving with variable velocity is said to possess acceleration. Acceleration is defined as the rate of change in velocity. It is a vector quantity. Unit of acceleration is meter/second^2 in SI system of the units.

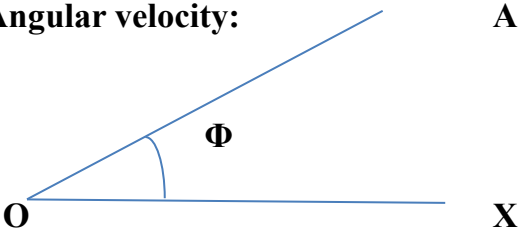
Let the velocity be ‘v’ at time 't', which changes to v + dv at time 't' + dt

$$\text{then the acceleration ‘a’} = \frac{dv}{dt}.$$

10.4 Relative Velocity:

If two bodies A and B move in a straight line with velocities u and v respectively, where u is more than v. Then, the distance between the two bodies increases at the rate of u - v, which is the relative velocity of A with respect to B.

10.5 Angular velocity:



Let 'A' be the instantaneous position of a particle, then angular velocity $\omega = \frac{d\phi}{Dt}$ where angle ø is measured in radians.

Angular Acceleration: $\frac{d\omega}{dt} = \frac{d^2\phi}{dt^2}$

Some Useful Formulae:

The following are the formulae governing velocities, accelerations, distance and time: -

$v = u + at$

$v^2 = u^2 + 2as$

$s = 1/2\ (u+v)\ t$

$s = ut + 1/2\ at^2$

$s = vt - 1/2\ at^2$

Where,

u = the initial velocity

v= the final velocity

t = the time taken from initial velocity u to final velocity v.

a= the acceleration assumed constant

s = the distance moved in time 't'

10.6 Mass, Weight, and Force:

1. **Mass:** is the measure of the quantity of matter (m) in a body and is an inherent property of that body.
2. **Weight:** is the gravitational pull (force) of the earth on the body and varies according to its distance from the earth's centre. It is equal to m x g where 'm' is the mass and 'g' is the acceleration due to gravity.

3. **Force:** is that which causes or tends to cause change in the state of motion or rest of a body. The unit of force in Newton (N) i.e., a force, when applied to a body of a mass of one kilogram gives an acceleration of one metre per second squared.

10.7 Newton's Laws of Motion:

1. **First Law:** Everybody preserves its state of rest or of uniform motion unless it is compelled by an impressed force to change its state.
2. **Second Law:** The rate of change of momentum is proportional to the applied force and takes place in the direction of the force.
3. **Third Law:** To every action, there is an equal and opposite reaction.

10.8 Work, Energy, and Power:

1. **Work:** Work is done when a force produces some kind of displacement. It is equal to the product of the force and the displacement caused by the force.
2. **Energy:** Energy is defined as the capacity to do work.
   a) **Kinetic Energy:** is the capacity to do work because of the motion of a body and is equal to ½ mv^2 where 'm' is the mass and 'v' is the velocity.
   b) **Potential Energy:** is the capacity for doing work because of the position of a body and is equal to WH where 'W' is the weight of the body and 'H' is the height from the ground level.
3. **Power:** Power is defined as is the rate of doing work. Suppose a person can do a work of 1500 metric kilograms in 15 seconds, his power is

$$\frac{1500}{15} = 100 \text{ metric kilograms (per second).}$$

10.9 Centre of Gravity:

The centre of gravity of a body is that point at which the weight of a body or system may be considered to act. The force of attraction due to gravity always acts in a vertical direction. In any position of the body, the attraction forms a system of a number of parallel forces which act on particles of matter constitution the body.

10.10 Friction:

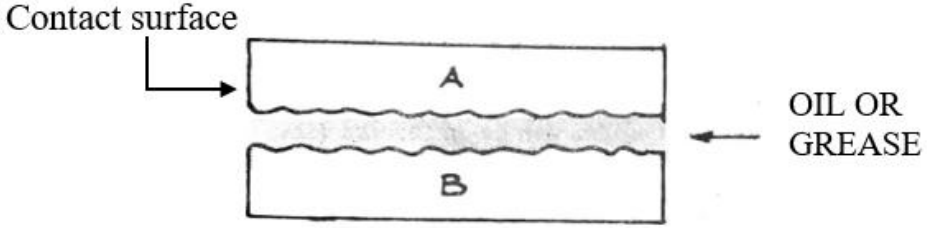
When two solid surfaces in contact move or tend to move relative to one another, the friction (a sort of force) acts opposite to the direction of motion. The frictional forces are generally a nuisance and must be reduced or minimised at some cost by lubrication, etc. But they do also serve some useful purpose by allowing tractive effort of locomotives or breaking effort of Rolling Stocks to work and are, therefore, not always unwelcome.

10.11 Laws of Friction:

1. **First Law:** When two bodies are inContact the direction of the friction force on either of them is opposite to the direction in which the point of contact of this body would move if sliding occurred. When one body is just on the point of sliding over the other, the maximum friction force is being exerted. This is called the limiting friction.
2. **Second Law:** The limiting friction (F) bears a constant ratio to the normal reaction (R). This ratio is called the coefficient of friction and is denoted by the letter μ, i.e., F/R = μ. μ depends on the substance of which the bodies are made and the nature of the surface in contact.
3. **Third Law:** The limiting friction is independent of the area of contact provided the normal reaction is unaltered.

10.12 Lubrication:

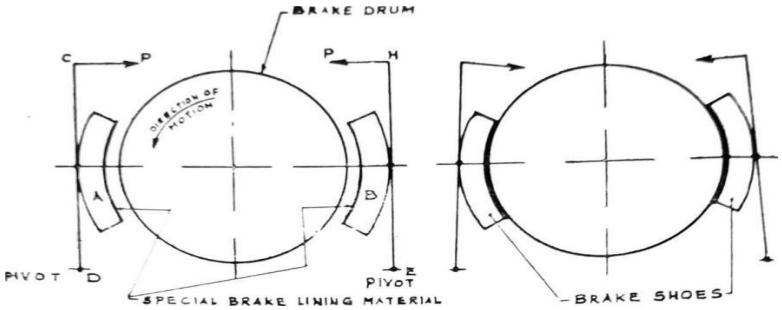
The friction forces can be reduced by lubricating the common contact surfaces.



The surface A floats on the oil/grease film resulting in the reduction of the coefficient of friction μ. The lubricant used may be either grease or oil. Grease is used where loads are heavy.

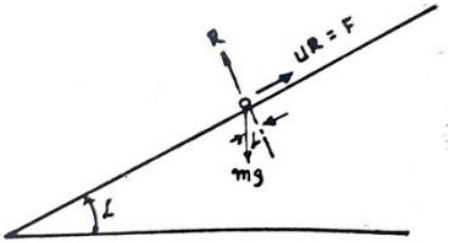
Braking

The friction is utilized on the advantageous perspective in applications. The rotating wheel of a vehicle can be slowed down or stopped by bringing another material i.e., brake block into contact with the wheel in motion. The following diagram illustrates a typical operation of a vehicle.



Motion on Inclined Plane & Friction:

1. Let a particle of mass 'm' rest on a smooth plane of an angle α to the horizontal as follows:



The only forces acting on the particle are its weight, a force of mg vertically downwards, and the reaction of the plane on the particle 'R'. The force acting down the plane is mg sin ∡ α which gives rise to

$$\text{an acceleration 'a' of } \frac{Mg \sin \angle \alpha}{M} = g \sin \angle \alpha.$$

The force acting at right angles to the plane is mg cos ∡ α which is balanced by the reaction 'R' i.e., R = mg cos ∡ α.

2. If the plane is rough there is an additional frictional force F along the surface of the plane which is equal to μ R, where μ = Coefficient of friction. Resolving the forces, we now have.

$$mg \sin \angle \alpha - \mu R = ma$$

$$mg \cos \alpha - R = 0$$

Eliminating R, $a = g (\sin \angle \alpha - \mu \cos \angle \alpha)$

If μ cos ∡α is greater than sin ∡ α, the particle would not move.

10.13 Impulses:

An impulse is the product of a force and the time it acts. It is measured In Newton seconds. In some cases, it is not possible to obtain accurate measurement of the magnitude of the force or of its duration, but the change of momentum is the impulse. For instance, when a train starts abruptly and the couplings are loose, a large force acts on the couplings for a short while resulting in a large change of momentum which is the major of impulse.

Conservation of Linear Momentum:

The total momentum of a system of particles in any direction is unaltered by mutual collisions between the particles. The principles of conservation of linear momentum applies to linear motion of rigid bodies during collision, the line of impulse being the perpendicular to the common tangent plane of the bodies during contact. Let m_1 and m_2 be the masses of particles u_1 and u_2 their velocities before impact and v_1 and v_2 their velocities after impact. Then $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$.

Coefficient of Restitution:

When body strikes a perfectly hard fixed surface, there is an instant during the impact, when its momentum has been destroyed and at this instant, the body has its maximum deformation. After this instant, the body begins to regain its shape and some momentum. Therefore, firstly and impulse that destroys the momentum and subsequently an impulse that restores the momentum comes into action. The ratio of the restoring impulse to the destroying impulse is called the coefficient of restitution and denoted by 'e'.

$$\text{Thus} \quad \frac{\text{Momentum after impact}}{\text{momentum before impact}} = e$$

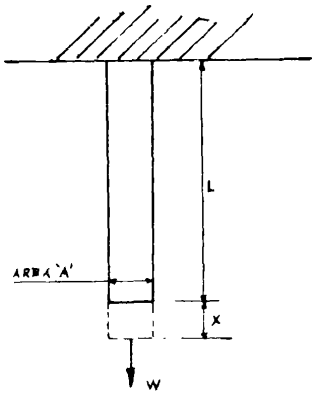
Assuming that the mass remains constant, the coefficient of restitution can also be denoted as follows, taking the velocities in opposite direction.

$$\frac{\text{Velocity after impact}}{\text{Velocity before impact}} = e$$

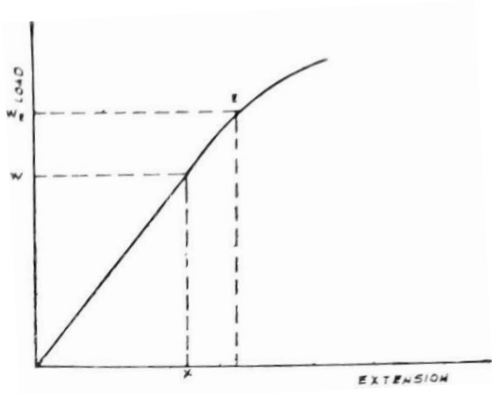
If 'e' is zero, the body is said to be inelastic and if e=1, perfectly elastic in the contact with the specified surface.

Stress and Strain:

1. Let a bar be firmly fixed at one end and subjected to a tensile load at the free end.



2. Under this tensile load, the bar will extend by an amount 'x', Let a graph be plotted with extension and load as follows:



The graph is a straight line up to point **'B'** and then start deviating from the straight line. The point **'B'** is the **'Elastic limit'** i.e., if the load is removed at any point below **'B',** the material will return to its original

length **'L'.**

3. Actually, when the bar extends, the cross-sectional area of the bar decreases. But normally the original cross-sectional area is taken into account for all calculation purposes.

$$\text{Nominal stress} = \frac{\text{Load}}{\text{Original Sectional Area}}$$

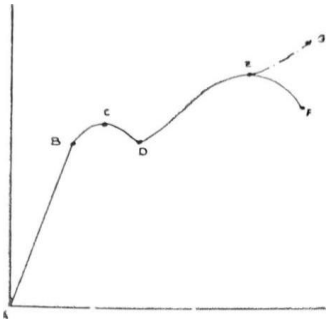
4. The ratio of the extension of the specimen to its original length is called the strain of the specimen.

$$\text{Strain} = \frac{\text{Extension}}{\text{Original length}}$$

5. The ratio of stress to strain gives a constant up to point B and is known as **Young's Modulus of Elasticity** and is denoted by the letter E.

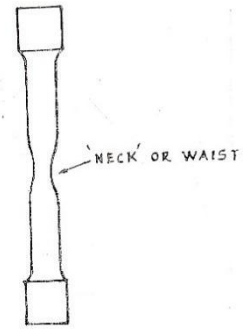
$$\text{Young's Modulus of Elasticity} = \frac{\text{Stress}}{\text{Strain}} = E$$

According to Hooke's Law, stress is proportional to strain within the elastic limit.



6. If a specimen is tested to destruction, the graph is a straight line up to point 'B'. A point will be reached in the test where the load will remain constant or even reduce, but the specimen will still extend. This is known as the yield point of the material 'C' is called the upper yield point and 'D' the lower yield point. When the test is carried on beyond 'D', the material offers the resistance and once again the load begins to rise with the extension. At 'E' the maximum load is reached, beyond which point the load reduces and the specimen forms a 'waist' or 'neck', and extension takes place along only a small portion of the standard length.

7. The load then reduces until the specimen fractures. But if the true stress-strain diagram is plotted by dividing each load by the cross-sectional area of the specimen at that load, then from E to F, the area gets reduced more rapidly due to necking and the stress will rise as shown by dotted line 'EG'. The graph ABCDEG is called the **Nominal Stress-Strain graph** and ABCDEF the true **Stress-Strain graph.**



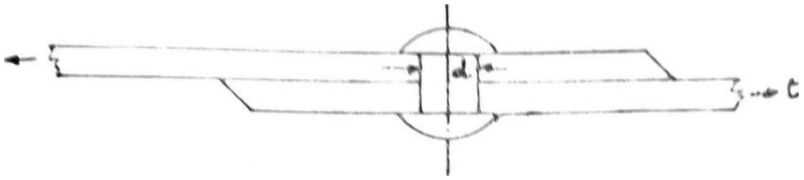
8. The stress strain diagram for compression is similar in appearance to that it in tension, except that instead of elongation there is compression in length. Further, if the load is not applied axially or the length is unduly large, there will be bending or buckling. Within the elastic range, compressive strength is much higher than tensile strength for the same metal. If the sides of the specimen are fully constrained, there can be an indefinite increase in the compressive strength.

10.14 Creep:

Metals are not perfectly elastic and exhibit a slow plastic flow called 'creep' even when subjected to a steady stress below the yield point because of "progressive grain-boundary sliding and the movement of dislocations". Creep is thus an extra strain on account of continuous subjection to stress but depending upon time, Creep increases rapidly with temperature. The rate of creep, however, decreases with time.

10.15 Shear Stress:

When a material is under shear stress, there is a force tending to make one surface slide over the other



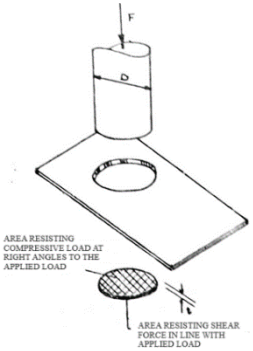
In the above diagram, the two plates are joined together by a rivet which is subjected to shear stress. If 't' is the force. the shear stress is equal to

$$\frac{t}{\Pi d^2/4} = \frac{4t}{\Pi d^2}$$

For tensile stress, the area considered is at right angles to the applied load; for a shear stress, the area subject to shear stress is the one in the same direction as the load.

10.16 Punching Shear:

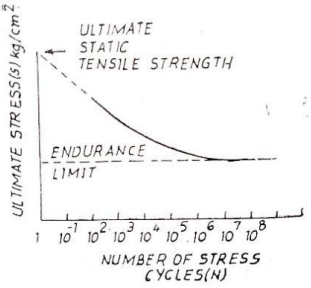
The punch in the above diagram pushes out a small metal piece. The surfaces which are sliding over each other are the circumferential surface of the small cylinder being pushed out of the metal. This area works out to πd x t. Punching shear stress is, therefore,



$$\text{equal to} \frac{F}{\pi d \times t}$$

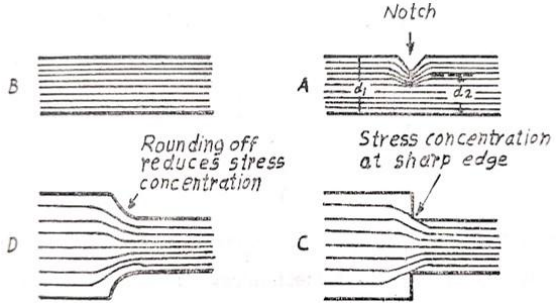
Torsion:

When a solid circular bar is twisted about its axis by applying equal and opposite moments at its end, there is a shear stress ranging from zero at the center to maximum at the surface, The bar is said to have been subjected to a torsional force.



Fatigue:

1. Fatigue of metal parts arises out of repeated applications of stress depending upon the range of variation of stress and the number of cycles of repetition. A material under fatigue suffers in internal structure and fails below the ultimate strength. Such a failure is called fatigue failure. The stress-cycle life curve flattens out towards asymptote as per the figure shown below If the stress is below a minimum value known as endurance limit, the material will not fail on account of fatigue.
2. The fatigue failures originate out of microscopic cracks because of tensile failure at some weak point on the surface, like a surface neck, sharp corner, abrupt change in section, inclusions, etc. Such weak points are called stress raisers Cracks grow in depth with repeated cycles of stress reducing the effective area of the member to such an extent that the fracture occurs suddenly.

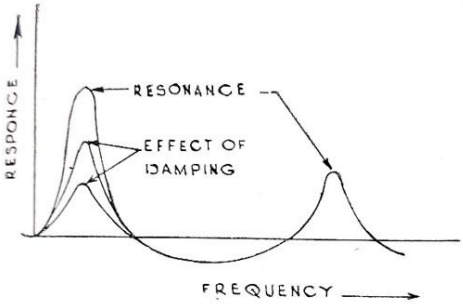


3. A rough surface lowers fatigue strength when compared to a polished surface. Stress concentrations can be avoided by giving a good surface finish by rounding off edges and corners, easing off abrupt changes in section. Ultrasonic detection of cracks in advance can avoid failure by fatigue.

10.17 Vibrations and Oscillations:

Vibration implies a faster movement at a high frequency while oscillation applies to a slower movement even if its amplitude is larger. Any mechanical system with springs and masses is subject to oscillation when disturbed externally from its position of equilibrium. The oscillation can, however, be set at naught with suitable dampening devices. If the disturbance is recurrent and

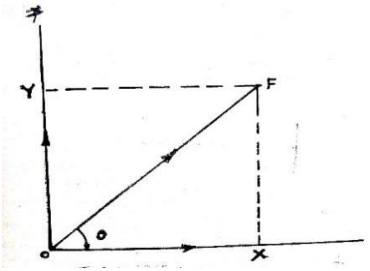
the rate or frequency of repetition is gradually increased, the amplitude of the vibration increases out of proportion to the amplitude of the disturbing force, until it reaches the maximum value. The system is then said to be resonating at its natural frequency which is a function of the inertia and resilience (mass and elasticity) of the system. When the frequency of the disturbing force is raised above the material frequency, the amplitude comes down again, generally as shown below. Resonance for some other spring mass combination in the system may produce a second peak at a higher frequency.



In a resonant system, there is a continual interchange of energy between mass and spring. Any mechanical component under vibration is subject to alternating stresses which become very high as resonance is approached and the component is likely to fail out of fatigue if the resonance continues for long.

Resolution of Forces:

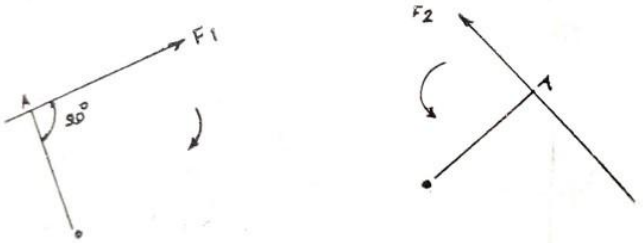
1. A force is a vector quantity with magnitude and direction and can be represented by a straight line. When a number of forces act on a body in the same plane — called co-planer force — a single force called the resultant force can replace all these forces, but still have the same effect on the body. If the body is to be in a state of equilibrium, a force equal and opposite to the resultant, called the equilibrant must be applied.
2. Many a time, it is useful to replace a single force by two components which are at right angles to each other.



If a force 'F' acts at a point 'O' equal in magnitude and direction to 'OF', the same can be resolved into two components OX and OY equivalent to 'F' Cos 'Ø' and 'F' sin 'Ø' respectively.

Turning Moment of a Force:

1. The moment of a force is the product of the force multiplied by the perpendicular distance of the force from the point about which it is acting.



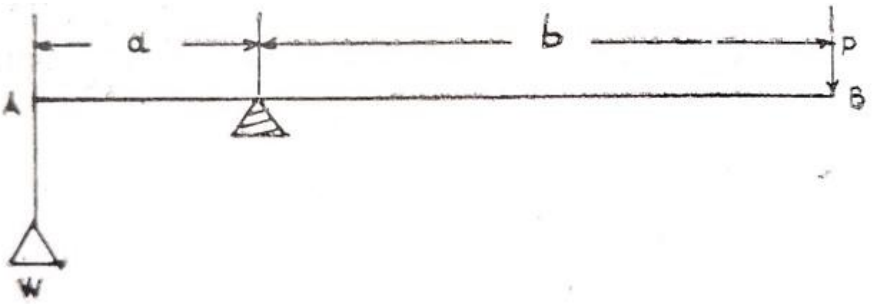
Thus, in the above figures F x OA is the moment. F_1 x OA is the clockwise moment and F_2 x OA is the anti-clockwise moment. The point O about which the force turns is called a pivot or fulcrum.

2. If a body is at rest under the action of several forces in the same plane, then,
   a) The resultant force is zero.
   b) The clockwise moments of any point must be equal to the anti-clockwise moments about the same point.

These principles are useful in finding out unknown forces acting on bodies in a state of rest. For instance, reactions at the support can be found when a beam rests on two supports.

Levers:

The lever is a simple machine which uses the principle of moments in order to raise loads of large magnitudes by means of small forces. The lever turns about a fixed point called the 'fulcrum'.



In the above arrangement,

$$w \times a = p \times b, \text{ or } p = \frac{a}{b} \times w$$

The longer the power arm b' is when compared to the weight arm 'a', the smaller is the force *P' required to lift the load 'w'.

The ratio $\frac{b}{a}$ is called the 'mechanical advantage'.

Machines:

1. In the above example, it is seen that a heavy weight could be lifted with a small effort by using a lever and a fulcrum. A heavy load could be moved horizontally on ground by inserting circular rollers under the weight, because the rolling friction is very much less than the sliding friction. Thus, simple machines are devised to perform tasks for which a man is not strong enough.
2. All machines are used to overcome resistance by means of an effort and generally the resistance overcome is large when compared with the effort. The resistance or the load is the output side of the machine, and the effort is the input side of the machine.
3. A winch is a simple example of a machine.
4. The following equations are worth remembering: -

$$\text{Mechanical Advantage (M.A.)} = \frac{\text{Load}}{\text{Effort}} = \frac{W}{P}$$

$$\text{Velocity ratio (V.R.)} = \frac{\text{Distance moved by the effort.}}{\text{Distance moved by the load in the same time.}}$$

$$\text{Efficiency} = \frac{\text{Work output}}{\text{Work input}} = \frac{\text{Load x distance moved.}}{\text{Effort x distance moved.}}$$

$$\frac{W}{P} = \frac{1}{V.R.} = \frac{M.A.}{V.R.}$$

If the efficiency is 1 or 100%. i.e., when there are no losses due to friction, etc., M.A. = V.R. But normally, the efficiency is less than 100% due to losses.

5. The above principles are adopted in the design of screw jacks, pulley blocks, etc.

Metals, Characteristics & Treatment

Metals:

They are divided into two groups, viz. ferrous and nonferrous. Ferrous metals belong to the iron group and all other metals are classified as non-ferrous.

Hardness:

Is a property in a metal to withstand scratching by harder substances. If a harder and softer metal scratches each other, the harder will scratch the softer. This property in a metal gives it the ability to resist being permanently deformed when a load is applied.

Malleability:

A metal is said to be malleable if it can be beaten or rolled into thin sheets without rupture.

Ductility:

Is a property which enables a metal to be drawn out into a wire without rupture and is akin to malleability but opposite to brittleness.

Brittleness:

is a property in metals of breaking without permanent distortion.

Annealing:

The metals are annealed by heating them slowly to a temperature just above the critical range and kept under that temperature for long enough to allow the internal changes to take place and then cooled down slowly out of contact with the air. Annealing aims at improving ductility and is opposite to hardening and its object is to soften the metals so that they can be machined easily to relieve the internal stresses caused during hammering, rolling, or stretching and to obtain refinement of grains of metals.

Hardening:

The metals are hardened by heating metals and then quenching them suddenly in water or some other liquid; hardness depends upon the temperature to which the metal is heated and the cooling speed. The metals are hardened to resist wear and to enable to cut other metals.

Tempering:

Is the process of reheating the pre-hardened metals from 216° C (for turning tools) to 290° C (for screw drivers) and then quenching them slowly. The

metals, when hardened, become hard and brittle. Tempering is, therefore, necessary to relieve the hardening strains.

Normalizing:

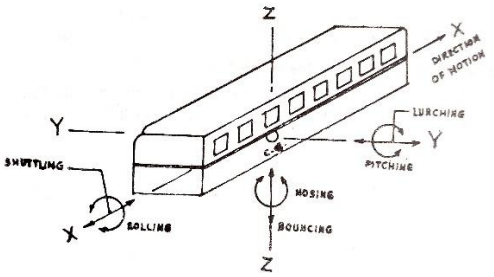
When steel is cold worked, the normal molecular structure is distorted and disturbed on account of the internal stresses and the metal becomes brittle. Also, when steel is kept heated for a considerable period above the higher critical temperature, a growth in the gram size takes place and when cool, the metal may lose its toughness It is. therefore, necessary to bring back the molecular structure to its normal state by heating the articles to annealing temperatures i.e., 843° C to 954° C, according to the composition of steel and then allowed to cool as rapidly as possible in air, draw bars are normalized before use after welding.

Ultrasonic Flaw Detection:

Vibrational waves above the hearing range of the normal ear (i **e.** more than 20,000 cycles per second) are termed ultrasonic waves. These waves are useful in detecting the flaws in metals. Metals with their elastic properties can transmit ultrasonic vibrations. When these waves are impressed on a body, they pass through the metal and are reflected back from the other end. However, if a discontinuity exists in the metal body, the waves get reflected back from the location of the flaw which can be picked up and the flaw detected. This principle is used in the detection of flaws in rails and axles.

Parasitic Motions of Vehicles on Track

There are six kinds of motions of railway vehicles. There are linear oscillational motions along the three Cartesian axes (X, Y, Z) and the remaining three are the rotational oscillations about the same axes. The center of gravity of the vehicle constitutes the origin of the Cartesian coordinates. 'X' axis is in the direction of the motion of the vehicle (parallel to track), the lateral or transverse direction (at right angles to track) is the 'Y' axis and the vertical direction is the 'Z' axis.



Parasitic Modes of Oscillations

The definitions of various parasitic motions of a vehicle are as follows:

1. **Shuttling:**
   Linear oscillation in a fore and aft direction parallel to the track (along 'X' axis)
2. **Rolling:**
   Rotational oscillation about the longitudinal axis (i.e., about 'X' axis)
3. **Pitching:**
   Linear oscillation in a lateral direction (along 'Y' axis).
4. **Lurching:**
   Rotational oscillation in about the lateral/transverse axis (about 'Y' axis)
5. **Bouncing:**
   Linear oscillation in up and down direction (along 'Z' axis)
6. **Nosing:**
   Rotational oscillation in up and down direction (about 'Z' axis)
7. **Hunting: (Yawning): -**
   Is the combined effect of Nosing, Lurching and rolling, i.e., all rotational oscillations about three axis.

Important Motions

Out of the six fundamental motions, rolling, lurching, and bouncing are normally the more significant. The Hallade instrument measures these three motions.

Parasitic Motions:

Due to irregularities in the track geometry and variations in the elastic characteristics of track as well as tolerances from the ideal values of vehicles the vehicles in motion on track execute the above six kind of motions, called parasitic motions, since they feed themselves on the motion of the vehicles on track just like parasites.

BASICS OF PERMANENT WAY
FOR ACCIDENT INVESTIGATION
(THE RAILWAY TRACK)

11

The track structure consists of following four main components:

1. Formation
2. Ballast
3. Sleepers and fastenings
4. Rails

These are required to be regularly and periodically checked by Assistant Divisional Engineer (IRPWM- 2020 Maintainers (or Section Engineer/P. Way (SSE/PW) Overall in-charge (IRPWM- 2020 para 104 & 106), Junior Engineer/ Senior Section Engineer/P. Way Sectional (IRPWM- 2020 para107, 109), Junior Engineer/ Senior Section Engineer/P. Way (IRPWM- 2020 Para 110) as well as by Gang Mate, Keyman, Patrolman and Track Maintainers (IRPWM- 2020 Para 112, 114).

11.1 Formation

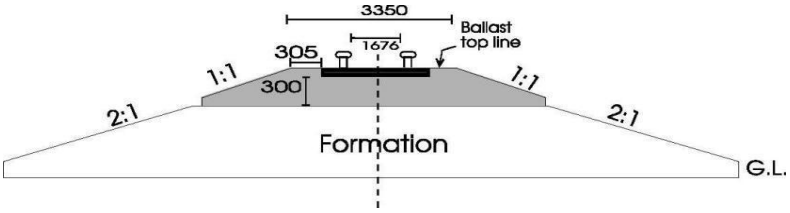
The railway track is laid over a formation prepared on soil. The strength of formation depends upon the type of soil i.e. sandy, loam clay etc. and it serves the following purposes:

1. Distributes the weight of train, track, and ballast over a wide area of natural ground.

2. Facilitates good drainage.
3. Provides a smooth and regular surface on which the ballast and track can be laid.

The formation is affected by following factors:

1. Sudden subsidence of embankment
2. Base failure
3. Ballast puncturing due to heavy rains etc.
4. Muddiness



B.G. Formation

The inadequate care taken in maintaining the formation may cause derailments as failure of formation results in disturbance of track geometry. The steps to be taken for avoiding derailments on account of formation failure include measures to prevent sinking of track during diversions and use of new formations especially during rains. The geometry of the track should be maintained as per laid down standards for passage of traffic at stipulated speeds. Where abnormal behaviour of formation or - supports is expected, the track geometry and packing/supports must be checked regularly or as often as warranted.

11.2 Failure of formation

This feature is obvious and would not need any elaboration. Sudden subsidence of embankment, slope or base failure, slips, etc. are examples of formation failures which could cause a derailment.

Other subtle formation failures e.g., ballast puncturing into the formation soil and forming ballast pockets, settlement of formation top accompanied by cess heave, mud-pumping conditions, problems in formation of expansive soils e.g., black cotton soil, etc. are gradual processes which do not affect safety directly but only through effect on track geometry, retentivity of which is reduced appreciably, needing more frequent attention.

11.3 Ballast

In track geometry, ballast plays an important role. It absorbs noise, shocks, and vibrations and distributes the load transmitted by the wheels over the formation. The ballast provides a flexible base to the track and controls the lateral and longitudinal movement of track. It keeps the track in position and at the required

level. If sufficient quantity of ballast is not available, track may get distorted and/or buckled. The specification of ballast as under:

Ballast Specifications

1. **Basic Quality**
   Ballast should be hard, durable and as far as possible angular along edges/corners, free from weathered portion of parent rock, organic impurities and inorganic residues.
2. **Particle Shape**
   Ballast should be cubical in shape as far as possible. Individual pieces should not be flaky and should have generally flat faces with not more than two rounded/sub rounded faces.
3. **Physical Properties**
   Following physical properties as determined in accordance with Indian standard codes as specified by Indian Railways.
4. **Size And Gradation**
   Ballast should satisfy the following size and gradation

(a) Retained on 65mm Sq. mesh sieve	5% Maximum
(b) Retained on 40mm Sq. mesh sieve*	40%-60%
(c) Retained on 20mm Sq. mesh sieve	Not less than 98% for machine crushed Not less than 95% for hand broken

* For machine crushed ballast only.

4.1 Oversize ballast

1. Retention on 65mm square mesh sieve.
   A maximum of 5% ballast retained on 65mm sieve shall be allowed without deduction in payment.
   In case ballast retained on 65mm sieve exceeds 5% but does not exceed 10% payment at 5% reduction in contracted rate shall be made for the full stack. Stacks having more than 10% retention of ballast on 65mm sieve shall be rejected.
2. In case ballast retained on 40mm square mesh sieve (machine crushed case only) exceeds 60% limit prescribed as above, payment at the following reduced rates shall be for the full stack in addition to the reduction worked out at i) above.

a) 5% reduction in contracted rates if retention on 40mm square mesh sieve is between 60% (excluding) and 65% (including)
b) 10% reduction in contracted rates if retention on 40mm square mesh sieve is between 65% (excluding) and 70% (including)

3. In case retention on 40mm square mesh sieve exceeds 70% the stack shall be rejected.
4. In case of hand broken ballast supply, 40mm sieve analysis may not be carried out. The executive may however ensure that the ballast is well graded between 65mm and 20mm size.

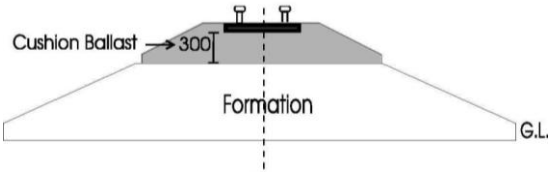
4.2 Under size ballast

The Ballast shall be treated as undersize and shall be rejected if-

1. Retention on 40mm sq. Mesh sieve is less than 40%.
2. Retention on 20mm sq. Mesh sieve is less than 98% (for machine crushed) or 95% (for hand broken)

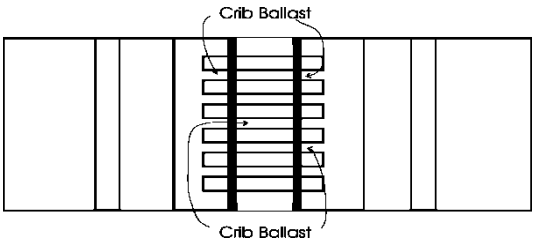
a) Cushion Ballast:

The depth of ballast below the bottom of sleeper, normally measured under the rail seat, is termed as cushion ballast.



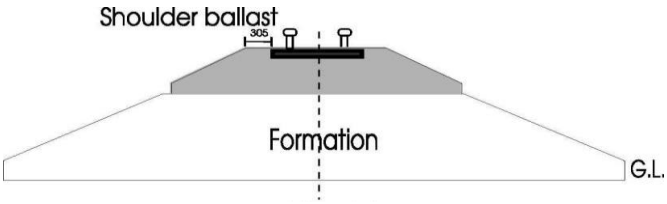
b) Crib Ballast:

Ballast provided in between the sleepers is termed as crib ballast. (Fig. 4.3)



c) Shoulder ballast:

Ballast provided beyond the sleeper edge is called shoulder ballast.



At deep screening and relaying spots, the top table or gauge face of the rail gets smeared by ballast. This enhances friction at the flange contact area and encourages mounting of wheel specially in case of empty stock. The running surface of the rail should therefore be maintained clear of ballast particles.

Ballast Resistance

The ballast plays an important role in absorbing shocks. The factors affecting the ballast resistance are:

1. Ballast material
2. Size
3. Shape of ballast particle
4. Ballast profile
5. State of consolidation
6. Type of sleeper

Failure of ballast

Ballast performs a vital role in the track structure and could be aptly called the muscle of the track. It absorbs noise, shocks, vibrations and energy, distributes load over the formation, ensures provision of a well-drained support, provides a convenient means of bringing up the track geometry, and most important of all, contributes overwhelmingly to the lateral and longitudinal strength of the track (roughly 55 to 70% of the lateral strength of the track is contributed by ballast). Care is, therefore, needed in respect of factors which affect the lateral and longitudinal ballast resistance.

Lateral resistance is essential for ensuring safety against track distortion and buckling.

Longitudinal resistance, if reduced, increases creep in fish plated track (which could lead to jamming of joints and lateral buckling of track) and increases the breathing length in long welded track and, hence, the rail end movements at the switch expansion joint.

Factors which affect the ballast resistance are:

1. Ballast material
2. Size of ballast
3. Shape of ballast particle

4. Ballast profile
5. State of consolidation
6. Deep screening

1. Ballast material

A hard, sound and durable ballast material ensures good resistance for a far longer period of time as compared to inferior ballast, which under traffic and weathering action, wears out and becomes rounded sooner.

2. Size of ballast

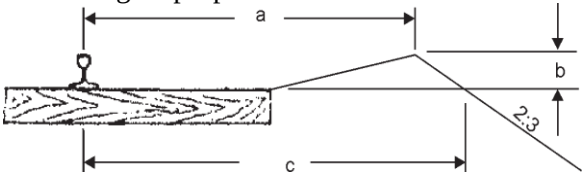
There is an optimum size which ensures the maximum resistance. Any size smaller or larger would mean a slight reduction in resistance. 65 mm is the size found to be optimum on the Indian Railways (a certain grading of size is desirable for better resistance).

3. Shape of ballast particle

Crushed stone ballast, angular or cubical in shape, has greater resistance than that of rounded ballast.

4. Ballast profile

To ensure adequate lateral resistance, a minimum width of ballast shoulder is necessary. For long welded track, which is subjected to thermal compressive forces, additional strength is provided by heaping of ballast, as widening the shoulder alone does not give proportionate increase in lateral resistance.



Ballast shoulder and heap

a (cm)	b cm)	c (cm)	Wooden sleeper
90	0	90	100% (reference value)
120	0	120	102.6%
90	10	105	130.7%
120	10	135	149.2%

5. State of consolidation

Ballast is cohesionless, the best means of compacting which is vibration. Vibrations due to passage of traffic gradually consolidate

the ballast to a peak value. As the ballast consolidates, it settles and with it does the track. Since the settlements are not expected to be uniform, the differential settlements of the track result in deterioration of the track geometry. It is to bring up the track geometry that the ballast is given a packing.

Packing involves breaking the consolidated pattern of the ballast particles, loosening them and then packing them back after holding the track to the correct geometry. Such packing can never achieve the same degree of consolidation as existed prior to commencement of packing operations. Thus, certain passage of traffic is necessary to regain the earlier peak level of consolidation.

A maintenance operation, necessary for improvement of the track geometry, is accompanied by a drop in the lateral ballast resistance. If the maintenance operation involves lifting of track the loss of resistance would be still more.

It is for this reason that one of the criteria for design of rolling stock is that they should not exert a lateral force greater than the strength of a track which has just been given maintenance attention.

Such limit on the lateral force exerted by an oscillating vehicle had earlier been given by Blonded as 0.4P+2 (in tonnes), where P= axle load (in tonnes).

Almost all the World Railways, including Indian Railways, have since adopted the Prudhommes limit, viz.

$$\left(1+\frac{P}{3}\right) P \text{ where p is normally } 0.85$$

In the case of long welded track, maintaining adequate lateral ballast resistance, particularly during the high temperature periods, is crucial for safety against buckling. Interference with the state of consolidation of the ballast, which a maintenance attention inevitably causes, should, therefore, be kept to a minimum. Through maintenance attention should be completed well before

the onset of summer (see provisions of LWR/CWR Manual).

6. Effect of deep screening

As deep screening loosens up ballast in the cushion also, the loss in ballast resistance is substantial. It is for this reason that speed restriction is imposed after deep screening and the same is relaxed in stages to match with the gradual buildup of strength under traffic (refer IRPWM).

11.4 Sleepers and Fastenings

The sleepers and fastenings hold the rails within desired gauge parameters. If sleepers and fastenings fail, the entire geometry of the track gets disturbed, and the rails may shift from their due position. The loosening or failure of fastenings also indicates lateral distortion of rails under load. Thus, they perform the following functions:

1. To hold the rails as per desired gauge limits
2. To transmit the load from rail to a wider area over the ballast.
3. To provide resilient support with the ability to absorb high frequency vibrations.
4. To provide lateral and longitudinal strength to the track
5. To permit rectification of track geometry
6. Be amenable to packing and retain it.
7. To resist longitudinal creep of rail
8. To resist overturning of rail

Types of Sleepers are:

1. Wooden
2. CST 9 (Central Standard Trial-9) Cast Iron
3. Steel trough
4. Concrete

The various **fastenings** used are bearing plates, fish plates, Screws, Spikes, Steel keys, cotters, Pandrol clips etc.

Sleeper Density:

Definition:

The Sleeper density is expressed as the number of sleepers per km of track and is fixed taking into consideration the maximum permissible speed and the traffic density of the section.

Minimum Sleeper Density:

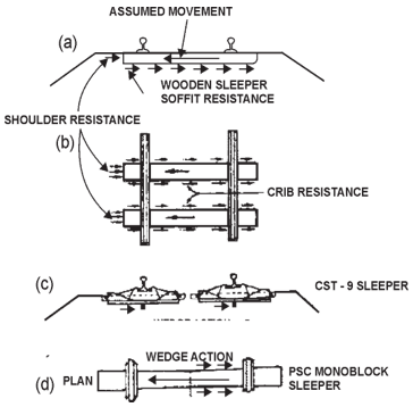
a) The minimum sleeper density for all track renewals (complete track renewal and through sleeper renewal), doubling, gauge conversion, new line construction works for main lines shall be 1660 nos. per km and for loop lines & sidings (permissible speed up to 50 Kmph) it shall be 1540 nos. per km. For sidings with a permissible speed more than 50 Kmph minimum sleeper density shall be 1660 nos. per km. Note: Higher sleeper density may be provided with the approval of the Principal Chief Engineer.

b) Where concrete sleepers are required to be laid in unavoidable circumstances, in SWR track, the sleeper spacing including at fish-plated joint, shall be kept uniform. In addition, 1 m long fishplates, be provided at fish plated joints.

Failures of Sleeper and Fastening

Sleeper and fastening perform the following functions:

1. hold the two rails to the desired gauge.
2. transmit the load from rail to a wider area over the ballast.
3. provide a resilient support with the ability to absorb most of the high frequency vibrations.
4. provide, along with ballast,



(a) Soffit resistance (b) Crib and shoulder resistance (c) Keying action CST9 sleeper and (d) Wedge action in Monoblock PSC sleeper

lateral and longitudinal strength to the track.

5. permit rectification of track geometry.
6. be amenable to packing and retaining it.
7. resist longitudinal creep of rail.
8. resist overturning of rail.

Lateral strength is contributed by sleepers in two ways:

1. development of ballast resistance either by friction between sleeper and ballast at bottom (soffit resistance) and sides (crib resistance) and passive ballast resistance at the shoulders (shoulder resistance) of the sleeper, or by physical keying or wedge action of the sleeper, or a combination of both.
2. development of lateral track frame stiffness with torsional resistance of the fastenings.

The aspect of ballast resistance has already been discussed. For ensuring adequate frame stiffness of the track, the fastenings should be maintained in tight condition and elastic fastenings should be kept adequately tensioned. Longitudinal resistance is provided by sleeper-ballast resistance (through friction or keying)

1. **Rail fastening-sleeper grip**

The lower of the above two determines the longitudinal resistance, as the weaker of the two will give way first. If fastenings are too loose, rails would creep past the sleepers and lead to jammed joints and possibly buckling. Even if fastenings are tight, rail and sleeper may move as one assembly past the ballast, for instance, on steep gradients, thus leading to jammed joints.

On long welded rails where build-up of thermal forces occurs, special care is therefore required to be taken in summer to ensure that lateral and longitudinal ballast resistances are not allowed to become low. Prior to onset of summer, distressing of LWR shall be completed if the behaviour of LWR warrants the same. Special precautions during summer on LWR includes introduction of hot weather patrol when necessary, undertaking track maintenance works strictly within the permitted temperature ranges, etc.

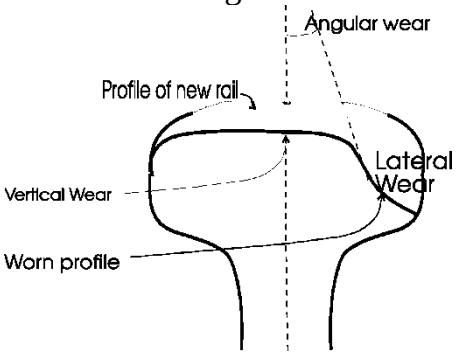
On winter months, special care shall be taken in early detection and replacement of suspected rail defect locations by USFD testing to prevent rail/weld fractures. Behaviour of LWR, as adjudged by the gap measurements at SEJ, shall form the basis for necessity of distressing the LWR and this should be done well before onset of winter.

11.5 Rails

The wear on rails plays a vital role in increasing the mounting tendency of wheel on the rail table. The excessive wear may even result in rail fracture which may cause derailment.

The types of rail wear are:

A. Vertical
B. Lateral
C. Angular



Limits of Rail Wear

The permissible limits of rail wear (IRPWM Para. 302 iii & iv) are given below:

Vertical wear

Measure the rail height at the center of rail (normally using callipers or profiling).

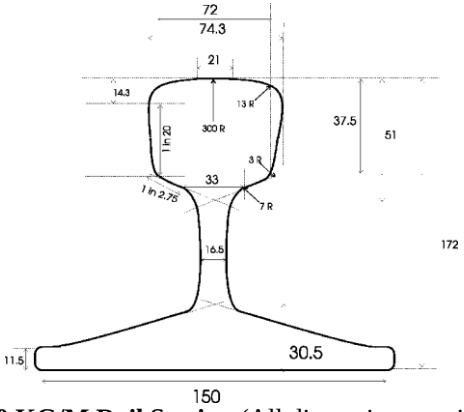
Gauge	Rail Section	Limit
	60 KG/M	13 mm
B.G.	52 KG/M	8 mm
	90 R	5 mm

Lateral wear

Section	Gauge	Category of track	Limit of Lateral wear
Curves	B.G.	A & B C & D	8 mm 10 mm
Straight	B.G.	A & B C & D	6 mm 8 mm

Note: The lateral wear should be measured 13 mm below the top surface of the rail.

The maximum angular wear permitted is 25^0 on all tracks. The typical profile and main dimensions of a new 60 KG UIC rail section are shown below.



60 KG/M Rail Section (All dimensions are in mm)

1. If vertical wear is excessive, a deep flange may ride over the fish plate/distance block/check block and may damage the track components.
2. Excessive lateral wear increases the play between the wheel set and the track which would contribute to increased oscillations and greater angularity of the flange during run.
3. The angular wear is most critical. Angular wear is invariably encountered on the outer rails on sharp curves as well as on turn outs. If angular wear is excessive, the rail presents an inclined plain to the wheel on which the flange may slide upwards.

Failures of Rail

Two aspects are important:

1. Rail failure or fracture
2. Rail wear

The first feature as a contributory cause of derailment is obvious, unless the failure or fracture is as a result of the derailment. This can be established by physical and metallurgical examination of the fractured surface. If the failure or fracture is as a result of the derailment, the entire surface of fracture will show a brittle failure, whereas, if the crack existed prior to derailment, a relatively polished fatigue zone will be evident. Fractured rail pieces resulting in derailment are required to be sent to M&C Directorate of RDSO for examination and analysis.

Locations where the incidence of rail fractures may be high included those where corrosion also is predominant e.g., in tunnels, and at platform lines. It is preferable to test such sections more frequently by ultrasonic rail flaw detector. In tunnels, the rails should be renewed on a planned basis and the sound released rails re-used elsewhere.

11.6 Track Geometry

In simple terms, the rail tables and the gauge face of the two rails form the track geometry.

Precisely, track geometry is defined through the geometry of vertical profile as well as the lateral profile of the running surfaces on individual rails. By design, vertical profile is fixed through the track gradients (as reflected on Longitudinal Sections) and through the superelevation or cross level. The lateral profile is fixed by the extent of straight and curved alignments and by track gauge. The profiles of running surfaces form the basic data for construction of railway line. However, during subsequent maintenance, track geometry is measured through track geometry variations parameters, as defined below.

Vertical Profile

1. Unevenness measured as mid chord offset.
2. Cross level difference/super elevation, as well as its variation with reference to length of track, namely, Twist.

Lateral Profile

1. Alignment measured as mid chord offset.
2. Slackness or tightness of track gauge, as well as its variation with reference to length of track.

It may be seen that during maintenance, the straightness of the running surfaces is measured as relative measurement, taking the reference of the existing profile itself. For normal speeds of operation (up to 160 km/h), this method of measurement is found to be adequate.

Relative measurement of straightness in vertical plane through mid-chord off-set on a chord of 3.6 m or 7.2 m does not, however, bring out the variations of gradient, which can only be identified by using very long chords. Such defects which are perceptible on long chords are termed as long wave track defects. During normal maintenance, for speeds up to 160 km/h, such measurement on very long chords (of the order of 100 m) is not essential., However, whenever the track profile is adjusted while executing major track works, like deep screening, track relaying etc., the long wave track defects should be eliminated.

Long wave track defects combined with poor engineman ship can lead to unfavorable forces being exerted over the couplings/ buffers, which can lead to derailment. Therefore, in derailment investigations, the contribution of the track profile measured over long stretches of track by absolute measurement (levelling) should also be examined in conjunction with the engineman ship of the driver for the possible off-loading of the wheels leading to the derailments. Such long wave track defects, as far as high-speed passenger rolling stock is concerned, generally lead to unfavorable ride behaviour. These may not lead to unsafe conditions unless adversely compounded by other factors. For monitoring long wave track defects on high-speed routes on Indian Railways, a chord length of 9.6 m is presently being adopted for unevenness and alignment.

Track geometry can be measured on the spot by using equipment like gauge-cum-level, nylon chord, stepped gauge and scale. Track Recording Cars (TRC) measure the track parameters on a continuous pattern, producing roll charts with marks to locate kilometrage. The use of TRC has enabled categorization of the quality of track geometry and has been providing valuable guidance for track maintenance activities.

Maintenance Limits for Different Speed Bands:

Based on TRC and OMS results, various limits of PML NBML and UML for Unevenness, Alignment, Gauge and Twist Parameters for different speed bands are stipulated as under:

1. For Speeds up to 100 Kmph:

SN	Parameter	Planned Maintenance Limit (PML)	Need Based Maintenance Limit (NBML)	Urgent Maintenance Limit (UML)
1	**UNEVENNESS (UN)**			Vertical and lateral acceleration peak of 0.30 g
1.1	UN-1	SD-5.0 mm	SD-6.8 mm Peak-20 mm	
1.2	UN-2	-	-	
2	**ALIGNMENT (AL)**			
2.1	AL-1	SD-3.3 mm	SD-4.9 mm Peak -15 mm	

2.2	AL-2	-	-	
3	**GAUGE**			
3.1	**Mean gauge over 200 m section over nominal gauge**			
(a)	Straight	-	-8 mm to +10 mm	-10 mm to + 12 mm
(b)	Curve with radius 440 m or more	-	-5 mm to +14 mm	-7 mm to +17 mm
(c)	Curve with radius less than 440 m (Permissible speed as per relevant Para of IRPWM)	-	-5 mm to +18 mm	-7 mm to +20 mm
3.2	**Isolated defects – Nominal track gauge to peak value**			
(a)	Straight	-	-10 mm to +12 mm	-12 mm to + 15 mm
(b)	Curve with radius 440 mts or more	-	-7 mm to +17 mm	-11 mm to +20 mm
(c)	Curve with radius less than 440 mts (Permissible speed as per relevant Para of IRPWM)	-	-6 mm to +22 mm	-8 mm to +25 mm
4	Twist (TW-1)		5 mm/m	7 mm/m

2. For Speeds above 100 Kmph and up to 110 Kmph:

SN	**Parameter**	**Planned Maintenance Limit (PML)**	**Need Based Maintenance Limit (NBML)**	**Urgent Maintenance Limit (UML)**
1	**UNEVENNESS (UN)**			Vertical and lateral acceleration peak of 0.30 g
1.1	UN-1	SD-3.8 mm	SD-5.5 mm Peak-17 mm	
1.2	UN-2	SD-5.4 mm	SD-7.5 mm Peak-23 mm	
2	**ALIGNMENT (AL)**			
2.1	AL-1	SD-2.5 mm	SD-3.9 mm Peak -12 mm	
2.2	AL-2	SD-4.1 mm	SD-6.7 mm Peak-20 mm	
3	**GAUGE**			
3.1	**Mean gauge over 200 m section over nominal gauge**			

(a)	Straight	-	-8 mm to +10 mm	-10 mm to + 12 mm
(b)	Curve with radius 440 mts or more	-	-5 mm to +14 mm	-7 mm to +17 mm
(c)	Curve with radius less than 440 mts (Permissible speed as per relevant Para of IRPWM)	-	-5 mm to +18 mm	-7 mm to +20 mm
3.2	**Isolated defects – Nominal track gauge to peak value**			
(a)	Straight	-	-10 mm to +12 mm	-12 mm to + 15 mm
(b)	Curve with radius 440 mts or more	-	-7 mm to +17 mm	-11 mm to +20 mm
(c)	Curve with radius less than 440 mts (Permissible speed as per relevant Para of IRPWM)	-	-6 mm to +22 mm	-8 mm to +25 mm
4	Twist (TW-1)		4 mm/m	7 mm/m

Note: In case of curve, the limits for alignment prescribed are above average versine.

3. For Speeds above 110 Kmph and up to 130 Kmph:

SN	Parameter	Planned Maintenance Limit (PML)	Need Based Maintenance Limit (NBML)	Urgent Maintenance Limit (UML)
1	**UNEVENNESS (UN)**			
1.1	UN-1	SD-3.3 mm	SD-4.9 mm Peak-15 mm	Vertical and lateral acceleration peak of 0.25 g
1.2	UN-2	SD-5.1 mm	SD-7.4 mm Peak-22 mm	
2	**ALIGNMENT (AL)**			
2.1	AL-1	SD-2.5 mm	SD-3.6 mm Peak -11 mm	
2.2	AL-2	SD-3.5 mm	SD-5.3 mm Peak-16 mm	
3	**GAUGE**			
3.1	**Mean gauge over 200 mts section over nominal gauge**			
(a)	Straight	-	-8 mm to +10 mm	-10 mm to + 12 mm
(b)	Curve with radius	-	-5 mm to +14 mm	-7 mm to +17 mm

	440 mts or more			
(c)	Curve with radius less than 440 mts (Permissible speed as per relevant Para of IRPWM)	-	-5 mm to +18 mm	-7 mm to +20 mm
3.2	**Isolated defects – Nominal track gauge to peak value**			
(a)	Straight	-	-10 mm to +12 mm	-12 mm to + 15 mm
(b)	Curve with radius 440 mts. or more	-	-7 mm to +17 mm	-11 mm to +20 mm
(c)	Curve with radius less than 440 mts. (Permissible speed as per relevant Para of IRPWM)	-	-6 mm to +22 mm	-8 mm to +25 mm
4	Twist (TW-1)		4 mm/m	6 mm/m

Note: In case of curve, the limits for alignment prescribed are above average versine

4. For Speeds above 130 Kmph and up to 160 Kmph:

SN	Parameter	Planned Maintenance Limit (PML)	Need Based Maintenance Limit (NBML)	Urgent Maintenance Limit (UML)
1	**UNEVENNESS**			
1.1	UN-1	SD-2.9 mm	SD-4.4 mm Peak-13 mm	Vertical and lateral acceleration peak of 0.20 g
1.2	UN-2	SD-4.4 mm	SD-6.6 mm Peak-20 mm	
2	**ALIGNMENT**			
2.1	AL-1	SD-1.9 mm	SD-3.6 mm Peak -11 mm	
2.2	AL-2	SD-2.5 mm	SD-4.9 mm Peak-15 mm	
3	**GAUGE**			
3.1	**Mean gauge over 200 m section over nominal gauge**			
(a)	Straight	-	-6 mm to 10 mm	-8 mm to + 12 mm
(b)	Curve with radius 440 mts. or more	-	-5 mm to 13 mm	-7 mm to +15 mm
(c)	Curve with radius less than 440 mts. (Permissible speed as per relevant Para of IRPWM)	-	-5 mm to 18 mm	-7 mm to +20 mm

Track Parameters in Floating Conditions:

The Gauge and Twist values for manual measurement in floating conditions are as under:

(1) **Gauge:**

While it is desirable to maintain correct gauge, variation in gauge may be there due to age and condition of the rail, sleepers, and fastenings. The limits of gauge as per measurement in floating condition, for the guidance of the engineering officials regarding condition of track from passenger comfort perspective shall be as given below, provided that generally a uniform gauge can be maintained over long lengths.

a)	On straight Track	-6 mm to +6 mm
b)	On curves with radius 440 m or more	-6 mm to +15 mm
c)	On curves with radius less than 440m	Up to +20 mm

In case of exceedances of these limits, the results of last TRC/ OMS shall be analyzed for planning suitable maintenance action.

2. **Twist:**

It is desirable to maintain the track geometry for a comfortable ride at sectional speed.

The limits of twists as per measurement in floating condition, for guidance of the engineering officials regarding condition of track from passenger comfort perspective shall be as under; (to be calculated on a base of 3.0 m)

(i) On straight and curve track, other than transition - 3.5 mm/m

(ii) On transition of curve- 2.1 mm/m (Local defects above Designed value)

In case of exceedances of above limits, the results of last TRC/OMS shall be analyzed for planning suitable maintenance action.

Track Parameters for Low Speeds: -

For guidance of field officials, following track Parameters are stipulated in floating conditions, for maintenance of tracks where speeds are low such as worksite, yard line, etc.

Speed (in Kmph)	Peak value of UN (on 3.6 m chord in mm)	Peak value of twist (on 3.0 m chord in mm)	Permissible gauge range
Up to 45	22	18	-10 to +27 mm
Up to 30	24	21	-10 to +27 mm
Up to 15	33	25	-10 to +27 mm

Stability of Trains Against Derailment:

The stability of trains against derailment depends upon several factors such as track geometry, vehicle characteristics and state of their maintenance and speed of the particular vehicle at relevant point of time etc. Rail wheel interaction is, thus, a complex phenomenon and, therefore, safety tolerance for track alone cannot be prescribed in Isolation. Accordingly, safety tolerances for maintenance of track have not been prescribed on Indian Railways. Each derailment case, therefore, needs careful examination of all available evidence, in respect of track, rolling stock, speed and other factors considered relevant, to arrive at the cause. The provisions and tolerances mentioned herein before and elsewhere in this Manual are with a view to maintain track geometry for good riding comfort considered and deviation from these maintenance Parameters should not be considered alone for cause of accident without examining all evidence mentioned above.

11.7 Track Gauge

The distance between the two running edges of left and right rails is known as Gauge. It is 1676 mm on B.G. The irregularity in gauge leads to excessive sinusoidal motions of the vehicle leading to development of attack of wheel flange with the rail. If a gauge is

found to be less than 1676 mm, it is termed as Tight Gauge. If the gauge is more than 1676 mm, then it is termed as Slack Gauge.

It has been well established that a uniform departure, but within practical limits, does not have any adverse effect on safety, stability or comfort. What are the practical limits for safety, however, are difficult to establish for reasons already discussed.

If the gauge is more or less uniform, the extent of its departure from the standard value can be discussed only in general terms. Besides, this parameter has to be considered along with the thickness of flange and the play and clearances at axle box level, as ultimately it is the total effective play between the wheelset and the track which is actually relevant. If this play is excessive the wheelset will be prone to increased oscillations as well as greater angularity.

If the gauge is too tight, the wheelset would strain the track fastenings and, in the event of failure of fastenings, the rail may either move outwards or may over-turn or in the event of the track holding, the wheel may lift off the rail. The gauge has a very definite effect on the period of nosing. Lateral force at axle bearing increases markedly with the flange distance (play) and running speed. It also increases the angularity of the approach of wheel.

Whatever tolerances are available in the Indian Railways Permanent Way Manual and also those stipulated for speeds higher than 100 kmph on B.G. and 75 km/h on M.G. (see RDSOs Report C & M, 1 and C 138), are only good riding tolerances and not safety tolerances.

A variety of tolerances have been laid down from time to time, for instance, by the 19th Meeting of the IRCA, Recommendations of the Efficiency Bureau Study No. 4/64 on Mid-section Derailments on Central Railway, Railway Boards letter dated 10-1-1964, etc. However, as already mentioned, these have not been fixed based on any derailment tests and as such have obvious limitations so far as investigation of derailments is concerned.

Effect of Tight or Slack Gauge

Due to slackness in gauge, play between flange and running edge of the rail increases. Thus, excessive slackness further increases lateral oscillations, hunting, excessive flange forces and angularity due to which the wheel may drop. The main indication of slack gauge is that either one wheel remains on the track and the other drops inside the track or both wheels drop inside the track.

Tight Gauge

Tight gauge increases the strain on track fastenings and creates a tendency for the wheel to lift on run. Due to tight gauge, the flange of the wheel starts grinding against the rail edge. This condition causes high flange forces to occur, and the flange ultimately mounts over the rail.

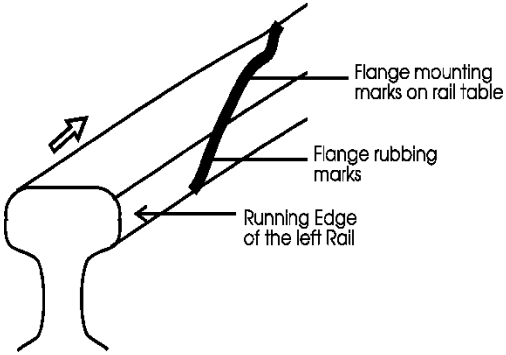
Causes of Gauge Distortion

The following are the major causes of gauge distortion:

1. Worn out fastenings due to which track could not hold the correct gauge.
2. Damaged sleepers and unserviceable sleepers due to which fastening become loose.
3. Fastening not properly secured and becoming loose due to high-speed vibrations.
4. Missing fastenings i.e. keys, dog spikes etc.

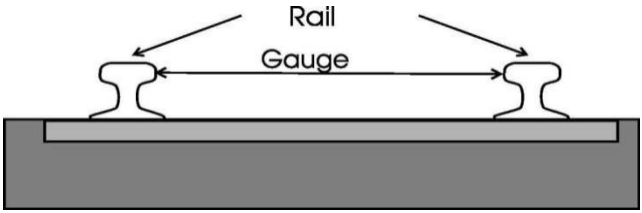
11.8 Marking Stations for Track Measurements

For investigating the cause of derailment, various measurements pertaining to track are required to be taken carefully. Before starting the measurements, the point of mount or drop must be ascertained jointly by nominated supervisors since the point of mount or drop is taken as reference point for many measurements. From the point of mount/drop, stations are to be marked on the rail table at an interval of 3 meters on either side of the track up to a distance of 45 meters. Hence 15 such stations are to be marked if the cause of - derailment is normal. However, if the cause is abnormal, as many as 30 stations at the rear of the point of mount/drop can be marked covering a distance of 90 meters if necessary. After completing this work, measurements with regard to track should be recorded from one end.



How to Measure Gauge

The Gauge should be measured at stations already marked 3 meters apart with the help of Gauge-cum-level instrument. Before using this gauge, ensure its correctness as well as spirit level sensitivity. It must be ensured that both ends are properly touching the running edge of the rails during measurement. The tightest point obtained determines the correct point to test the gauge. Record the reading showing tight or slack gauge. The gauge is designed to measure slackness or tightness up to 20 mm. If tightness or slackness is found beyond the measuring capability of the gauge, it should be measured by tape and recorded. **The gauge is measured 14 mm below the rail top table.**



11.9 Cross Level

The relative difference in the height of left and right rail at a given point on the track is known as **Cross Level (on straight track)**. The fluctuating cross level differences in the track result in track **Buckling** and help in developing undesirable oscillations on vehicles adversely affecting their stable running.

Effect of Variation in Cross Levels

Due to variation in Cross Levels, either one wheel is above or below the plane of other wheels of the vehicle. If one rail is higher, the wheel on that spot will be on a higher plane and will cause off-loading of that wheel. On the other hand, if one rail is lower, the wheel on that spot will be on a lower plane and will cause off-loading of the opposite wheel. Thus, variation in cross levels affects

stability.

A uniform cross level difference does not matter much from the point of derailment. A cant deficiency up to 75 mm is normally permitted. If cross level differences up to this extent are uniformly available over long stretches in the track, it may not lead to unstable conditions. However, the variations in cross level called **Twist** are very important from safety point of view. If the cross levels vary too frequently, the effect is the same as difference in camber of springs and this may lead to derailments. This effect is more pronounced in case of a four-wheeler stock in which one of the wheels tends to float due to excessive twist and may get derailed.

Cross level is an important factor to be considered in derailments and it should be recorded very carefully. Cross level should be recorded by taking left rail as the reference rail i.e. recording whether the right rail is low or high. Normally cross levels are measured from the point of mount or drop up to 45 meters on either side. Where the point of mount is not clear, 90 meters in rear and 45 meters ahead may be taken for measurement. The readings are essentially done from sleeper to sleeper.

How to Measure Cross Levels

For measuring cross level, modified RDSO gauge is used which records Gauge as well as Cross Levels simultaneously. For measuring cross level, a good quality of spirit level is used and is kept at the center of the gauge. Before using spirit level, the sensitivity should be checked i.e. whether the bubble is freely moving in the cage or not. In the gauge, space is provided for the spirit level which slides freely on the gauge. The sliding portion is calibrated on either side with which the difference in cross level in mm can be read directly. If spirit level moves 10 mm to the right of the gauge, it indicates that right side rail is lower by 10 mm as compared to the left rail. If the spirit level moves left side, then this indicates that left rail is lower than right rail. For measuring the cross levels, always take left rail as reference rail and it should be clearly mentioned i.e. left rail is low or high.

11.10 Twist

This is a crucial parameter. Though a number of studies have been carried out on some of the World Railways and by ORE, it has been found next to impossible to lay down safety tolerances for various types of rolling stock and speeds, the two variables which particularly determine such tolerances.

The only safety tolerances available for twist parameter on the Indian Railways is as per RDSO letter No. CRA/ 501 of 29.04.1983. This letter specifies the slow-down tolerances for unevenness and twist for 4-wheeler wagons as under. These tolerances are based on investigation into running of 4-wheeler wagons.

Rolling stock with a superior suspension would have a larger tolerance than the 4-wheeler wagon.

Speed (Kmph)	Peak value of unevenness on 3.6 m (mm)	Peak value of twist on 3.6 m (mm)
75	14	13
60	16	15
45	22	22
30	24	25
15	33	30

As per the above, the tolerance for twist for a 4-wheeler wagon at the slow speed of 30 kmph is approximately 7 mm/ m. UIC studies (ORE B/55) have suggested, for a 4-wheeler goods wagon at slow speed, a safety tolerance of 7% is for 5 m base of measurement. If within this 5 m, the base of measurement is 3 m, the tolerance would be 10% (i.e. 1 in 100).

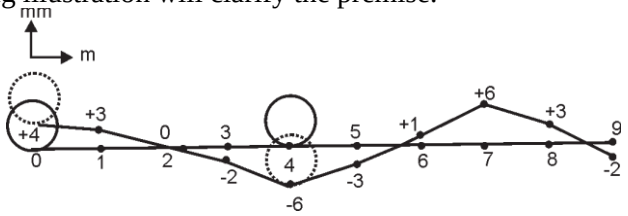
In other words, 1 in 144 (or 7%) safety tolerance would be for a vehicle with a 5m wheelbase. For a smaller wheelbase a steeper twist can be tolerated e.g. 10% (1 in 100) for a 3 m wheelbase.

For sectional derailments, where speed is higher, each case must be discussed on its own merits against background of type and condition of vehicle, its speed etc.

It is, however, of utmost importance that a twist is calculated over the wheelbase of the vehicle which derailed first, as that is the only twist which had been effective.

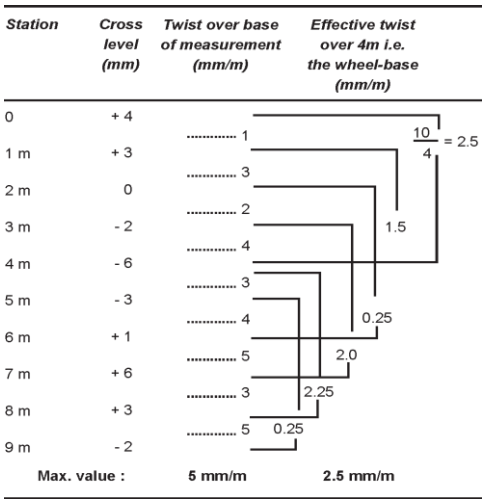
The twist should not be calculated over the interval of measurement of cross-levels, which are recorded at every sleeper or 3 m. The cross-level measurements only give the track record and from this record the steepest effective twist, which the derailing vehicle encountered, should be found by moving a tracing paper (with the wheel-base plotted) over the cross-level record and evaluating the twist at various positions of the wheelbase as under. The steepest effective twist can then be known.

The following illustration will clarify the premise.



Evaluation of twist effective for a particular wheelbase

Illustration: Say, wheelbase of vehicle which derailed first =4 m. Record of measurement (when the left rail is considered as base): -



It will be seen that though the maximum twist as calculated from the record of measurement is 5 mm/m (base is 1 m), the maximum effective twist which the vehicle actually encounters is only 2.5 mm/m (base is 4m).

Twist is rate of variation in cross level per meter. Normally twists are calculated for the stations marked on the track 3 meters apart from the reference point. If one rail is higher than the other at station No. 1 by 10 mm and the same rail is lower than the other at station No. 2 by 8 mm, then the twist between station No 1 & 2 (3 meters apart) will work out to be:

(10 + 8)/3 = 6 mm per meter

If one rail at station No. 1 is higher by 12 mm & on station No. 2, it is higher by 6 mm, the twist will be:

(12-6)/3 = 2 mm per meter

In finding out the real cause of derailment, the twist should be measured on the wheelbase of the vehicle which derailed first since this is the twist which played effectively at the time of derailment.

Effect of Twist

Twist has an adverse effect on running and plays an important role in derailment. The reason is quite clear. If at station 1, left rail is higher, than the left wheel is off loaded. If at station 2, right side rail is higher, right-side wheel is off loaded & left side wheel is loaded more. This will cause uneven loading of wheels and this condition is prone to derailment.

Calculating Effective Twist

Let the wheelbase of the first derailed vehicle is 4 meters. The twist will be calculated as under:

Distance from Ref. point (meters)	Cross Level reading in mm.	Twist over base of measurement (mm/meter)	Effective Change over 4 meters wheelbase mm	Twist in mm per meter
0	+5	-	(+5) - (-6) = 11	2.75
1	+7	2	(+7) - (+7) = 0	0
2	0	7	(0) - (+2) = -2	0.5
3	+3	3	(+3) - (+10) = -7	1.75
4	-6	9		
5	+7	13		
6	+2	5		
7	+10	12		

The highest value of effective twist on 4-meter wheelbase of the vehicle is between station 0 and station 4 above.

Track Alignment and Unevenness

The track should be in a well aligned position for good comfort and safety and limit the chances of flange coming in contact with the rail. **The flanges are actually the block stops for exceptional situations**. On encountering a track irregularity, the springs start oscillating and continue to offload the left and right wheels alternatively even after the irregularity is crossed. If the natural frequency of the vehicle happens to coincide with the exciting frequency, the oscillations can develop dangerous proportions causing derailment.

11.11 Creep

Creep is the longitudinal movement of rail in the direction of dominating traffic. In other words, the longitudinal movement of rails in the track is called Creep. Creep on the rails vary from place to place. In some places it may be as much as a few centimeters in a month whereas at some other locations, it may be negligible.

Due to creeping of rails, the openings in the rail joints at the point of creep gets widened. It is mainly due to ironing out of track by the moving load including braking force and its impact on the rail. It is generally in the direction of predominant traffic and is maximum in wooden sleeper track with dog spikes or similar rail-free fastenings.

Creep results in

1. sleeper getting out of square,
2. distortion of gauge,
3. loosening or jamming of joint,
4. shearing and breaking of spikes and fish-bolts, and
5. buckling of track or fracture in extreme cases.

Creep is also accelerated by the following factors:

1. Inadequate toe load of rail to sleeper fastenings and rails not secured properly to sleeper.
2. Inadequate ballast resistance to the movement of sleeper due to poor quality or insufficient quantity of ballast.
3. The rails are too light for the traffic they carry.
4. Uneven spacing of sleepers.
5. Badly maintained joints.
6. Inadequate sleeper density.
7. Worn-out sleepers and rails.
8. Lack of proper drainage.
9. Yielding formation and uneven cross levels.
10. Loose or uneven packing, and
11. Rail seat wear in metal sleeper road.

All the above deficiencies should not be allowed to cross the safe limits prescribed. Constant vigilance is, therefore, necessary to ensure that the causes of creep are reduced to a minimum and pulling back work is undertaken in time. Gap survey is also to be done. On wooden sleeper roads creep anchors should be fitted.

Causes of Creep

Many theories have been evolved to explain the reasons for creeping of rails in a track. Some are explained below.

A. Wave Theory

According to this theory, a moving train sets up a wave motion in the resilient track portion of the rail. Immediately under the

wheels of the train, the rails between adjacent sleepers get depressed or deflected somewhat due to vertical loading. The moving wheel pushes the elevated portion of the wave, which in turn forces the rail in the direction of traffic. The raised portion of the rail in front of the moving load is carried forward by the wheel and this helps in developing creep. The raised portion of the rail at the rear of the moving wheel then assumes its normal position.

Along with the moving wheels of the train, the depressions formed in the rail also moves with them. As soon as the loaded wheels pass over a depression, the portion of the rail springs back to its original level. In this way, the wave motion tends to move along the entire length forward with the moving train. Similarly, the impact of several wheels at a rail joint also causes creep.

The pitch and depth of the wave in the track however depends upon the following factors:

1. Stiffness of the track
2. Spacing of the sleepers
3. Wheelbase of the vehicles
4. Weight of the rail's quantity and quality of the ballast
5. Standard of the maintenance of the track
6. Track modulus of the material.

To reduce the creep, it should be ensured that the track possesses the following qualities:

1. Increased stiffness
2. Stable soil for formation
3. Angular ballast for better interlocking

B. Change of Temperature Theory

Development of creep rail may be caused by expansion/contraction of rails due to change in temperature. The change in temperature depends upon the range of temperature and the location of the track i.e., whether the portion is exposed

to sun or remains under shade. Creep is more rapid during hot summer as compared to cold winters.

C. Unbalanced Traffic Theory

According to this theory, if heavy traffic moves in one direction and light traffic moves in opposite direction predominantly on a single line track, unequal creeping occurs between the two directions. The net effect of creeping in the direction of movement of heavier traffic is more. In the case of double line tracks, the movement of trains is more or less unidirectional and as such creep develops in both the tracks in the direction of movements of trains.

Besides the above theories, the creep may also develop due to the following factors:

1. Loose fittings of rails
2. Bad quality of sleepers
3. Bad alignment of curves
4. Too tight or too slack gauge
5. Gradient of the track
6. Life of the rails
7. Uneven spacing of the sleepers
8. High embankments.
9. Weight of the rails.

In fact, it is very difficult to predict the magnitude of creep. Sometimes, only one of the rails may also start creeping in a direction opposite to the other rail.

Effect of creep

Though there are several serious effects of creeping, the most serious is **buckling** of the track. If proper attention is not paid, a buckled track may easily derail a train. The other harmful effects are as under:

1. The sleepers move out of square and position.
2. The gauge and alignment of the track gets disturbed.
3. The surface of the rails gets disturbed considerably

due to the movement of sleepers from their packed loads. This causes uncomfortable riding.

4. Rail joints at the starting points of the creep get opened out of their permissible limit considerably. The stresses develop in the fish plates and bolts. This may sometimes break the fish bolts and the rail ends gets battered badly. At the point where creep ends, the rail joint gets jammed and thus prevents free expansion of the rail.
5. Points and crossings get disturbed, and it becomes difficult to maintain the correct gauge and alignment. The movement of switches becomes difficult and even the interlocking arrangement is thrown out of gear.
6. The expansion gaps become either too big or too short.
7. Besides the above defects, kinking of rails forcing the ballast and even smashing the fish plates and fish bolts are common occurrences due to creep.

Measurement of Creep

The measurements of creep in a track may be done in the field as explained below:

A. Fix two creep indication posts or unserviceable rail pieces on either side of the track in the formation such that their tops are about 25 mm above the rail level.
B. Fasten a string to the tops of the posts such that it passes freely below the rail bottom.
C. Make a chisel mark or a point mark on the side of bottom flange of the rail on either side of the track. Note down the time and date of marking.
D. After a particular interval of time, measure the distance between the chisel marks and the string. This distance is the required amount of creep which has developed during the given time interval.

Remedial Steps against Creep

The following precautions are required to be taken to prevent and reduce the creep of rails in the track:

A. Keep the sleepers always well packed with heavy angular ballast and provide wide shoulders to resist the movement of the sleepers.
B. Keep all the rail joints level so that there are less chances of impact by the moving wheels.
C. Keep the fish bolts tight and oil them frequently so that the ends of the rails move freely under thermal stresses.
D. Provide anti-creepers or anchors on the top of sound sleepers. If the creep still continues, the number of anchors may be increased per rail panel.

Track Maintenance against Excessive Creep

The maximum permissible limit of creep is 150 mm. In case the creep exceeds this limit, the adjustments must be made as under:

A. Measure the expansion gaps and check against the total amount of gap in the length which should be equal to the standard expansion gap required at the given temperature multiplied by the number of joints in the rail panel.
B. Remove the keys and fish plates. Insert correct expansion liners before pulling the rail back with bars.
C. Tighten up the fish plates and insert the key properly.
D. In case the total gap is more than the standard gap, the required closure rails may be used with a speed restriction of 30 Km/h till the gaps are removed.
E. While adjusting the creep, the sleeper spacing should also be adjusted**.**

Track Lengths susceptible to Creep.

The locations in track more susceptible to creep are:

1. Steel sleeper track CST-9 sleeper track joining the wooden sleeper track.

2. Long stretches on gradients having dips.
3. Approaches to major girder bridges or other stable structures.
4. Approaches to level crossings and points & crossings.

11.12 Buckling of Track

When the track alignment gets affected due to excessive thermal forces in rails, which cannot be contained by the inherent strength of track, the track is said to have buckled. On the other hand, if the track gets out of alignment due to excessive flange force, which the track cannot resist, the track is said to have distorted. Serious controversies arise at the accident sites on this aspect, mainly because the evidence of track such as closed expansion gaps and poor lateral strength get destroyed in the accident. The following important particulars must be recorded correctly at site:

1. Alignment of track in the rear of point of derailment (offsets)
2. Creep in rear and advance of the site of accident.
3. Location of expansion gaps w.r.t. joint sleepers
4. Condition of sleeper packing
5. Rail temperature while measuring expansion gaps.
6. Length of track between reference points (If the measured length is more than fixed length then track is buckled).
7. Ballast cushion (especially clean cushion)
8. Behaviour of formation at site (Whether yielding or not)
9. Whether any gang worked at site leading to weakening of track
10. Sleeper spacing (irregular or not) and expansion gaps in switch expansion joints in long welded rails.
11. A thorough probe on vehicles defects which can lead to excessive flange forces.

Buckling of track occurs when very high compressive forces are created in the rails. A special watch should be kept at the

junction of two stretches of track where one is liable to creep, and the other is held against creep. Some of the examples are:

1. Track laid on wooden sleepers with inadequate anchors and scanty ballast.
2. Track laid on metal sleepers with loose keys butting against the track laid on new sleepers with tight fastening.
3. Track anchored with welded track.

As one side of such a junction point is held firmly, the movement of rails due to creep from the other side is restricted resulting in heavy compressive forces being exerted. This will tend to buckle the track. Jammed rail joints are therefore an indication of the track being subjected to undue strain which may result in track buckling.

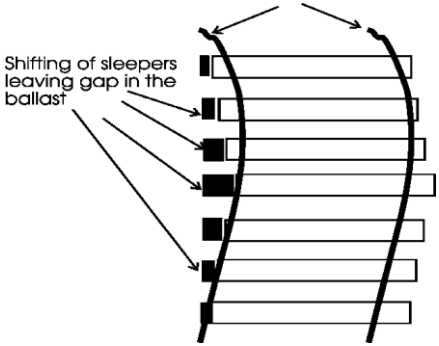
Conditions inducing track Buckling.

The following conditions create high compressive forces in the rail:

1. Inadequate expansion gaps
2. Failure to counter act creep in time
3. Non lubrication of rail joints
4. Failure to remove rail closures from track.

Precaution against Buckling

1. Greasing of fish plates should be done before the hot weather sets in.
2. The joints gap survey is done in the case of SWR and adjusted before the hot weather.
3. Adequate precautions are taken to reduce creep.
4. Over tightening of fish plate bolts is avoided - but they should be reasonably tight.



Shifting of Sleepers in Derailments due to Buckling

It is observed in many derailments attributed to track buckling that a severe cut/dent mark occurs on the foot board brackets on the inner side of non-derailed coaches having passed the point of derailment. Corresponding grazing marks are also found available on the top sole plate of the bogies. Another indication is the shifting of sleepers towards one side from their original position leaving gaping holes in the ballast.

11.13 Unevenness and Low Joints

These cause wheel offloading. But what are the safety tolerances, is a question which has not been satisfactorily answered.

More often than not, it may be the resonance effect resulting from unevenness occurring in a repetitive wave-like form, which combined with inadequate damping, may be the cause of offloading to unsafe levels, If the defect is an isolated one, even a comparatively large defect can be tolerated.

As is evident from field trials reported in RDSO Report C & M-1 (Feasibility Studies for 120 kmph operation) even a larger unevenness at a joint does not produce appreciable offloading of wheel. In fact, the unevenness value for high speeds has to be restricted more from consideration of deterioration of the joint and its fittings, joint packing etc, rather than from consideration of wheel off-loading.

We will now discuss some of the special track features.

11.14 Curves

Curves, by their very nature, are more derailment-prone than straights. For one, on a sharp curve, axle angularity tends to be high, and this angularity persists throughout the curve negotiation.

On the transition portion, the inherent twist due to cant gradient reduces the margin by which irregularities in twist parameter could be allowed to occur, thus needing more frequent attention, Effect of Track or Vehicle Twist on Wheel Off-loading).

The outer rail suffers angular wear, which may result in reduced flange safety depth and reduced effective flange slope.

Besides, vehicle design and its condition have considerable relevance to safe curve negotiation; for any hindrance to rotation or rotation and sliding of bogie or truck designed for such movement on curve would result in appreciably high flange forces, which might cause track distortion or lead to flange climbing derailment through high Y/Q ratio.

In a curve, large flange forces may arise due to unsatisfactory curving characteristics, unsatisfactory riding of the vehicle, and misalignment in track or misalignment of vehicle/bogie wheelbase. The majority of railway vehicle have unsatisfactory curving characteristics. Ideally, vehicles should negotiate a curve almost without any flange contact, steering being achieved by axles assuming radial position under the effect of steering forces generated on the wheel trade. However, most of the railway vehicles have a very low YAW flexibility and, as a result, steering around a curve is achieved by large flange force on the leading outer wheel, under the condition of a large angle of attack. This effectively reduces the limiting safe value of (Y/Q) on the leading outer wheel. Further, greater angle of attack is generated on the outer wheel of leading axle under conditions of cant excess (and vice-versa for cant deficiency), as cant deficiency results in the trailing axle moving outward, thereby reducing the angle of attack.

Variation of versine in a curve can be evaluated in terms of variation from the designed versine or station to station variation. The former is related to unbalanced centrifugal force, affecting safety and curve negotiability. The latter relates to the rate of change of lateral acceleration, affecting the comfort level. Generally, on Railways, including the Indian Railways, the guiding factor is the rate of change of lateral acceleration and, hence, station to station variation of versine is stipulated for maintenance. Calculations show that this variation is important only at higher speeds. It is irrelevant for speeds lower than 60 kmph and important for speeds higher than 90 kmph.

Realignment Criteria for Curves

The running over a curve depends not only on the difference between the actual versine and the designed versine but also on the station-to-station variation of the actual versine values, which determine the rate of change of lateral acceleration, on which depends the riding comfort.

S.N.	Speed on curve	Limits of Station-to-Station Variation of Versine (mm)
1	160 Kmph and up to 110 Kmph	10 mm (15 mm for speed of 110 Kmph;) or 20% of average Versine on circular portion, whichever is more.
2	Below 110 Kmph and up to 50 Kmph	20 mm; or 20% of average Versine circular portion, whichever is more.
3	Below 50 Kmph	40 mm; or 20% of average Versine on circular portion, whichever is more.

In case exceedances of the above Limit is observed during inspection, local adjustment may be resorted to in cases where the variation of versine between adjacent stations is only at a few locations, at the earliest possible. If more than 20% of stations are having versine variations above the limits prescribed, complete realignment of curve should be planned within a month.

As lateral forces, in general, are higher in a curve as compared to a straight, loss of lateral strength of track should be guarded against.

A vehicle entering a curve at a speed higher than the maximum permissible may cause distortion of the track or lead to mounting of the wheel over outer rail. Mounting over

the inner rail is also possible if there is sudden braking causing the vehicles to bunch, or if there is a jerky bogie rotation.

Another seemingly strange derailment has been often reported viz. of a wagon when just starting to move after having stopped on a sharp curve, particularly with high superelevation.

When the train starts on a sharp curve, a net component of the tractive force is generated towards the center of the curve at the coupling level, due to string lining of the wagons. This causes off-loading of the outer wheels. The amount of off-loading is higher for sharper curves and higher acceleration. Further, when a wagon stands on high cant, the outer wheels get off-loaded substantially (the whole cant acts as cant excess).

Also, when the wagon starts moving, even at such crawling speed, the rail guiding force acting on the outer leading wheel will be significant as this will be the force required to turn the vehicle (bogie) along a curved path. The Y/Q ratio for the outer leading wheel, thus, becomes quite adverse and the wheel mounts the rail, or so to say, just rolls off the track.

Derailments occurring under the conditions above should be investigated keeping in mind the above factors and analyzing the extent of sudden acceleration and the features of rail – wheel profile.

Check Rails on Curves

Check rails are sometimes provided as one of the measures against derailment proneness on sharp curves.

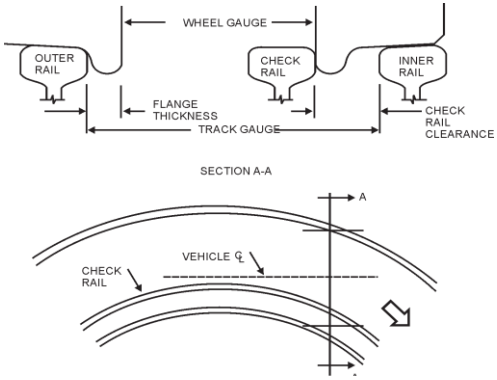
Other advantages claimed for check rails are:

1. reduction of lateral and angular wear of outer rail
2. increase in stiffness of track frame and, thus, in the lateral strength of track against distortion.

Check rail, however, is not a solution which can be applied indiscriminately. A popular misconception is that the check rail shares the curving forces with the outer rail. In fact, for any given wheelset only if the flange thickness, wheel gauge and check rail clearance are exactly matching-a rare possibility- will the curving forces be shared by both the outer rail and check rail.

The above parameters are linked by the following expression:

Check rail clearance = Track gauge* - (wheel gauge + flange thickness) + allowance for angularity of axle



Check rail on curve

(*N.B.: This is the gauge actually provided i.e. including any gauge widening).

Though track gauge and wheel gauge may be taken, more or less as fixed or of known values, flange thickness is certainly not. Flange thickness for various wheel sets can vary over a wide range. This presents a problem, how to calculate the check rail clearance. For this, normally the predominant average flange thickness is taken viz. somewhere in between a new flange thickness and a thin flange.

Taking an example on B.G. new flange thickness	**28.5**
Thickness of thin flange	**16 mm**
Assume average flange thickness	**22 mm**
Track gauge (assuming 6 mm gauge widening)	**1676+6**
	1682 mm
Wheel gauge	**1600 mm**
Check Rail clearance	**1682 – (1600+22)**
	1682-1622
	60 mm

Allowing 4 mm for angularity of axle, check rail clearance works out to= 64 mm, say 65 mm.

Now, when a wheel with flange thickness more than 22 mm negotiates the curve, only the outer rail will bear the guiding forces and the check rail will not come into play at all. When flange thickness is less than 22 mm, only the check rail will guide the wheelset and outer rail will develop no flange force.

In case the check rail is intended only as a safeguard against derailment it need not be called upon to perform the guiding function. In that case check rail clearance can be increased to such a limit that only when the outer wheel mounts the rail should the check rail come into play and help in forcing the wheel back to the track.

For this the only criterion is minimum bearing of inner wheel on the rail, which may be taken as 40 mm.

11.15 Points and Crossings

Considering the discontinuities inherent in a turnout, it forms a weak link in the track structure.

Care in laying and maintenance of turnouts is thus crucial.

Some of the aspects are highlighted below:

1. Gauge at approach to the switch portion of a turnout should be given particular attention and should be maintained to finer tolerances, so that the vehicle sets into more or less a stable motion before negotiating the discontinuity in the form of switch portion.
2. The gauge opposite to nose of crossing needs equal care. If it is tighter than the nominal value, there would be danger of a new wheel hitting the crossing nose.
3. Similarly, check rail clearance opposite the nose of crossing should be checked frequently, as an excessive clearance might cause a new wheel flange to hit the nose of crossing.
4. Turn-in curve following a turnout, especially on running loops, should be given the same attention as that for main line curve,

   i.e., the frequency and thoroughness of inspection and rectification should be the same.

   It is good practice to provide the same track structure for turn-in curves as that for main line curves, or even to provide extra ballast shoulder say 150 mm on the outside of turn-in curves.

5. Angular wear at the tongue rail and the lead curve should not be allowed to become large so as to affect safety.

Lifting of Track

A track generally settles down under the passage of wheels from a predetermined longitudinal profile and should be restored to original level by maintenance. Lifting is occasionally required to be undertaken for regarding certain sections to suit the requirement of higher speed or increased train loads. Most of the routes are electrified.

Therefore, whenever any lifting is to be done the following precautions should be taken to ensure safety:

1. The existing longitudinal levels of track must be taken. proposed levels determined and plotted on graph. Level pegs must be provided at the site.
2. Lifting should be restricted, preferably to 50 mm at a time.
3. Work should be undertaken under speed restriction and protection of the track by placing engineering signals when the lifting work is in progress.
4. Easing of grade should be done to avoid steepness and for smooth passage of trains.
5. Lifting should commence and be carried out in the rising direction.
6. On curves, it is the inner rail which is the base rail, and the outer rail is to be superelevated.
7. On electrified routes, the Electrical (Traction Overhead) department must be informed well in advance about the amount of lifting involved. The work should be carried out in conjunction with them. Special care must be taken to ensure that no train is immobilized in a neutral section.

There may be derailments at work sites in the course of lifting of track if proper care is not taken. Care should be taken to see that, during execution of work, neither the irregularity in longitudinal

level or in cant gradient nor variation in cross level reaches beyond permissible limits. It is also to be ensured that vertical clearance between the OHE contact wire and the rail top is not infringed. Similarly, at the approaches to major girder bridges, tunnels, etc. the lifting operation must be undertaken very carefully without infringing the standard schedule of dimensions.

Lowering of Track

Lowering of track is to be avoided as far as possible. However, in unavoidable cases, it should be done only under speed restriction and protection of track with engineering signals. Lowering should be done only in the direction of falling gradient. Ramping, as in the case of lifting, is essential before passage of any train.

Slacks in packing

Slacks in packing generally occur on stretches of yielding formation on high banks and deep cuttings, bridge approaches. badly aligned curves, where ballast is inadequate or poor in quality or drainage is defective. The failure to identify and rectify these defects in time may lead to accidents if the track parameters exceed the safety limits because of such defects.

Girder Bridge (Unballasted) and Level Crossing Approaches

Girder bridges and level crossings provide far more rigid support than ballasted soil formation. The sudden change in track modulus at their approaches sets up oscillations in the vehicle, which apart from increasing the wheel off-loading, increases the dynamic augment at the approaches as well as on the bridge. This increases the rate of track deterioration.

Such approaches, therefore, need more frequent attention.

Track maintenance precautions in Electrified Routes

Permanent way engineers, supervisors and staff are required to take special precautions during maintenance of track in electrified areas as follows:

1. To ensure that traction bonds, e.g. longitudinal, cross and structure bonds, are not disturbed during track

maintenance operation as these are safety devices and may endanger the life of workmen.

2. To maintain continuity of flow of return current through rails, metallic jumpers of approved design should be used wherever gaps are created in rails owing to opening of fishplates, rail fracture, dismantling of track during renewal, etc.
3. While doing excavation in formation workers should look out for the underground traction feeder cables. Cable route markers should be provided to indicate the location of cables.
4. Precautions are required to be taken in respect of transverse or lateral clearances while undertaking local adjustment or realignment or adjustment of cants in curves and lifting or lowering of track during maintenance operations. Clearances less than the specified tolerances may not only damage the electrical installations like pantographs, catenary wires, etc. but may cause infringement on moving dimensions, thereby leading to derailment. In fact, a number of derailments have occurred owing to infringement when open doors of wagons hit the OHE masts,
5. Track tools, machines, particularly cranes, should be kept at a safe distance of about 2 meters from the OHE live wires. Otherwise, the work must be stopped and done under "power block" only. Placing of banner flags for track maintenance should be carefully done in electrified sections to ensure that a train is not immobilized in a neutral section.

The Slackness in Management and Supervision of track maintenance

The Slackness in Management and Supervision of track maintenance has also been noticed in some of the area as under:

1. Absenteeism noticed amongst trackmen and other maintenance groups or units is highly detrimental to the upkeep of track.
2. When the required number of man-days are not available for various reasons such as strikes, bandhs, patrol, etc., the same must be made good even by fresh recruitment of temporary labour.
3. Inspection registers of track maintenance by permanent way staff must be scrutinized by senior officers of the Division and headquarters to ensure that the inspections are properly done at scheduled intervals and follow-up action is ensured.
4. There seems to be a general apathy towards the maintenance of records because of slackness in supervision and complacency in maintenance of track.
5. There are cases where provisions of LWR manual have not been followed, e.g. rectification of rail fracture on LWR and discontinuity in LWR are allowed without any speed restriction.
6. Keeping historical records of unusual occurrences or behaviour of Switch Expansion Joints, movement of breathing lengths, etc. and taking timely action are also very important aspects of maintenance. If the maintenance procedures are not meticulously followed, deterioration of the track is bound to occur, which may cause an accident.
7. Removal of speed restrictions even before getting the rail fracture repaired properly and in time has led to accidents in some cases.

The derailments and other accidents have also been caused by

1. Non-checking and non-recording of versine's and cant in the curve register at regular intervals,
2. Poor quality of overhauling,
3. Injudicious recoupment of ballast, and

4. Non-provision of bearing plates on wooden sleepers in the points and crossings layout including the lead portion.
5. Adequate supervision to ensure specific quality of track components, track maintenance and track construction methods is the only way to avoid accidents on track account.

The concept of Zero Missing Fitting has been introduced to ensure that the fittings of the running track are complete in all respects. This is a commendable step towards safety.

11.16 Safety at Worksites

One of the major causes of derailment/accident on track account is inadequate care taken at work spots. Few instances are listed along with the required precautions as follows:

1. Sinkage of track on diversions/ new formations/ supports of temporary arrangement, especially during rains, leads to derailment. The track geometry should be maintained to adequate standards for passage of traffic at stipulated speeds. Where abnormal behavior of formation/supports is expected, track geometry and effectiveness of packing/ support should be checked as often as warranted even during nighttime.

2. Derailment takes place due to failure to pack the track after lifting the same here and there for adjusting the levels during maintenance, if speed of train is not restricted.

3. At deep screening and relaying spots, if the top-table and gauge face of rail are smeared with ballast particles, the enhanced friction at flange contact area can encourage mounting of the wheel, especially with empty wagon, sharp flange, angularity of axle, difference in buffer heights and bad engineman ship. This kind of derailment can take place even at very slow speeds. Before the passage of each train at such work spots, the running surfaces of rail should be

cleaned. It is also desirable to hand-grease the gauge face.

4. Imposition of speed restriction with duly displayed SR boards needs care. Non-provision of suitable SR boards as required and/or sudden display of STOP (red) signal by gang staff/stationary watchman can lead to unsafe conditions. The positions of SR and Caution Boards should be correctly decided, duly ensuring proper visibility during day and night. Full details should be furnished in the caution orders issued to the drivers, indicating the correct kilometrage of the SR and Caution Boards. The description of the work requiring speed restriction should be given in a brief and simple manner in caution order so that the driver fully understands the implication. Working of materials lorry on the track requires all the stipulated precautions being observed.

Revised Norms of Track Maintenance and Criteria of Track Renewal (Railway Board's Letter No. 2021/CE-II/TSC/10th Extraordinary dated 16.07.2021)

Revised norms of track maintenance and criteria of track renewal duly approval by Board (MI) is given below-

SN	Description of Item	Revised Norms/Criteria
01	**Deep Screening** of plain track and turnout **(Para 636(2)(e) of IRPWM-2020)**	1. Deep screening of track shall be carried out - **a. For plain track on main line** **i.** If the clean ballast cushion is less than 200 mm for section having sectional speed of 130 Kmph and above. **ii.** If the clean ballast cushion is less than 150 mm for section having sectional speed less than 130 Kmph. **b. For Turnout on main line** If the clean ballast cushion is less than 200 mm. 2. All the loop lines should be deep screened once in 15 years.
02	02 Service Life of **Rails** **(Para 702(1)(d) of IRPWM-2020)** The Rails shall be planned for through renewal after it has carried the minimum total traffic as below -	**1. Routes covered by Rail Grinding** Service life of 60 Kg.90 UTS rails in terms of GMT is 1000 GMT. All other existing criteria of Rail renewal shall continue.

<table>
<tr><td></td><td></td><td>2. Routes not covered by Rail Grinding
Existing service life and other criteria of rail renewal shall continue.</td></tr>
<tr><td></td><td>Rail Section
<table><tr><td></td><td>Total GMT carried</td></tr><tr><td></td><td>72 UTS</td><td>90 UTS</td></tr><tr><td>60 kg</td><td>550</td><td>800</td></tr><tr><td>52 kg</td><td>350</td><td>525</td></tr></table></td><td></td></tr>
<tr><td>03</td><td>Service life of PSC Sleepers (Para 718 of IRPWM-2020)</td><td>Condition basis viz. Rail seat grooving, insert corrosion, cracking in continuous stretches etc. as decided by CTE.</td></tr>
<tr><td>04</td><td>Service life of Turnout
(Para 717(1)(b) of IRPWM-2020)</td><td>Switches:
52 Kg. - 250 GMT or condition basis as decided by CTE.
60 Kg - 300 GMT or condition basis as decided by CTE.
CMS Crossing:
i. 52 Kg & 60 Kg. - 350 GMT with replacement of fittings on condition basis, in case of in-situ reconditioning using Robotic welding machine.
ii. 52 Kg. & 60 Kg. — 300 GMT,in case of reconditioning using H3B/H3C IRS electrodes.
Thick web Switches:
52 Kg & 60 Kg. - 800 GMT or on condition basis as decided by CTE.</td></tr>
<tr><td>05</td><td>Service life of P.Way components (Fittings)
(Para 718 of lRPWM-2020)</td><td>GFN-66 Liners:
200GMTor 4 year whichever is earlier or condition basis.
Metal Liner:
400 GMT or 8 years whichever is earlier or on condition basis.
ERC:
400 GMT or 8 years whichever is earlier or on condition basis.
CGSRP:
400 GMT or 8 years whichever is earlier or on condition basis.</td></tr>
<tr><td>06</td><td>Service life of Glued Joint
(Para 702(1)(f) of IRPWM-2020)</td><td>Tentative life of glued joint shall be enhanced to 400 GMT for 60 Kg glued joints with 6mm gap.
However, renewal of such special track components shall continue to be planned on condition basis after they have degenerated to a level where they are not able to serve their desired purpose as per provisions of Para 702(1)(f) of IRPWM-2020.</td></tr>
</table>

7	Service life of **Channel Sleeper** **(RDSO Letter No. CT/PTX/TSC dated 07.12.2018)**	1. Service life of galvanized channel sleeper - 14 years/800GMT or on condition basis as decided by Chief Track Engineer of the Railway, whichever is earlier with replacement of fittings as and when necessary. 2. Service life of Rubber components of galvanized channel sleeper shall however be kept as 400 GMT or on condition basis as decided by Chief Track Engineer of the Railway, whichever is earlier.

Precautions to be taken while laying New Lines/Double Lines

New lines are provided with suitable track structure depending on the route classification, axle load, traffic density, speed potential, etc. The formation must have adequate strength, so that trouble-free track is available for traffic operation. Suitable soil with due compaction is to be used for this purpose. This is further supplemented by provision of blanketing layer of suitable thickness of moorum, sand or quarry dust which satisfy the requisite classification and particular size distribution. The choice of replacement of existing soil by suitable type and depth of blanketing materials are governed by economic considerations.

For executing new works in yards, phase plans are prepared to complete the entire remodeling work in phases to ensure that traffic movement is least affected. Safety at each stage of the work is also to be ensured. It is obligatory to obtain sanction from the Commissioner of Railway Safety before opening new lines.

Failures of Permanent Way Staff

Some of the failures of the permanent way staff which may lead to accidents are:

1. Maintenance of track without protecting the site of work by placing banner flag or by incorrect placement of the same.
2. Working without traffic or power blocks where required.

3. Working of trolley, lorry, and motor trolley without observing the rules prescribed in the Permanent Way Manual
4. Non-protection or faulty protection of track by the Patrol- man in the event of breach, submergence, landslide, etc.
5. Negligence of the Patrolman during hot-weather patrolling. resulting in failure to detect buckling of the track.
6. Failure of the Gateman to protect the obstruction at the level crossing as per rules.
7. Failure to maintain gauge, cross level, and twist in track.
8. Failure to maintain switch assembly.
9. Negligence in duty by the Keyman, resulting in non-detection of faults in the track, sabotage, etc.
10. Greasing of fishplates without observing the rules laid down in the Permanent Way Manual.
11. The work being entrusted to staff at a lower level like Gangmate or Mistry without any supervision.
12. Working at night without proper arrangement of lighting.

The norms specified in the track maintenance manuals should be strictly adhered to. Points and crossings being the vulnerable portions of track, special attention should be given to them to ensure that the gauge, cross level, clearances, and alignments are properly maintained.

The engineering staff, viz Gangmen, Gatemen, Patrolmen, should be educated about the rules for protection of track. All the engineering officials right from the track engineers to the Gangmen must know the correct method of displaying hand signals, banner flags and using detonators for protection of the track in case of an emergency.

The engineering staff should be made acquainted with the Do's and DON'Ts with regard to train parting, derailment, road vehicles

blocking the track or level crossings, etc. In course of routine maintenance of track, it should be ensured that the opening of ballast in LWR track is done as per the norms specified and the gang should not go for tiffin without giving proper alignment and level to both the rails of a track. The following areas also require special attention for safe running of trains:

1. Bad banks.
2. Areas with black cotton soil.
3. Locations with diamond-and-scissors crossings.
4. Tunnels and long girder bridges.
5. Location of reverse curves.
6. SEJs and buffer rails.
7. Adjustment of creep.

The track engineers, while certifying a track as safe for train operation, should ensure following:

1. The formation is laid on good soil with proper drainage. requisite slopes and is free from any infringement.
2. Adequate ballast cushion is available as per specifications.
3. Rails, sleepers, and fastenings are properly laid, secured and are of standard serviceable condition.
4. Gradients are well maintained, versine's and superelevation's on the curves are correctly provided and maintained.
5. The rails, sleepers and fastenings are capable of bearing permissible axle load.

THE RAILWAY SAFETY ON BRIDGES

12

The railway bridge is a structure supporting the track spanning a river, valley, nallah, road, another track, etc. to provide through passage to a train. A bridge is a part of the track-it may be a pipe culvert, slab bridge, arch bridge or girder bridge made of masonry, concrete, steel, or prestressed concrete. India being a vast country with many roads, rivers, nallahs and valleys crisscrossing the railway network, trains must run on numerous bridges, and this poses a problem for safety.

The importance of Railway Bridge is such that there is a separate bridge organization in every Zonal Railway for proper maintenance and special attention to bridge super structures. It is headed by a Chief Bridge Engineer, assisted by a Deputy. Chief Engineer(s). Bridge Engineer(s) and Assistant Bridge Engineer(s), and Bridge inspectors.

12.1 Track on bridges:

The track should be properly laid on the bridges and maintained as per norms indicated below:

1. The longitudinal level of the rails at the bridge should be same throughout the bridge.
2. The rail should be laid with inward cant of one in 20 by continuing the same cant at the approaches.
3. In case of small bridge opening less than 6.1 m, rail joints should be avoided at the bridges. For other spans, the preferred position of the rail joint is 1/3 span from the end.
4. SWR may be continued at all girder bridges with unballasted decks up to 13.3m opening if the length of the SWR is symmetrical to the centre line of the bridge and up to 6.1m opening if the length of the SWR is unsymmetrical to the centre line of the bridge. No fishplate joint should be located on the girder or within 6 metres from either abutment. In all such cases, rail-free fastenings such as rail screws, dog spikes or rail-free clips should be used for allowing free movement of rails on the bridges.
5. In case of SWP/LWR/CWR the relevant provision of SWP/LWR/CWR Manuals should be observed for installation and maintenance of track on the bridge and its approaches.
6. Guard rails should be provided in all girder bridges (including prestressed concrete girder bridges with deck slab), whether major or minor.
7. On all flat-top and arch bridges and prestressed concrete girder bridges with deck slabs where guard rails are not provided, the whole width of the bridge between the parapet walls should be filled with ballast up to the sleeper level.
8. Overall girder bridges footpaths should be provided at the centre of the track over the sleepers to facilitate inspection by the engineering staff.
9. The approach track for a length of at least 50 m should be fully ballasted.

10. The track at the bridge and its approaches should be attended to frequently so that the track geometry is maintained within the prescribed tolerances.
11. The prescribed spacings of bridge timbers, and guard rails. proper alignment and tightening of hook bolts should be ensured.

12.2 The components of a Bridge:

Bridge is a structure providing passage over or under an obstacle without closing the way beneath or above. The components of a Railway Bridge are as follows:

1. Superstructure consisting of a slab, girders, trusses, etc. above the level of bearings.
2. Bearings for the superstructure.
3. Abutments and piers - called sub-structure.
4. Foundations for the abutments and pier - below the level of bearings.
5. Protection works such as floorings, slope pitching's, guide bunds, aprons at bed level, etc.

12.3 Classifications of bridges:

The bridges are classified as under: -

1. **Pipe culverts.**
2. **Rail Openings:**
   Clear opening with no girder of any kind between the abutments (Adopted only in unimportant yards).
3. **Timber Top Openings:**
   Permanent way carried on longitudinal sleepers or on cross sleepers on longitudinal sleepers. (These are not favoured for permanent openings since longitudinal tembers decay and catch fire).
4. **R.C.C. Slab Top Culverts:**
   Reinforced concrete slab with or without earth cushion (Stone slabs are obsolete since they break

under dynamic loading).

5. **R.C.C. Box Culvert:**
   Reinforced in all sides.
6. **Arch Bridges**:
   Arch with open spandrel or spandrel filled:
7. **R.S.J. Girder Bridges:**
   Steel joints with or without flange plates and with cross sleepers carrying the permanent way:
8. **Deck Plate Girder Bridges:**
   Single or duplicate girders with cross sleepers on top flanges.
9. **Half Through Plate Girder Bridges:**
   Plate girders
10. **Deck Triangulated Girders:**
    (Also called underslung girders): Triangulated girders with P. Way carried on top.
11. **Half through triangulated griders or pony girders:**
    Triangulated girders with no overhead bracing and with track carried on cross giders and stringers between bottom booms.
12. **Through Triangulated Girders:**
    Triangulated girders with overhead bracing and track carried on floor system between bottom booms.
13. **Pile Bridges:**
    Girders supported on piles (instead of abutments and piers)
14. **Prestressed Concrete Bridges:**
    Pre-stressed concrete girders are used.

12.4 Design of Bridges:

The design of bridges is based on Bridge Rules, Bridge Sub-Structure Code, Steel Bridge Code, Concrete Bridge Code and Arch

Bridge Code. To computing stresses, the following items shall, where applicable, be taken into account:

1. Dead load
2. Live Load
3. Impact effect
4. Forces due to curvature or eccentricity of track
5. Temperature effect
6. Frictional resistance of expansion bearings
7. Longitudinal forces comprising of the tractive effort of the driving wheels of locomotives, the braking force resulting from the application of the brakes to the braked wheels, resistance offend by the bearings to movements due to change of temperature
8. Raking forces
9. Forces on parapets
10. Wind pressure effect
11. Seismic forces
12. Erection forces and effects

Impact Effect:

The impact factor on account of dynamic loads is given by the following formula:

(a) I (Impact factor) $\frac{20}{14+L}$

Where L = Loaded length of span in metres for the position of the train for worst effect.

This applies to single track span and should not exceed 1.

(b) For main girders of double track span with two girders,
I = 0.72 x $\frac{20}{14+L}$ not exceeding 0.72.

(c) For intermediate main girders of multiple track spans,
I = 0.6 x $\frac{20}{14+L}$ not exceeding 0.62.

Design of Bridge Waterways:

The design flood discharge is calculated by one or more of the accepted methods Normally a 50-year flood frequency is taken into account to compute the maximum discharge.

Foundation Design Discharge:

The foundations are designed for a flood discharge of higher magnitude (Providing for a 100-year flood frequencies) which is more than the design flood discharge (para 6-6) by 10 to 30% depending upon the magnitude of the catchment area.

Linear waterway:

1. When the banks of a water course are well defined, the linear waterway should be the full width of the stream.
2. For large alluvial stream with undefined banks, the required linear waterway should be determined using Lacey's formula,

$$L=C\sqrt{Q}$$

Where, L = the linear waterway in metres

Q = the designed maximum discharge (para 6-6) in m^3/se

C = a constant, usually taken as 4-8, but varies from 4-5 to 6.3 depending upon the bed material and characteristics of the flood flow.

Depth of scour:

$D = 0.473 \times (Q/f)^{1/3}$

Where D = Depth of scour in metres from the H.F.L.

Q = Foundation design discharge (para 6-7) in m^3/sec.

f = Lecey's silt factor varying from 0-4 to 2.0 depending upon the size of the particles.

The above is the normal depth for regime channels. This depth Increases at other places as per the following table:

Nature of the river	Depth of scour
In a straight reach	1.25 D
At a moderate bend condition (e g. along apron of guide bund)	1-50 D
At a severe bend	1-75 D
At a right-angle bend or at nose of piers.	2.00 D
In severe swirls. (e. g. against mole head of a guide bund)	2-5 to 2.75 D

The minimum depth of foundation below H.F.L. is kept at 3D for erodible strata. The depth of the foundation below the maxi- mum scour depth is called the grip length and when adequate, this ensures stability under heavy flood conditions by mobilising passive pressure against horizontal forces.

Afflux:

is the heading up of water over the flood level caused by the constriction of waterway at a bridge site.

$$X=\frac{V^2}{2g}\left(\frac{20}{14+L}-1\right)$$

where X = afflux
V = Velocity of normal flow in the stream

L = Width of stream at H.F.L.
L_1 = Linear waterway under the bridge:
C = Coefficient of discharge through the bridge, taken as 0-7 for sharp entry and 0-9 for bell-mouthed entry:
g = acceleration due to gravity.

AFFLUX causes increase in velocity on the downstream side and increases the scour depth affecting the foundation. The afflux should be kept to the minimum and limited to 300 mm.

Vertical Clearance:

is the vertical height between the designed flood level including afflux of the stream and the lowest point of the bridge substructure.

This is required to allow for any possible error in the estimation of the H.F.L. and the design discharge. It also allows floating debris to pass under the bridge without damaging the structure and provides a margin for silting of the stream bed. The clearances for various discharges are given below:

Design discharge	Vertical clearance
Up to 2.8 cumecs	610 mm
2.8 to 28 cumecs	610 mm
28 to 280 cumecs	1220 mm
280 to 2800 cumecs	1525 mm
2800 and above cumecs	1830 mm

Free Board:

is the difference between the design flood level after allowing for afflux and formation level of the Rail- way embankment on the approaches or top level of guide bunds. This should not be less than 1 m normally. In cases where heavy wave action is expected, the free board should be suitably increased.

Note: Sometimes the terms "vertical clearance" and "free board" are mixed up. The reader may note the distinction between the two from the above definitions.

12.5 Types of Foundations:

The types of foundations used in bridge structures may be broadly classified as-

1. Shallow foundation; and
2. Deep foundation.

A deep foundation is sometimes defined as one whose depth is greater than its width. The foundations consist of

1. Open foundation:
2. Foundation with friction piles:
3. Foundation with point bearing piles:
4. Well, foundation.
5. Caisson foundation.

The foundations are likely to fail due to undesirable scours during floods or undue settlement due to poor bearing capacity of soils or due to poor design of structures.

12.6 Substructures of Bridges

Substructures of Bridges are designed as per the provisions of the sub-structures code. But in case of the existing bridges, Completion drawings are not always available to check their strength. Further a high factor of safety of as much as 8 has been adopted in the design of masonry substructures. The theory of longitudinal forces also, as presently adopted, is not a reliable one. Taking all these factors into the account, some dispensations are given as follows in the case of mansonry substructures (not concrete substructures).

1. New types of rolling stock/existing stock with material modifications such as change in braking equipment, change in traction motors with different characteristics, any modifications tending to improve the adhesion etc., may be permitted over the existing masonry structures, provided the calculated over-stress, if any, in compression does not exceed 100% of the permissible values, neglecting the tension zone in cases where the permissible tensile stress is exceeded. The substructures which are thus allowed to be overstressed shall be kept under regular observation.
2. In the case of existing masonry substructures, where the rolling stock already in operation is found to cause over stresses exceeding the limit of 100% mentioned above, and in the case of existing substructures other than masonry where the stresses are found to exceed the permissible values and in other cases where it is not practicable, for want of completion plans of the substructure, to

calculate the theoretical stresses, continued operation of the existing rolling stock may, at the discretion of the chief Engineer, be allowed to such substructures being kept under observation and subject to any other safeguards that he may consider necessary and provided that the substructures did not show signs of distress under these loads.

3. On B. G. sections where coupled operation of diesel electric locomotives, each of tractive effort capability up to 30 t is already permitted in terms of sub-para 6-14-1 above, a single diesel/electric locomotive can also be permitted at the discretion of the Chief Engineer, provided its tractive effort capability does not exceed 37-5 t and provided physical condition of the substructure is such as not to render them liable to rapid deterioration under the proposed locomotive.
4. The Chief Engineer may, at his discretion, also certify bridge structures falling under categories mentioned in sub-para 6-14-3 above, for running of new types of rolling stock/existing stock with material modifications provided their effects are not more severe than those already operating on the section and the tractive effort capability of each loco is not more than 30 t and not more than two locos are coupled together and provided that the physical condition of the sub-structure is such as not to render them liable to rapid deterioration under the proposed stock.

Note: Sub-paras 6-14-1 to 6-14-4 above are based non clauses 24.3 to 24-6 of the substructure code.

12.7 Accidents due to failure of bridges:

1. Collapse of bridges

Collapse of bridges on account of failure of substructures is very rare. Before such a collapse takes place, the masonry shows sufficient distress by developing progressive hair cracks. Such warnings come to notice in the course of periodical bridge inspections and timely action is taken to relieve the load on the bridges by imposing a suitable speed restriction with or without some temporary arrangements.

2. There have been cases of failures of triangulated girders in the

past due to bad design, sub-standard construction and poor maintenance.

3. **Corrosions in steel members of the bridges**
   Corrosion is one of the causes for weakening the members of girders leading to their failure. In the early stages of bridge construction, wind forces were not sufficiently taken into account. With the advancement of the science of bridge design, construction and maintenance, such failures are the things of the past.
4. **Bridge failures due to foundation or approaches**
   Bridge failures due to foundation and/or approaches giving away, though many of them did not lead to train accidents. Such failures were many a time detected, and trains were protected well in advance before a disaster.
5. **Inadequacy of Waterway:**
   The flood discharges of a bridge vary violently from year to year and an occasional cloud- burst in the catchment area may give rise to an abnormal flood for which the bridge might not have been designed. The linear water- way of a bridge is designed for a 50-year flood discharge and its foundation for a 100-year flood discharge. A 100-year flood or even a 1000-year flood can occur within a year of the construction of a bridge and undermine its approaches and foundation, since the maximum floods in a given period (50 or 100 or 1000 years) do not occur with any regularity. There are also cases of failures of bridges on account of the failure of railway affecting works, such as, tanks, dams and other irrigation works.
6. **Parallel Flow of Streams to Track**
   Parallel Flow of Streams to Track is dangerous in that it can undermine the approach banks when the banks are not properly protected with pitching, toe walls, aprons, spurs, guide bunds, etc.

12.8 Speed over railway bridges:

The Railway bridges are designed to carry traffic at axle loads and speeds specified by the Railway Board for track. Movement of Over-Dimensional Consignment (ODC) is governed by the minimum clearances available on the bridges en route. There are some old bridges where traffic is allowed with load and speed restriction, depending on the strength of these bridges.

12.9 Maintenance of bridges:

Bridge structures which are con- structed with reinforced concrete or pre-stressed concrete need less attention for maintenance compared with steel bridges. Steel bridges need painting at regular intervals. Piers and abutments of bridges require regular checks to detect cracks which are rectified by grouting.

12.10 Vulnerability of the bridges

The railway bridges are the most vulnerable part of railway track; therefore, those need to be taken seriously. Some of the vulnerabilities of the bridges are as under:

1. The presence of Railway Affecting Works like irrigation tanks or reservoirs owned by the government, quasi-government, or private bodies on the upstream may make a railway bridge or embankment vulnerable.
2. The presence of steep slope due to existence of hills in the vicinity on the up stream of the railway bridge may cause flash flooding making the bridges vulnerable.
3. Every Zonal Railway maintains a list of Railway Affecting Works in the Division as well as in the headquarters, which are updated every year.
4. Stationary watchmen should be posted at some of these bridges for keeping vigil round the clock during monsoon.
5. There is arrangement with the State Irrigation Department to advise the Station Master of the

nearest railway station in case of any apprehended danger or actual damage to the Railway Affecting Works. To take precautionary measures to ensure safety of trains.

6. In addition, there must be an arrangement with the Indian Meteorological Department to get weather warning or cyclone warning information for alerting the Division to take safety measures by introducing patrolling of track and watching vulnerable points.

7. Flood warnings are also collected from the State Irrigation Department or Central Water Commission whichever is having gauging sites on the upstream of flood-prone rivers having railway bridges across them. Safety measures should be taken according to necessity.

UNDERSTANDING COACHING STOCK

13

Indian Railway is having five type of conventional bogie stock:

1. IRS
2. ICF Laminated (Schlieren)
3. BEML (Bharat Earth Movers Ltd.)
   (this bogie was earlier known as HAL-MAN)
4. ICF all-coil
5. LHB (Fiat Bogie)

At present, IRS, ICF laminated and BEML coaching stocks have been phased out and fast process is also on for phasing our ICF (All coil) Rolling stock. To improve riding quality, speed potential and safety, LHB stock with FIAT bogie is being inducted in coaching fleet of Indian Railway. LHB is modern.

Recently, FIAT bogie (on LHB coach) has been inducted on the Indian Railways. This can be called the modern coaching stock. Features of this bogie are very different and, hence, they are discussed separately.

All the above conventional stock has two-stage suspension bogies. In general, the suspension arrangement of such bogies is as under:

13.1 Vertical Load Transmission

A bogie frame rests on primary springs which are supported on the

axle boxes. From the bogie frame are hung swing links, which support (either directly or through a spring plank) the secondary springs. The secondary springs support the bolster on which the vehicle body rests, with its weight primarily carried either on center pivot, or two side bearers.

Below diagram (Fig. 13.1) illustrates the schematic arrangement of such a suspension.

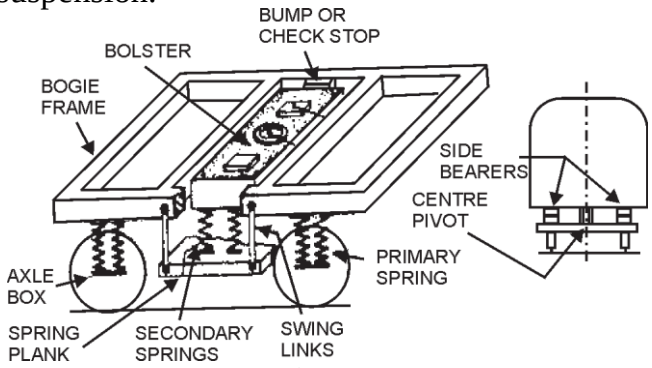


Fig. 11.1

Schematic arrangement of suspension systemof a typical coaching stock bogie

In IRS & ICF Laminated bogies, body weight is primarily supported on center pivot on the bolster at each of the two bogies. Since one-point support at either end of the vehicle body would be unstable (in rolling mode), two side bearers on the bolster provide the necessary support during vehicle motion, otherwise, there is clearance between the body and the side bearers.

In BEML & ICF all-coil bogies, body weight is supported on the two side bearers on the bolster, the center pivot not carrying any vertical load. However, in all the four types of bogies, the center pivot acts as the center of bogie rotation and transmits the tractive and braking forces from the body to the bolster.

Hence, for defects in the context of hindrance to bogie rotation, surfaces of the following should be checked.

IRS ICF Laminated	Mainly, the center pivot. Since one of the two side bearers also carries load during vehicle motion, the side bearers also should be checked for any defects or

	features that would tend to cause jamming or hinder free bogie rotation.
BEML ICF all-coil	Mainly, the two side bearers

Transmission of tractive and braking forces

The vehicle body transmits these forces to the bolster through the center pivot. The transmission is directly to the bogie frame through swivelling anchor links, bypassing the secondary suspension. From bogie frame to the axle, these forces are transmitted as under.

IRS	axle guard bearing against the axle box groove
ICF Laminated	through dashpot
BEML	through axle holding arms (also called axle links)
I CF all-coil	through dashpots cum axle guide
Lateral restraint for axle held in the bogie is provided as under:	
IRS	axle guard in axle box groove
ICF Laminated	through dashpot
BEML	by bronze rollers with ferrozol bushes moving up and down in precom pressed state on vertical rubber bonded plates. There are a set of one plate and 2 rollers (one roller on either side of the plate) on either side of eachaxle box i.e. 32 rollers in all per coach(16 per bogie.)
ICF all-coil	by dashpot cum axle guide

In BEML bogie, the axle holding arm is provided with silentblock (rubber bonded) bushes at its ends where swivelling actiontakes place with vehicle oscillations. As the rubber wears out,the longitudinal play of the axle in the bogie frame increases, leading to severe vibrations of the wheelsets. The condition ofthese bushes and bearings and play of the axle holding armsshould, therefore, be checked.

The lateral sway of the bolster is checked beyond certain limits by bump or check stops on the sides of the bogie frame. A heavy indentation at such locations is indicative of the bogie having been subjected to high flange forces.

13.2 ICF All-Coil Bogie

Various components of ICF All-coil Bogie and their features are

discussed in the following paras.

Bogie Assembly

The bogie frame and components are of all-welded light construction with a wheelbase of 2.896 meters. The maximum axle load bearing capacity is 13t and 16.25t. The wheel sets are provided with self-aligning spherical roller bearings mounted in cast steel axle box housings. Helical coil springs are used in both primary and secondary suspension. The weight of the coach is transferred through side bearers on the bogie bolsters. The ends of the bogie bolsters rest on the bolster helical springs placed over the lower spring beam suspended from the bogie frame. A photograph of ICF All-coil Bogie is shown in **Fig.** 13.2. General arrangement of ICF. A photograph of the Secondary Suspension arrangement is shown in **Fig.** 13.4.

Swing Links

Swing Link (also called Hanger) isolates lateral movement of the coach from that of the bogie frame to a large extent, thus reducing lateral oscillations of the coach and lateral flange forces. It should swivel freely in the lateral direction. Any tendency of jamming of swing links (at points of articulation in bogie frame and spring plank) during lateral swing would result in occurrence of higher flange forces (Y) and higher lateral accelerations in the coach.

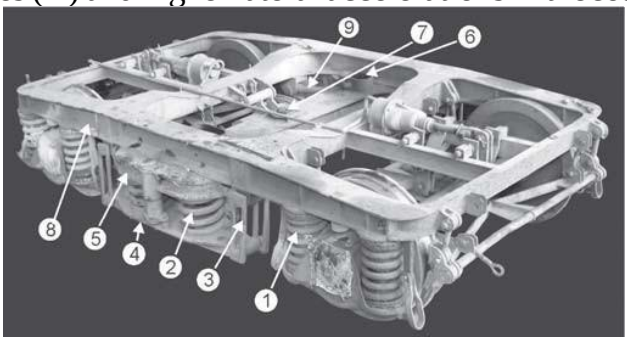
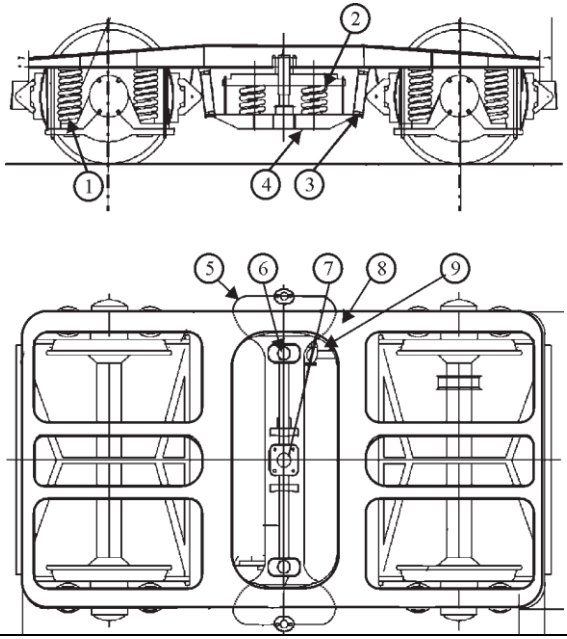


Fig. 13.2 ICF All-coil Bogie



1.Axle box spring 2. Bolster spring 3. Swing link 4. Spring plank 5. Bolster 6. Side bearer 7. Centre pivot 8. Bogie frame 9. Anchor link

Fig. 13.3 ICF All-coil Bogie – General arrangement

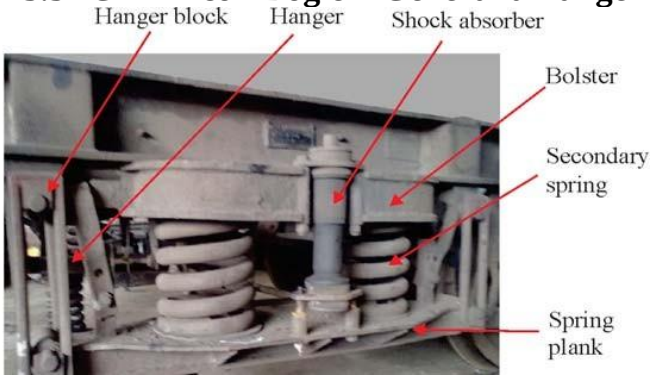


Fig. 13.4 ICF All-coil Bogie – Secondary suspension

Hanger is an important component of bogie as it transfers both vertical and lateral loads at the secondary suspension stage (Figure 13.4). Due to swivel action, wear occurs on the Hanger block and

inside surface of Hanger. Wear limits of Hanger block and limit of clear inside length of Hanger are stipulated. Upon exceedance of the limits, these components are replaced. Else, the chances of failure of Hanger would be high.

Swing link is a vulnerable component. Hence, its failure should be observed at the derailment site.

Axle box guide with dash pot

Axle box guides are of cylindrical type welded to the bottom flanges of the bogie side frame (Figure 13.5). These guides together with lower spring seats located over the axle box wings, house the axle box springs, and serve as shock absorbers. These guides are fitted with guide caps having nine holes of diameter 5 mm equidistant through which oil in the lower spring seat passes under pressure during dynamic oscillation of coach and provide necessary damping to primary suspension to enhance better riding quality of coach. This type of rigid axle box guide arrangement eliminates any longitudinal or transverse relative movement between the axles and the bogie frame, through provision of bronze bushes at the lower end of the axle guide and transmits lateral and longitudinal forces. The assembly is made oil tight by provision of sealing rubber rings.

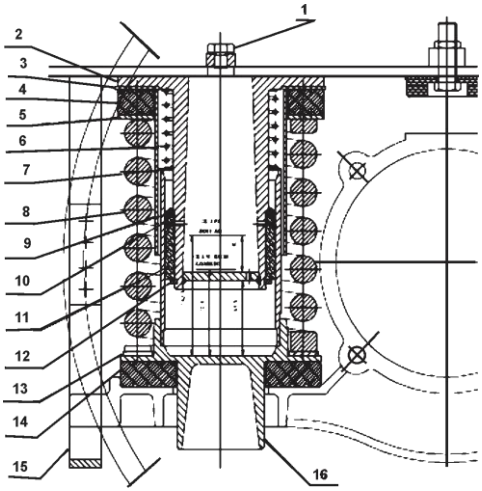


Figure 13.5 Axle Guide with Dash pot

1.Screw with sealing washer 2. Guide 3. Protective tube 4. Rubber washer 5. Top spring seat 6. Dust shield spring 7. Dust shield 8. Spring 9. Guide ring 10. Rubber packing ring. 11. Guide bush 12. Circlip 13. Compensating ring 14. Rubber washer 15. Safety strap 16. Lower spring seat

On the bogie side frames, directly above the dashpot's, tappedholes are provided for replenishing oil in the dash pots. Specialscrews with copper asbestos washers are screwed on the tappedhole to make it airtight. Oil level (above top of guide cap) is measured by insertion of a flexible wire through the hole. A lower oil level would result in a decrease in damping, which would adversely affect comfort and safety.

Centre pivot and side bearer arrangement

The center pivot pin joins the body with the bogie and transmits the tractive and braking forces on the bogie (Figure 13.6). It does not transmit any vertical load. It is equipped with rubber silent block bushes which tend to centralize the bogies with respect to the body and, to some extent, control and damp the angular oscillations of the bogies. During assembly, graphite grease is applied on the Centre Pivot Pin to reduce friction and it is secured with a cotter and pin arrangement.

The side bearer arrangement consists of a machined steel wearing plate immersed in an oil bath and a floating bronze-wearing piece with a spherical top surface kept in it, on both sides of the bogie bolster (Figure 13.7). The coach body rests onthe top spherical surface of these bronze-wearing pieces through the

corresponding attachments on the bottom of the body-bolster. The whole arrangement is provided with a cover to prevent entry of dust into the oil sump. During Schedule Inspection, oil is replenished if its level has gone down below the level of last thread of oil filling cup.

The thickness of the Wear plate are 10 mm (new) and 8.5 mm (condemning). The thickness of bronze piece are 45 mm (new) and 42 mm (condemning). Condemning thickness for High Speed ICF Bogie for Rajdhani are 9.0 mm and 43.5 mm, respectively.

Obstruction to bogie rotation increases vulnerability to derailment, particularly in sharp curves, to a very large extent. Therefore, defects which cause such obstruction, such as excessive/ uneven wear or formation of an obstruction/ notch/ridge on wear plate/ bronze piece, lack of lubrication in oil bath; lack of verticality, tendency of jamming of center pivot pin etc. must be thoroughly checked during investigation of derailment.

Anchor link

The floating bogie bolster which supports the coach body is eld in position longitudinally by the anchor links which are pinned to the bolster sides and the bogie Transoms. One anchor link is provided on each side of the bolster diagonally across. The links can swivel universally to permit the bolster to rise and fall andsway side wards.

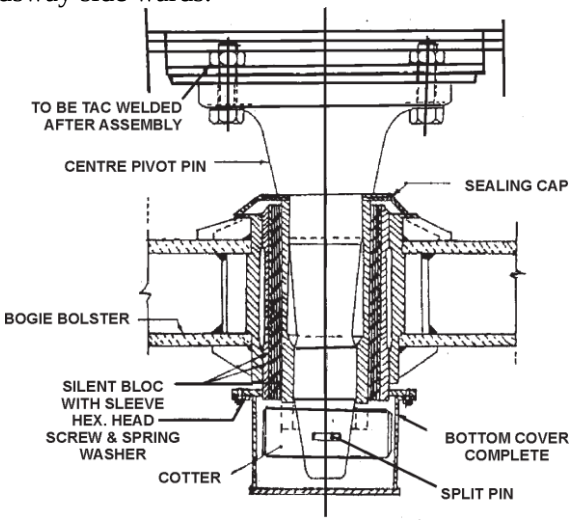


Fig. 13.6 Centre Pivot Pin

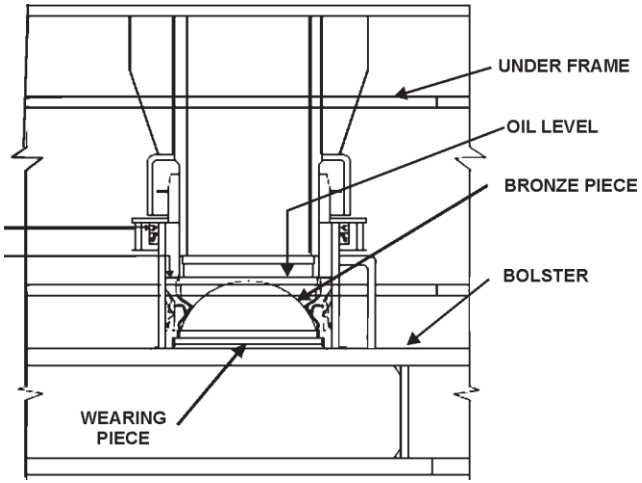


Fig. 13.7 Side Bearer

They are designed to take tractive and braking forces. The anchor links are fitted with silent block bushes,in order to reduce the jerks during acceleration/ braking. A broken Anchor Link would result in eccentric transfer of longitudinal load, causing increased angular run and lateral forces.

Equalizing stay

This device has been provided on bogies between the lower spring plank and the bolster to prevent lateral thrust on the bolster springs which have not been designed to take the lateral forces. These links have pin connections at both ends and, therefore,can swivel freely. A photograph of Equalizing stay and Anchor link arrangement is shown in Figure 13.8.

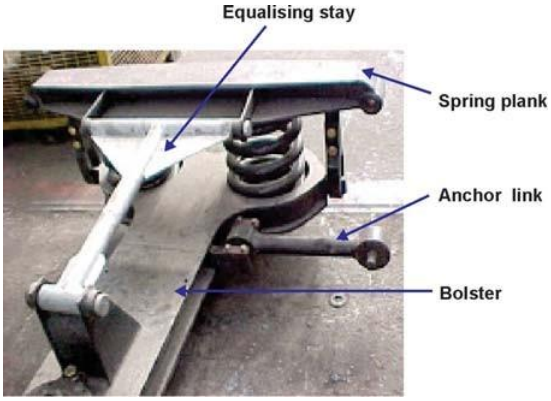


Figure 13.8 Equalizing Stay Arrangement

Helical spring and shock absorbers

Drawing number and Free height, loaded height and Grouping details of spring for BG Main Line coaches is shown in Table 13.1, 13.2 and 13.3. Springs should be grouped in three groups as shown in the Table, depending upon their height under test load. Spring groups are to be marked as per the colour code: A - Yellow, B - Oxford Blue, C – Green. For pairing, springs should be selected from the same group. The same group of spring is to be used on a particular bogie.

Defects of spring and their role in derailment has already been discussed in Chapter 3 – Rolling Stock Defects. Springs should be observed and measured accordingly during derailment investigation.

Three vertical clearances, between Axle Box crown and bottom of Bogie Frame, top of Bolster and bottom of Bogie Frame, and top of Bogie Frame and bottom of coach body are stipulated for various ICF coaches. Abnormal variation in these clearances may be caused by either defect in springs or excess/ uneven load. In such situations, the cause should be thoroughly investigated.

Two Hydraulic shock absorbers (one on each side), having a capacity of ± 600 kg at a speed of 10 cm/sec. are fitted to work in parallel with the bolster springs to provide damping for vertical oscillations. Leakage of oil and physical damage are the common items to be observed.

Table 13.1
Drawing code of springs for ICF BG coaches
(Reference RDSO Amendment slip no.5 of September 2001 to STR WD-01-HLs-94) (Rev.1 May 95)

Type of spring	Type of bogies	ICF Drg. No.	Drg. Code No.
Axle Box	All Non AC ICF Type	F-0-1-006	A01
	All AC ICF type	WTAC-0-1-202	A03
	Power car	WLRRM2-0-1-202	A04
	Double decker	DD-0-1-001	A06
	High capacity Power Cars	WLRRM8-0-1-802	A09
	High capacity parcel van	RDSO/SK-98017	A10
Bolster	All Non AC ICF type	F-0-5-002 WTAC-0-5-202	B01
	All AC ICF type	WLRRM2-0-5-202DD-0-5-	B03
	Power car	003	B04
	Double decker		B06
Bolster	High capacity Power Car	WLRRM8-0-5-802	B11 B13
	High capacity parcel van	RDSO/SK-98018	B15 B16

Table 13.2 Grouping of Axle box spring

Code	Free Height (mm)	Test load (Kg)	Acceptable Height under test load (mm)	Groups as per loaded spring height (mm)		
				A Yellow	B Oxford Blue	C Green
A01	360	2000	279-295	279-284	285-289	290-295
A03	375	2800	264-282	264-269	270-275	276-282
A04	372	3000	265-282	265-270	271-276	277-282
A06	337	2400	269-284	269-273	274-279	280-284
A09	360	3000	277-293	277-282	283-288	289-293
A10	315	1800	276-289	276-279	280-284	285-289

Table 13.3 Grouping of Bolster spring

Code	Free Height (mm)	Test load (Kg)	Acceptable Height under test load (mm)	Groups as per loaded spring height (mm)		
				A Yellow	B Oxford Blue	C Green
B01	385	3300	301-317	301-305	306-311	312-317
B03	400	4800	291-308	291-296	297-303	304-308
B04	400	6100	286-304	286-291	292-297	298-304
B06	416	4200	280-299	280-286	287-292	293-299
B11 B13	386	6700	306-322	306-311	312-317	318-322
B15 B16	393 386	6000	256-272	256-261	262-267	268-272

Summary

Various suspension particulars, damping arrangements, relevant RDSOs Reports, Speeds tested and cleared for, etc. in respect of the foregoing four coaching stock bogies are summarized in Table 13.4. The particular suspension

arrangements and defects and features to be checked during derailment investigation covered in the above paras are shown in **Fig.** 13.9 to 13.11.

The suspension arrangements of M.G. IRS and ICF All coil bogies are more or less similar to those of B.G. ones. The former have been cleared for maximum speeds of 80 km/h and 100 km/ h respectively, speeds tested and found stable for, being 100 km/h and 110 km/h.

Trolley frame defects - rejections (Prefixed by S)

1. Trolley frames visibly out of square or damaged.
2. Any member of trolley frame cracked, or welding failed. This shall include knee plates, gusset plates and diagonal barswith their rivets broken or deficient
3. Bearing spring hanger bracket cracked or broken
4. Bolster or spring plank cracked or broken, or bolsterimproperly secured
5. Bolster safety bracket cracked, broken or its pin or retainer deficient
6. Rocker bar/swing link broken and/or top or bottom arch bar displaced, cracked or broken
7. Pivot plate/casting or pin broken, cotter and/or nut deficient
8. Any part of side bearer assembly improperly secured ordeficient Bolster rubbing block/plate (on BEML) deficient
9. Centre bearing carrier (on BEML) broken or cotter deficient
10. Swing bolt or its safety bracket (on BEML) broken ordeficient
11. Bolster top truss (on BEML) broken/damaged and any ofits pins deficient broken or free to work out
12. Bolster bottom bars (on BEML) cracked, broken or damagedor its bracket or bracket bolts deficient
13. Axle box holding arm (on BEML type trolley) broken ordeficient or any of its securing studs/nuts loose or deficient
14. The anchor link broken or its pin deficient or free to work out.
15. Any safety strap bracket of wrong size/broken deficient orimproperly secured
16. Equalizing stay (on ICF all coil type) broken or deficient.

TABLE 13.4: COACHING STOCK

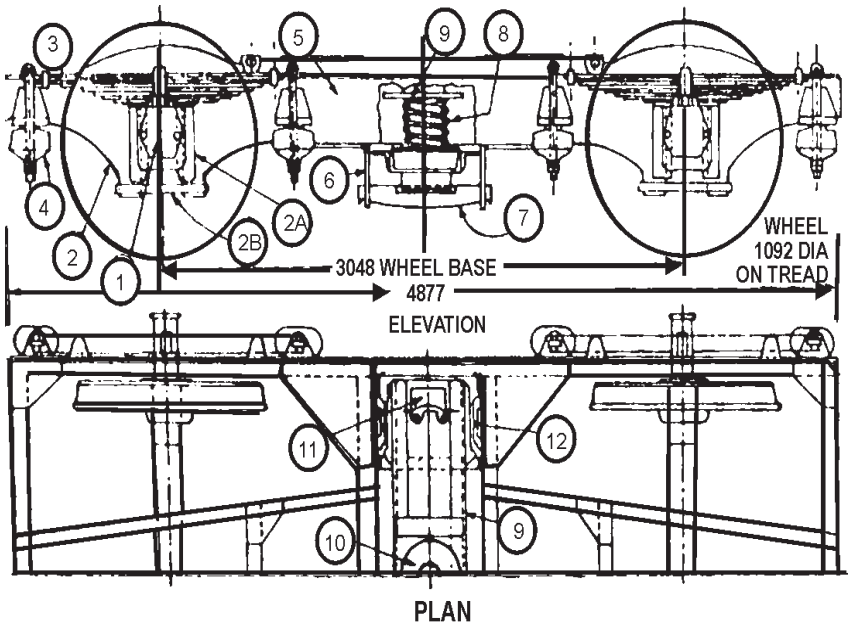
Sr. No.	Item	IRS (Rivetted under frame)	Schlieren (ICF Laminated) (Welded)	BEML (HAL-MAN)	ICF all coil
	RDSO' s report no.	M-130 M-277	M-130 M-188 M-277	M-130	M-130 C&M-1
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
1.	Type of bearing at journal	Conventional plain bearing axle box	Roller bearings	Roller bearings	Roller bearings
2.	**Suspension Vertical**				
	i) Primary springs (axle level)	Laminated springs plus auxiliary springs or rubber pad.	Coil-springs with dashpot. (Rubber pad on top).	Coil springs	Coil springs with dashpot (rubber pads-
				Bronze rollers with ferrosol bushes pressing against rubber bonded vertical plates – a set of 2 rollers and a plate on either side of axle box provide the lateral restraint as well as vertical damping – 32 rollers per coach) Coil springs (4 nests of 2 springs each). (with vertical shock absorbers 2 per bogie).	

(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
	ii)Secondary springs (Bolster level)	Coil springs (no damping). 4 nests of coil springs (each)	Laminated springs (grease lubricated)		4 Nos. Coil springs (on independent spring planks). (Vertical shock absorbers 2 per bogie.)
3.	Suspension lateral swing links (Length & angle of inclination)	343 mm (1/2") 110 to vertical	286mm (11 ¼") 70 to vertical	450/400mm 6.50 to vertical	410/425 mm 70 to vertical
4.	Lateral shockabsorbers	No	No (provided on some)	Yes (2 Nos. Per bogie) (Between under-frame and bogie)	Yes (in some of them e.g. for Rajdhani express)
		On center pivot lubricated by oil-soaked cotton waste. (2 side bearers also provided for restraining rolling oscillation).		On 2 side bearers (immersed in oil bathwith oil seal)	On 2 side bearers (immersed in oil bathwith oil seal)
5.	Loading (vertical)	(Centre pivot also transmits the longitudinal forces between the vehicle body and the bolsters.)		(Centre pivot acts only as center of rotation andfor transmitting longitudinal forces between the vehicle body and bolster).	
6.	Location of axle in frame. (for transmission of longitudinal forces between	Conventional axle guard-hom cheek guides.	Telescopic cylindrical guides immersed in oil	Two axle holding arms (with silent block bushes).	Telescopic cylindrical guides immersed in oil.

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(1)	(2)	(3)	(4)	(5)	(6)
7.	Transmission of longitudinal forces between bolster and bogie frame.	Check guides of 2 anchor links the bogie frame		2 drag (anchor) links, working in parallel with 2 leaf springs.	2 anchor links.
8.	Permissible swing of bolter in lateral direction.	31mm	41mm (stops are provided at end of travel)	25mm (Rubber bump)	57mm
9.	General	1) Lateral riding better than ICF Laminated, but more rolling oscillations. 2) Bolster starts hitting the bogie frame due to excessive swing on 30 curve at 1 03km/h (equivalent to 110 mm cant deficiency or 129 mm) Ride index >3.5 hence O.K. only for speeds equivalent to 110mm cant deficiency on track maintained to	While vertical riding is satisfactory, lateral riding becomes uncomfortable at higher speeds. Lateral shock absorbers do improve lateral ride, but as ICF an con coaches are used for higher speeds, these alterations are		Transverse damping by friction between links and hanger blocks.
10.	Speeds cleared for	110 kn/h	100 km/h	110 km/h	130 km/h
11.	Maximum test speed upto which found satisfactory.	125 km/h	110 km/h	125 km/h	145 km/h

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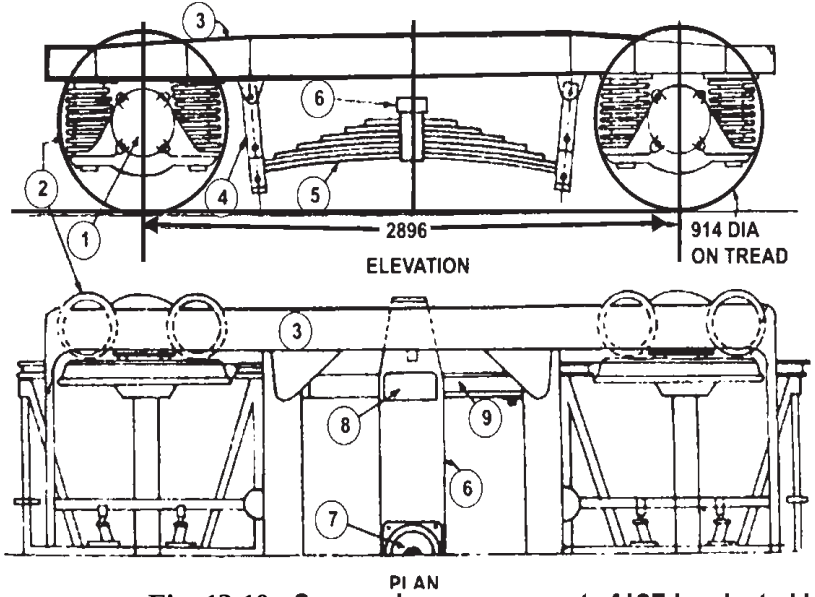
1. Plain Bearing Axle Box
2. Axle Guard
2A. Horn check
2B. Birdle Bar
3. Primary Springs (Laminated)
4. Auxiliary Rubber Block (Or Spring)
5. Bogie Frame (Rivetted)
6. Swing Links
7. Spring Plank
8. Secondary Spring (Helical)
9. Bolster
10. Centre Pivot
11. Side Bearers
12. Check Guides (Connected to Bogie Frame)

Fig. 13.9 Suspension arrangement of IRS (B.G.) bogie.

Particular items and features to be checked

* Surface of centre pivot - for any hindrance to bogie rotation (also check surfaces of side bearers in this context).
* Bolster sway - any heavy indentation marks indicative of sway being excessive.
* Swing links - whether swivelling freely and not jamming.
* Helical springs - specific deflection, to check possibility of springs getting fully compressed in dynamic condition.
* Condition of auxiliary rubber block or spring.

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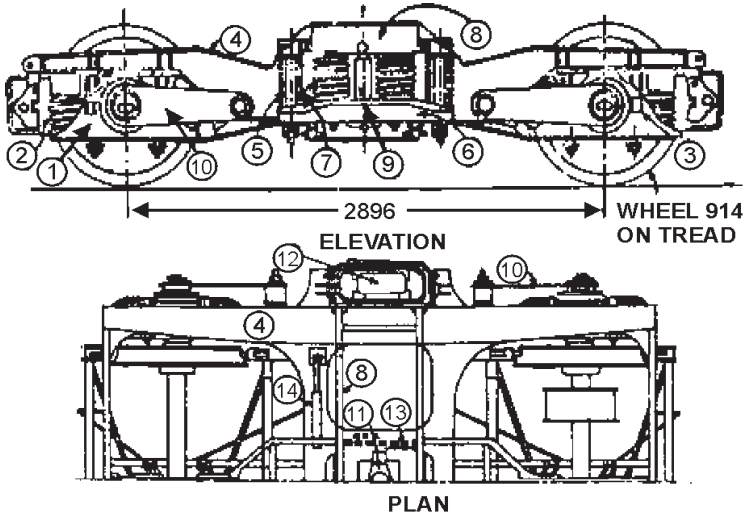
1. WING TYPE ROLLER BEARING AXLE BOX
2. PRIMARY SPRINGS (HELICAL) WITH DASH-POT INSIDE
3. BOGIE FRAME
4. SWING LINKS
5. SECONDARY SPRINGS (LAMINATED)
6. BOLSTER
7. CENTRE PIVOT
8. SIDE BEARERS
9. ANCHOR LINKS

Fig. 13.10 Suspension arrangement of ICF Laminated bogie.

Particular items and features to be checked

* Surface of centre pivot- for any hindrance to bogie rotation (also check surfaces of side bearers in this context.
* Bolster sway - any heavy indentation marks indicative of sway being excessiva.
* Swing links-whether swivelling freely and not jamming.
* Helical springs-specific deflection, to check possibility of springs getting fully compressed in dynamic condition.
* Level of oil in the dash-pot and condition of dash-pot assembly.
* Lubrication and condition of roller bearing axle boxes.
* Anchor links.

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1. WING TYPE ROLLER BEARING AXLE BOX
2. PRIMARY SPRINGS (HELICAL)
3. AXLE GUIDE ROLLER (16 NOS. PER BOGIE I.E. 32 NOS. PER COACH).
4. BOGIE FRAME.
5. SWING LINKS.
6. SPRING PLANK.
7. SECONDARY SPRINGS (HELICAL).
8. BOLSTER.
9. VERTICAL SHOCK ABSORBER (HYDRAULIC).
10. AXLE LINK (OR AXLE HOLDING ARM).
11. CENTRE PIVOT.
12. SIDE BEARERS
13. ANCHOR LINKS.
14. LATERAL SHOCK ABSORBER (HYDRAULIC).

Fig. 13.11 BEML Bogie Suspension Arrangement.

Particular items and features to be checked

* Surface of the two side bearers-for any hindrance to bogie rotation.
* Bolster sway - any heavy indentation marks indicative of sway being excessive.
* Swing links-whether swivelling freely and not jamming.
* Helical springs-specific deflection, to check possibility of springs getting fully compressed in dynamic condition.
* Axle guide rollers-whether deficient, having a flat, etc.
* Axle holding arms-longitudinal play and condition of rubber bonded silent block bushes.
* Wheel bases on either side of the same bogie (to detect error in fitment of axle holding arms).
* Lubrication and condition of roller bearing axle boxes.
* Anchor links.

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13.3 EMU Stock

The EMU stock running on suburban traffic contains two different types of coaches.

a. Motor coach
b. Trailer coach

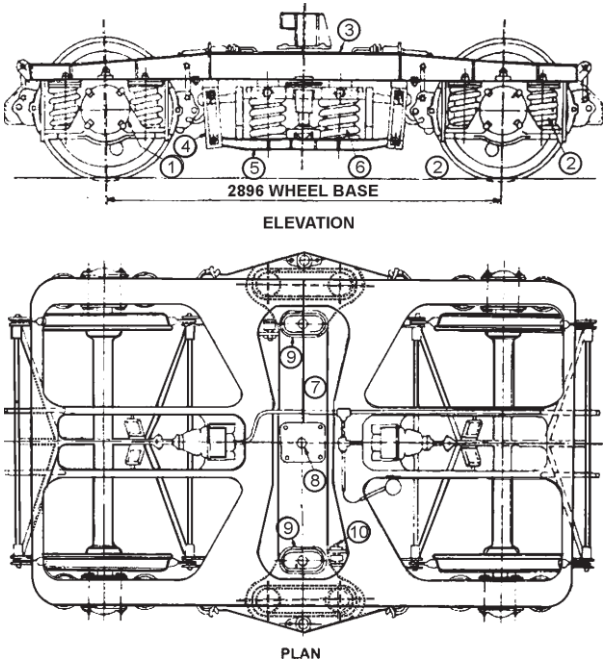
While the trailer coach bogie is identical to ICF All - coil coach bogie, certain modifications had to be carried out in the motor coach bogie for accommodating traction motors. The axle load of the motor coach is, therefore, 20 tonnes while that of the trailercoach is 17.5 tonnes.

Brief description of bogies

Bogies of motor coach and trailer coach (**Fig.** 13.12) are of all welded, light weight construction. Axles for these bogies with their self-aligning spherical roller bearing mounted inside the cast steel axle boxes are rigidly guided by telescopic dashpots and axle guide assemblies. Helical springs working in parallel with dashpots are used for primary suspensions. Coach body is supported on two side bearers located 1700 mm (trailer bogie) and 1200 mm (motor bogie) apart on a floating bogie bolster which in turn rests on two pairs of helical springs supported on a spring plank hung through swing links from bogie frame. The helical springs at each end of the bolster of trailer bogies are damped by hydraulic shock absorbers. The side bearer consists of metal slides immersed in oil bath well protected from dust ingress.

No weight is transferred through the bogie pivot which is located in the center of the bolster. The pivot acts merely as a center of rotation and serves to transmit acceleration and retardation forces.

The floating bolster in trailer coach bogie is secured in the longitudinal direction to bogie frame by means of two anchor links with silent block bushes, located diagonally opposite to each other and transmit draw and braking forces between bogie.



1. Wing Type Roller Bearing Axle Box 2. Primary Springs (helical) with dashpots inside 3. Bogie Frame 4. Swing Links 5. Spring Plank 6. Secondary Springs (helical) 7. Bolster 8. Centre Pivot 9. Side Bearers 10. Anchor Link

Fig. 13.12 Trailer Coach Bogie General Arrangement

frame and coach body through the center pivot. The motor bogiebolster is located between bogie transoms and transmits draw and braking forces through nylon rubbing plate fixed at the bolsterends.

Rigidly guided axles mounted on self-aligning spherical roller bearings, with practically no play in the longitudinal and lateral directions and helical springs working in parallel with dashpots/ shock absorbers of specified characteristics contribute to improved riding index. Therefore, it is essential to maintain these featureswithin the prescribed limits.

Roller Bearings and Axle Box

Both motor and trailer coach bogies have been fitted with double row self-aligning roller bearings. All roller bearings are to be cleaned, inspected, and filled with fresh grease at every POHor 2 years or 2 Lakh km, whichever is earlier.

Inspection involves removing the axle box body, cleaning different components, especially bearings, re- lubricating the bearings and re-assembly.

These self-aligning spherical roller bearings are housed inaccurately machined cast steel axle boxes. The axle boxes are provided with front and back covers secured by four bolts. Toprotect bearings from dust and moisture, the axle box housing forms a water-tight assembly.

Springs

The springs provided at the primary and secondary suspension levels are all helical springs. The free height and other specifications of these springs are shown in **Fig.** 13.13 and 13.14 for the trailer coach and motor coach, respectively.

All springs should be scrag tested up to home height unless otherwise specified in the drawing and free height measured. Springs whose free height after scrag test is not within the tolerance shall be rejected.

Dashpots and Axle Guide Assembly

Axle box guides are accurately machined hollow forgings welded to the bogie frame to ensure that the wheel sets are rigidly guided in parallel when assembled. These guides are fitted.

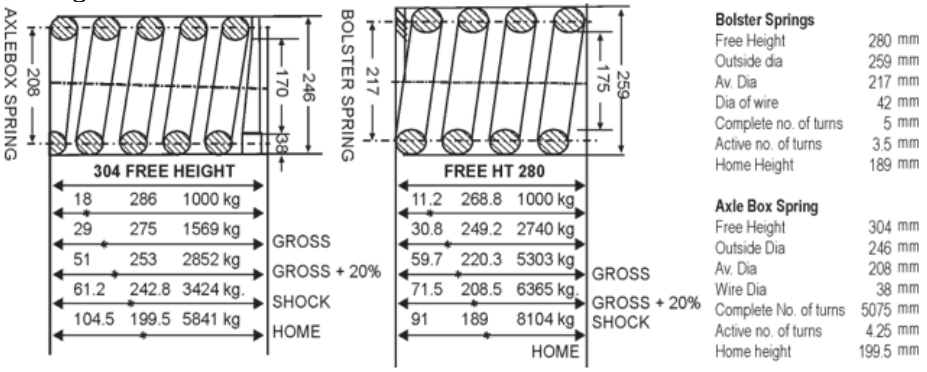


Fig. 13.13 Bolster and Axle Box Spring (Trailor coach)

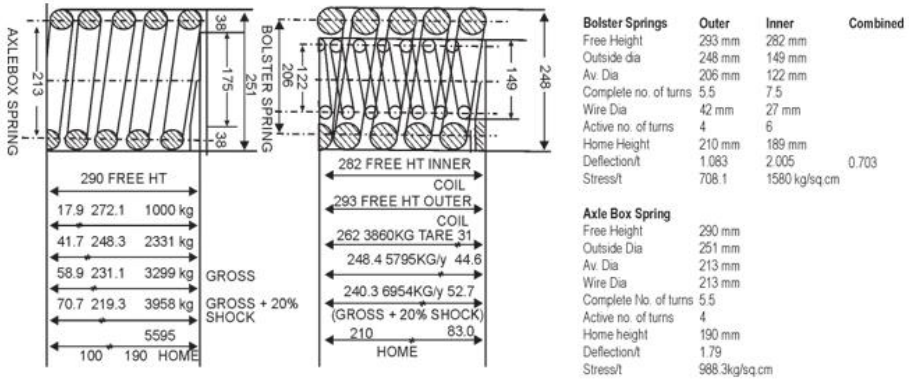


Fig. 13.14 Bolster and Axle Box spring (Motor coach)

The prescribed level of oil in dashpots for the trailer bogie is 77 mm and that for the motor coach bogie is 97 mm, from guide cap inner surface, to be measured when vehicle is empty.

13.4 Centre Pivot and Side Bearers

Centre Pivot and Side Bearers with bushes at the lower end to give the close guidance of the wheel set both in lateral and longitudinal directions, exactly in the similar fashion as in other ICF coaches.

The centre pivot for the trailer and motor coach is designed to transfer the tractive and braking forces and the vertical load is totally transmitted through the side bearers.

The side bearer consists of the hard-wearing ground steel plate immersed in an oil bath with a floating bronze wearing piece. The oil well is provided with a cover to prevent ingress of dust. Thehard ground plate and the spherical bronze wearing piece are likely to wear in service. The permissible wear on the hard ground plates is 1.5 mm and that on the bronze wearing piece is 3 mm. The replacement is resorted to either in case of wear being more than the permissible or in case of observing ridge formations or noticing damages on either of these two.

13.5 Anchor Links

These are provided only on the trailer coaches similar to that in ICF coaches. No coach should be permitted to run with brokenanchor links as this is the medium to transmit the draw and braking forces from the body to the bogie and vice versa.

In the case of motor coach bogie, the tractive and braking forces are transmitted from the bogie frame to the bolster by means ofNylon rubber plates fixed to the ends of the bolster. The gap between the nylon plate and the bogie frame shall be between 1mm to 3 mm.

13.6 Hanger and Hanger Blocks

A motor coach can be easily identified by the short hangers at the bolster level. For the trailer and the motor coach, hangers andhanger blocks are shown in **Fig.** 13.15. The extent of permissible wear on these components is indicated below into table 13.5:

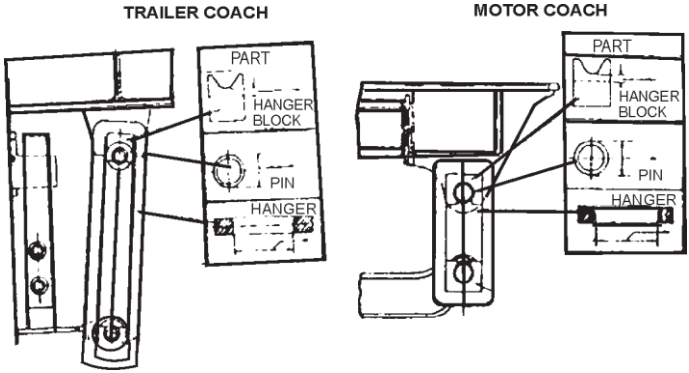


Fig.13.15 Hanger and Hanger block

Table 13.5

Component	Sizenew (mm)	Condemning (mm)	Wear (mm)	Shop issue size (mm)
Trailer Bogie				
Hanger block	8.0	6.5	1.5	7.0
Pin	34.0	32.5	1.5	33.0
Hanger	354.0	358.0	4.0	356.0
Motor Bogie				
Hanger block	9.5	8.0	1.6	8.5
Pin	45.0	43.5	1.5	44.0
Hanger	246.0	250.0	4.0	248.0

13.7 Wheel and Wheel Tread Diameter

The EMU stocks are provided with composite design of wheelsconsisting of rolled steel wheel centres with renewable tyres. The tyres are fastened to the wheel disc with glut rings and four locking keys to ensure positive securing.

The permissible variation in tread diameter of trailer and motorcoach bogies at the time of tyre turning or while replacement shall be as under:

Wheels on the same axles	0.5 mm
Wheels on the same bogie	5.0 mm
Wheels on the two bogies under the same coach	13.0 mm

13.8 High Speed Passenger Bogies On IR

ICF all-coil bogie with its 13t / 16.25 t axle load version has been the main stay for IRs Broad Gauge coaches for the last three decades. With the use of air brakes and improvements in the track structure, the speed potential of this bogie has been raised in steps from 110 to 120, 130 and 140 km/h but the bogie has not been found suitable for further higher

speeds.

With the thrust on development of technology for speeding up the passenger services initially to 160 km/h and later to 200 km/ h, the following bogies were developed/imported: -

13.9 IR-20 Bogie

A completely new bolster less bogie for operation at 160 km/ h and upgradable for higher speeds was designed and developed indigenously. Its bogie frame is suitable for 16.25 t axle load. Itis made of Corten steel, consisting of two box section dished side frames connected by two cross tubes. The bogie has a wheelbase of 2440 mm. Flexi-coil secondary suspension springs are in series with top and bottom rubber pads resting in central housings of side frames. Primary coil springs rest over axle box and go into the end housings of side frames. The transverse beam sitting over the secondary suspension springs carries the center pivot and forms the interface between bogie and coach body.

890 mm dia. wheels tapered roller bearings, axle mounted disc brakes, anti-roll bar, bogie rotation stops, transverse resilient stops, noise isolation through an elastic connection between bogie and coach body and yaw dampers in addition to the vertical dampers in primary stage and vertical and lateral dampers in secondary stage of suspension are the other important design features. These bogies were fitted under IR-Y shell. Later on, their production was discontinued due to import of FIAT bogie.

13.10 Fiat Bogie

FIAT bogies with LHB coach were imported from Linke Hoffman Bush of Germany along with technology transfer. The bogie is of a Eurofima type construction, consisting of a Y shaped longitudinal box section beam connected by two tubular members. The bogie is of two stage suspension. The primary suspension is combinedeffect of nested helical springs, control arm and rubber elements. The axle guidance between axle to bogie is achieved by control arm assembly. The secondary stage suspension is a combinedeffect of nested flexi-coil helical spring, rubber elements and rubber bellows. The unique feature of the suspension is the fitment of anti-roll bar, which controls the rolling of the vehicle body without reducing the vertical flexibility and even stiffens the secondary suspension.

The tractive and braking forces from bogie to coach body are transmitted

through rocker arm assembly, which swivels around center pivot. A rectangular shaped mounting frame connectedwith tubular members are housed with longitudinal and lateralrubber bumps through unique body-bogie connection above secondary suspension through which body weight is transmitted to bogie. The bogie is provided with disc brake system, tapered roller bearing and permanent earthing connections to avoid passage of current through roller bearings. It is also provided with wheel slip protection arrangement.

Figure 13.16 shows a photograph of Fiat bogie. Figure 13.17shows the General arrangement of the bogie.

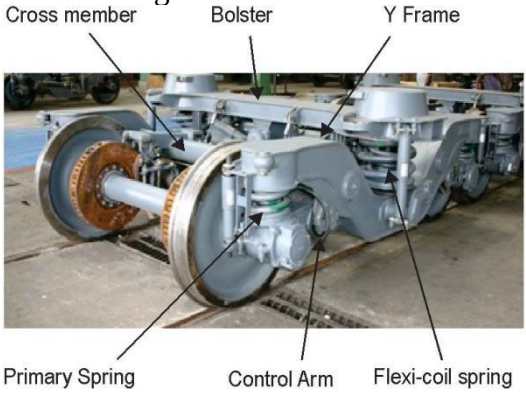


Fig. 13.16 Fiat Bogie – General Arrangement

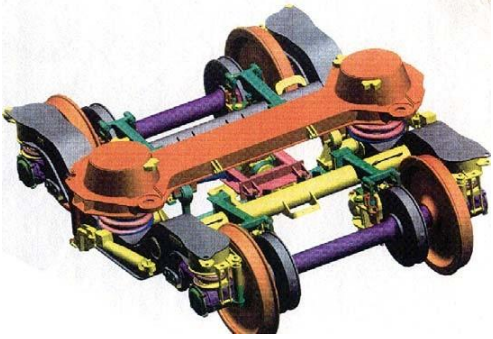


Fig. 13.17 Fiat Bogie – General Arrangement

Some of the important dimensions of the bogie are-

Wheel base	2.560 mm
Diameter of new wheels	915 mm
Diameter of max. worn wheel	845 mm
Distance between the wheels	1600 mm

Brake disc diameter	640 mm
Bogie width	3030 mm
Bogie lenght	3534 mm
Bogie weight	6300 Kg

Details of various components of the bogie are discussed below.

The bogie frame is a solid welded frame made of steel sheets and forged or cast parts. The frame is made up of two longitudinal components connected by two crossbeams, which also support the brake units. Various supports which connect the different bogie components are welded to the frame.

Primary suspension comprises of two units of two steel coil springs (internal and external) laid out on the control arm upper part by a centering disk and adjustment shims, (if required). Ithas a control arm fitted with twin-layer elastic joints, connecting the axle bearing to the bogie frame and transmitting flexibly, lateral, longitudinal and part of the vertical forces. One vertical hydraulic damper is provided for damping of vertical oscillations. Taper roller cartridge type bearing is used, and it makes up a preassembled unit. The axle bearings on the bogie are fitted withsensors for detecting speed, whose signal is analyzed by the antislipping system. A photograph of the Primary Suspension arrangement is shown in **Figure 13.18** and its various components are shown in **Figure 13.19**.



Fig. 13.18 Primary Suspension Arrangement

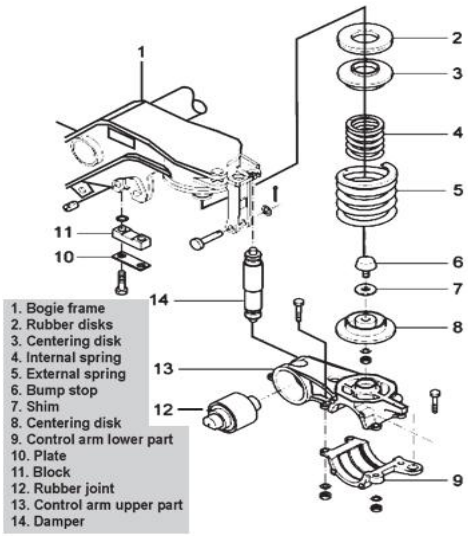


Fig. 13.19 Components of Primary Suspension

Rubber element in Ball Joint Control Arm is to be examined for external condition, crack, and detachment during maintenance. If crack length is more than 10 mm, it is to be replaced (**Figure 13.20**).

The Secondary Suspension (photograph at **Figure 13.21.1 & 13.21.2**) enables lateral and vertical displacements and bogie rotation with respect to body when running through curves. It is achieved by two spring packs which sustain the bolster beam over the bogie frame. Each spring pack is made up of an internal and an external spring, mounted and positioned through the centering discs. The bogie frame is linked to the bolster beam through two vertical dampers, a lateral damper, and the traction rods. The bogie frame is also linked to the carbody through two yaw dampers. Components of Secondary Spring and Dampers are shown in **Figure 13.22** and **Figure 13.24.**

Rubber spring is to be physically examined. Limit of length and depth of crack for vertical and horizontal cracks on the rubber are (10 mm, 4 mm) and (30 mm, 4 mm), respectively. These are to be measured with gauge and depth callipers. Rubber springs with cracks exceeding these limits are to be replaced during maintenance. Also, its load – deflection characteristics are to be checked. Please refer **Figure 13.23**. During Scheduled inspection, physical damage, crack of outer and inner coil spring and damage, crack and aging of upper and lower rubber ring is to be checked.

Air springs have also been introduced in secondary suspension of FIAT

bogie. Presently 120 kN, 140 kN and 160 kN air springs have been fitted in FIAT bogies of various types of LHB coaches.

An anti-roll bar, fitted on the bogie frame **(Figure 13.25),** realizes a constant, reduced inclination coefficient during running. The arrangement results in twisting of the Anti-roll bar due to rolling oscillation of the coach. This arrangement is a special feature of high-speed bogies, as it is able to control rolling oscillations without reducing the flexibility of secondary springs.

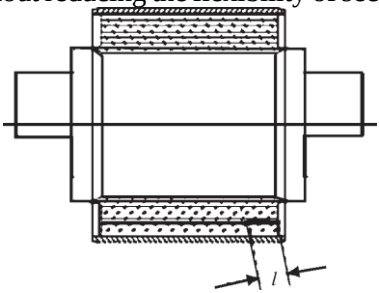
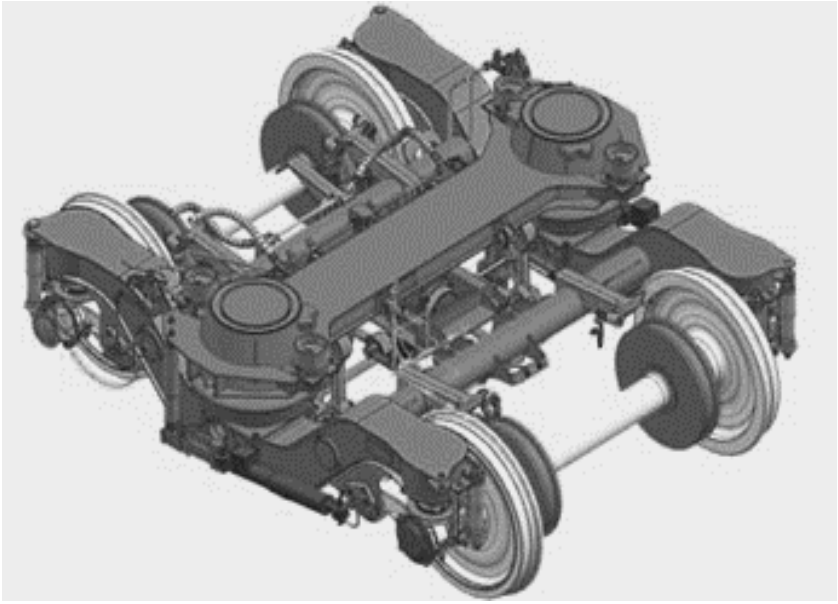


Figure 13.20 Rubber Element Ball Joint Control Arm



Figure 13.21.1 Secondary Suspension



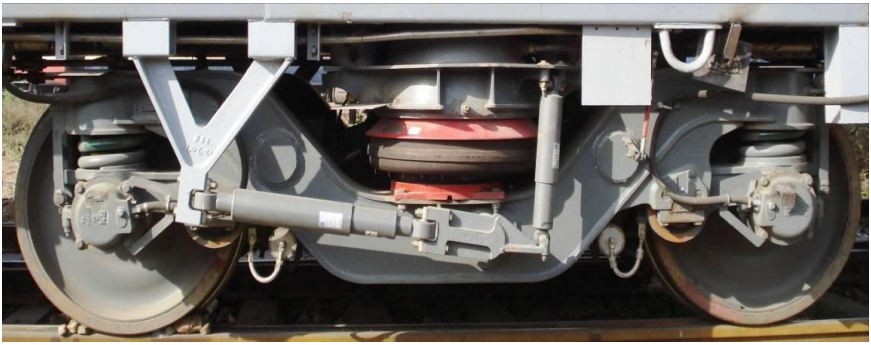


Figure 13.21.2 Secondary Suspension fitted with Air Spring

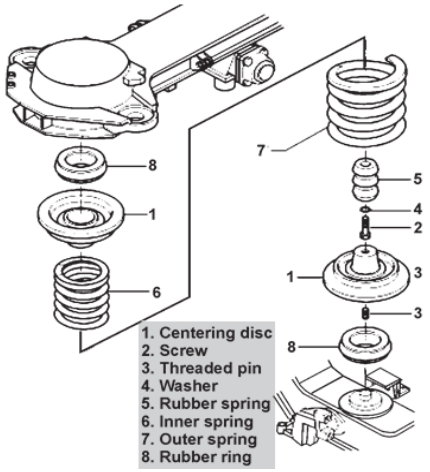


Figure 13.22 Secondary Spring Details

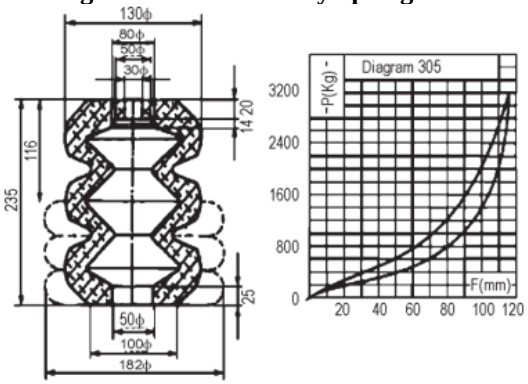


Figure 13.23 Secondary Suspension – Rubber Spring

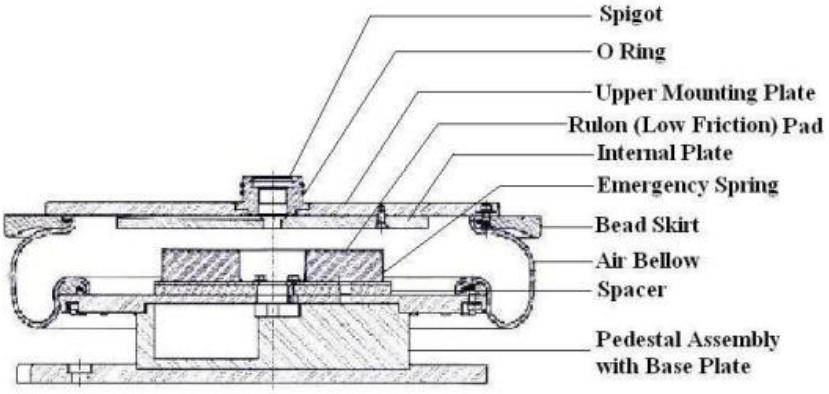
Air Spring (Pneumatic Suspension) in Secondary Suspension Stage

Air suspension is a suspension where properties of air are used for cushioning effect (springiness). Enclosed pressurized air in a pre-defined chamber called air spring, made up of rubber bellow & emergency rubber spring, provides various suspension characteristics including damping. Air springs are height-controlled load leveling suspension devices. With changing loads, air spring reacts initially by changing the distance between air spring support and vehicle body. The height monitoring valve (called levelling valve) is in turn actuated, either taking the compressed air pressure to the air spring or releasing air pressure from it to the atmosphere. Air spring installation height is specified 289mm to 294mm for LHB coaches with FIAT bogie. This process continues until the original height is restored. This mechanism ensures

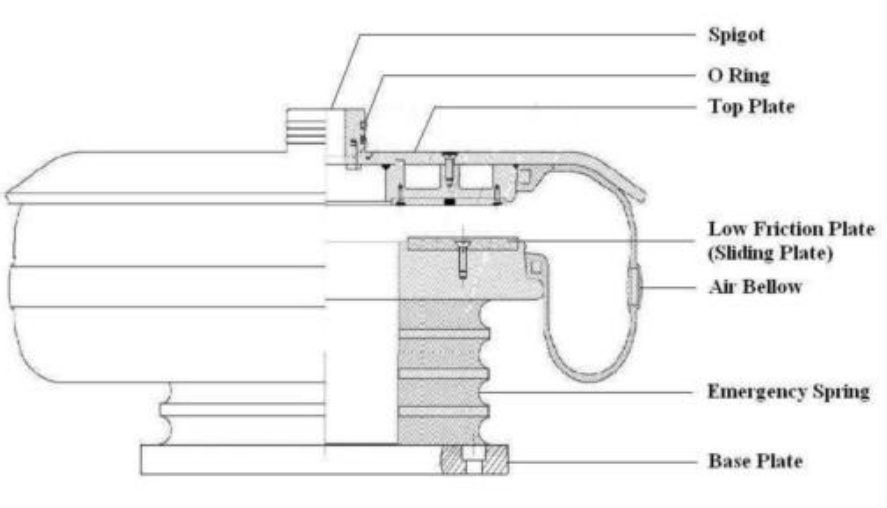
a constant floor height on coaches provided with air springs, irrespective of the load. This greatly reduces problems associated with low buffer / coupler heights.

Construction Details:

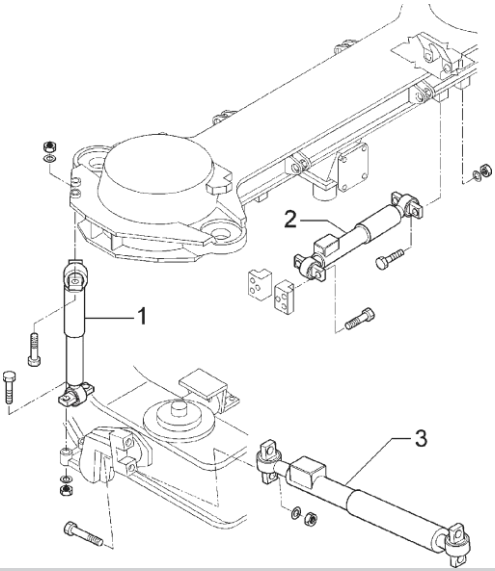
Construction details of air spring are shown in Fig. below (air spring with internal emergency spring) and (air spring with external emergency spring).



Air Spring Assembly with Internal Emergency Spring



Air Spring Assembly with External Emergency Spring



1. Vertical damper 2. Lateral damper 3. Yaw damper

Figure 13.24 Secondary Suspension – Dampers Arrangement

The Traction Centre **(Figure 13.27)** transmits traction and braking forces between bogie frame and body by a traction lever, on the bolster beam pin, and two rods. The traction lever is connected to the bolster beam by means of a rubber bush, and plates, while rods are connected to the bogie frame and to the traction lever by elastic joints. Traction Centre Rubber Bush and Ball Joint are to be examined for physical condition, crack, and detachment during maintenance.

The bogie is provided with a device for limiting the longitudinal and lateral displacement of the bolster beam, made by four bump stops **(Figure 13.28)**, two longitudinal and two lateral. Rubber elements in the Bump Stops are to be inspected for physical damage. During maintenance, Lateral Bump Stop is to be replaced if L becomes less than 30 mm (refer **Figure 13.29)**. Its Load – deflection curve must be within specified limits.

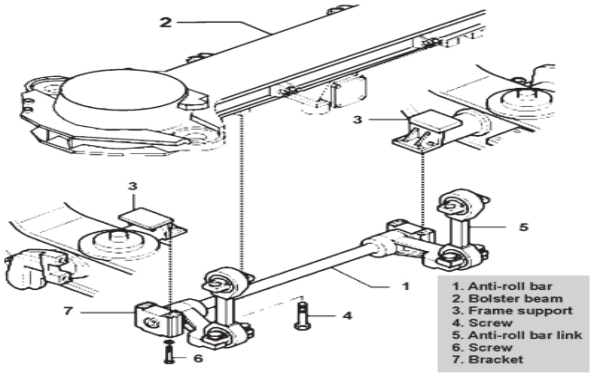


Figure 13.25 Anti – Roll Bar Arrangement

A photograph of Anti-roll bar and Traction Centre arrangement in the bogie is shown in **Figure 13.26**

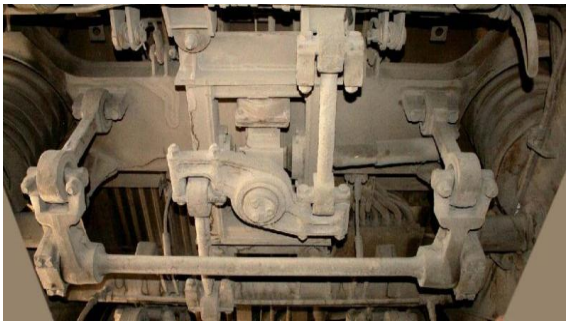


Fig. 13.26 Anti-roll Bar and Traction Centre

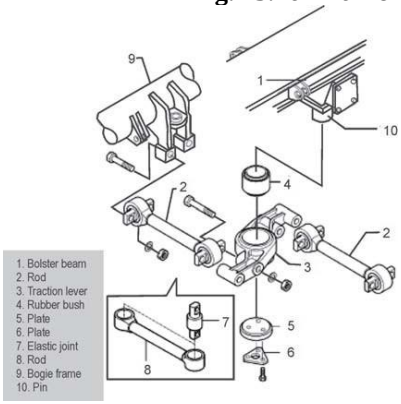


Figure 13.27 Traction Centre

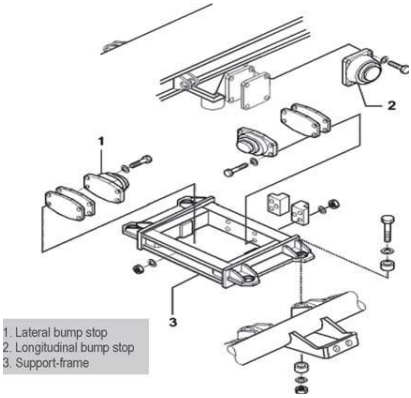


Fig. 13.28 Bump Stop Arrangement

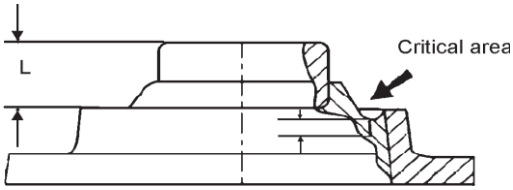


Fig. 13.29 Damage to Lateral Bump Stop

13.11 Comparison of Bogies

A comparison among these passenger bogies is given in the following table 13.6.

Table 13.6

Comparison among FIAT, ICF all coil & IR-20 bogies

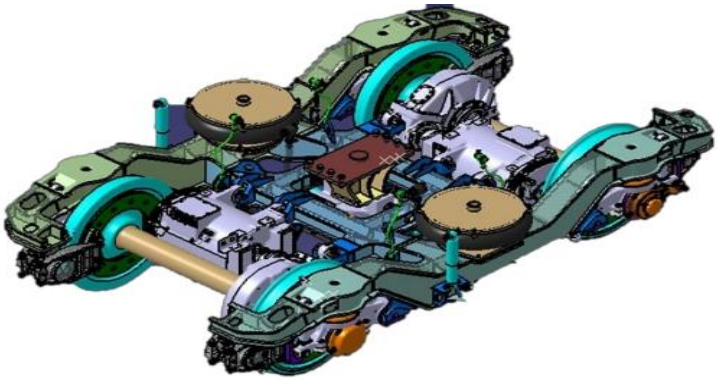
Features	FIAT	ICF all coil	IR-20
Speed Potential	160 km/h	140 km/h	160 km/h
Ride Index (max.)	2.75 at 180km/h	3.5 at 140km/h	3.0 at 160km/h
Weight (t)	6.5	5.72 (13t) 6.5 (16.25t)	6.8
Wheelbase (mm)	2560	2896	2440
Wheel dia. (mm)	915	915	890
Axle box guidance	Articulated	Rigid	Articulated
Dampers-Primary	Hydraulic	Dashpot	Hydraulic
Bogie frame	Without headstock	With headstock	Without headstock
Brake	Disc	Conventional	Disc
Bearing	Tapered	Spherical	Tapered

Vande Bharat Coaches

Train-18 is 16 car formation with 4 basic units i.e. two number of end basic units (DTC-MC-TC-MC2) and two number of middle basic units (NDTC-MC-TC-MC2) Ø All power components such as Line & Traction converters, Auxiliary converter, Air Compressor, Battery box, Battery charger, Brake chopper resistor are mounted under the frame Ø Electronics is distributed across all the coaches.

Technical details:

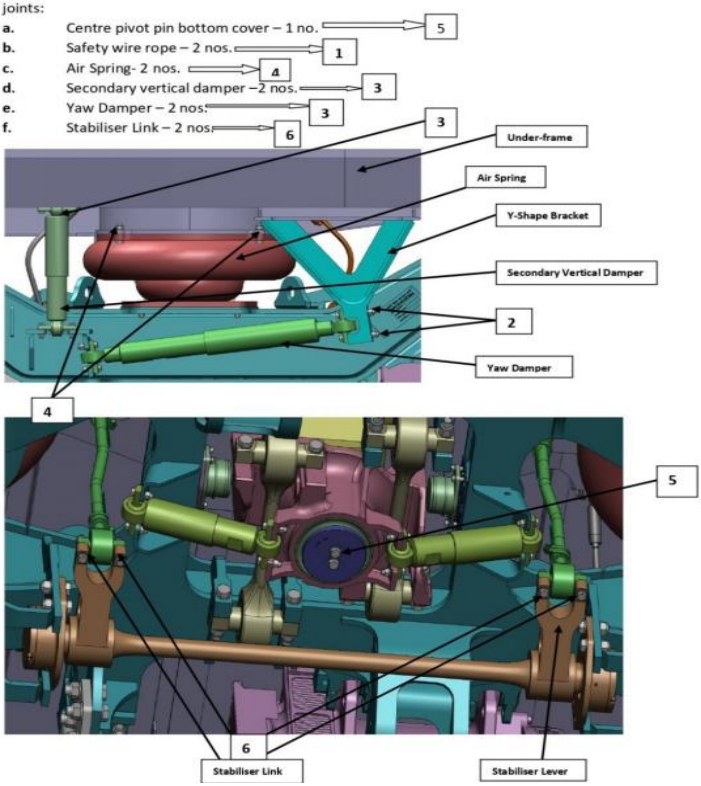
Description	Value
Track gauge	1,676 mm
Distance between center pivots	14900 mm
Speed Max.	160 km/h
Length of car-body (Over Coupler)	24000 mm
Width of car-body	3240 mm
Car height above top of rail	4140 mm
Wheels	952 mm dia.



Motor Coach Bogie for Vande Bharat Coach

Under-frame and Bogie are connected with each other through following mechanical links and joints:

a. Centre pivot pin bottom cover – 1 no.
b. Safety wire rope – 2 nos.
c. Air Spring- 2 nos.
d. Secondary vertical damper –2 nos.
e. Yaw Damper – 2 nos.
f. Stabiliser Link – 2 nos.



Mechanical links and bogie components

UNDERSTANDING FREIGHT STOCK
(Wagons)

14

The rolling stock involved in accident must be inspected in the presence of nominated team of supervisors and results should be recorded in the prescribed format.

The main items of inspection are as under:

14.1 Wheel Gauge

Wheel gauge is the distance between inside faces of the flange on the right and left side wheels of an axle (Fig. 10.1). There should be no variation in the values of wheel gauge - measured at four points 90 degrees apart on a wheel set. However, the actual value of the wheel gauge can vary as per - tolerances given in Table 10.1 (IRCA Part III Para. 2.8.7):

Table 10.1

	B.G.	M.G.
Standard	1600mm	930mm
Maximum	1602mm	932mm
Minimum	1599mm	929mm

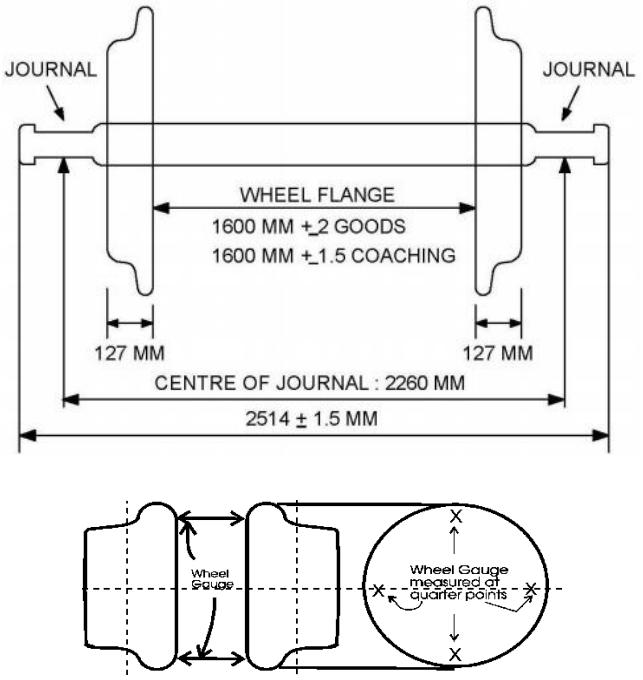


Fig. 14.1 Measurement of Wheel Gauge

The wheels are required to be gauged at three or four - quarters (as per possibility) and recorded duly indicating the following:

1. Tightness or slackness of gauge
2. Whether any indication exists about shifting of wheel on the axle.

Note: It must be ensured that the back surface of wheels is cleaned thoroughly before measuring the wheel gauge to avoid erroneous readings.

If the wheel gauge is more than permissible limit, there exists a possibility of a relatively newer wheel hitting the nose of crossing. This happens because the wheel gauge is one of the parameters affecting the clearance at check rail opposite the nose of crossing.

If the wheel gauge is less than minimum value, there is a possibility of wheel hitting at the back of a tongue rail while passing through the switch and thus damaging the tongue rail.

The variation in wheel gauge after lowering the coach body on wheels was examined by RDSO Lucknow and circulated to all

Railways vide their letter no. MC/WA/GENL Dated 27.6.88 as follows:

> "The question of variation in the wheel gauge under no-load and loaded condition has been examined by RDSO. The calculations for the 15-ton BG axle under tare load condition indicates that a variation of about 3 mm in the wheel gauge when measured at the top and bottom locations in the vertical plane is likely to take place due to bending of axle under coach load.
>
> This variation in wheel gauge under loaded condition, however, has no bearing on the safety of coach operation. However, if the measurements for wheel gauge are done in horizontal plane passing through the axle, then the effect of bending of the axle will not be there.
>
> It is therefore clarified that the wheel gauge tolerances of 1600+2/-1 mm as laid down in IRCA rule book is required to be checked under "No-load" conditions.

14.2 Bent Axle

A bent axle starts wobbling during motion causing severe vibrations. In order to confirm whether an axle is bent or not, it must be checked carefully on a sensitive machine or measuring table.

14.3 Tyre Profile

The outer periphery of a wheel which comes in contact with the rail is known as **tyre profile**. The standard tyre profile of B.G. is shown in the Fig. 14.2.

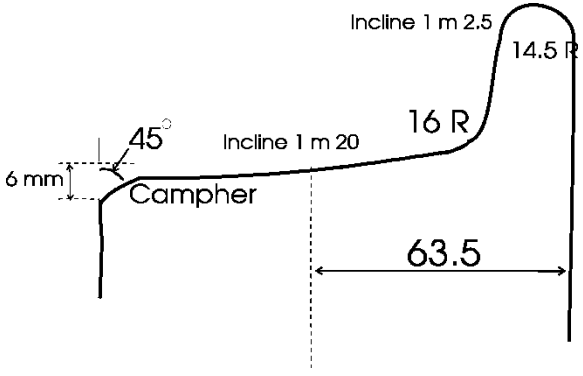


Fig. 14.2 Tyre Profile of a new Wheel

The important features of the tyre profile are as under:

A chamfer of 6 mm at 45 degrees on outer edge. This is provided to avoid sharp edges and also prevent small burs (chips of metal) projecting beyond the outer surface of wheel due to spreading of small thin layer on outer periphery of the tyre.

An upward inclination of 1 in 20 towards inside. It is provided to ensure that the wheels remain in central position of the track and allows the outer wheel to travel on the higher tread diameter and inner wheel on a smaller wheel diameter on curves.

14.4 Route radius:

A root radius is provided at the bottom of the flange. This radius for B.G. is 15 mm.

14.5 Height of wheel flange:

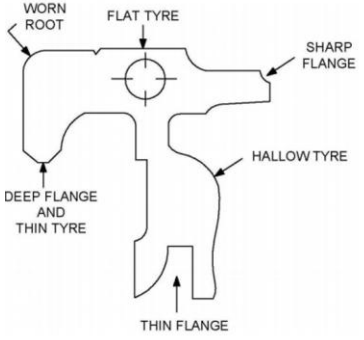
The height of wheel flange is measured from the tread of the tyre. It is kept 28.5 mm for B.G. This height also forms an important part in determining the tyre profile.

14.6 Wheel Defects

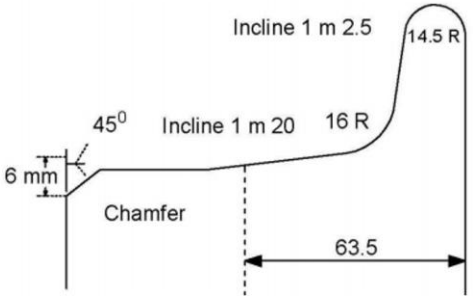
The following aspects should be checked on the suspected wheels:

1. Condemning limit
2. Flat places on tyre/skidding
3. Flanges - sharp/deep/thin
4. Radius too small at the root of the flange
5. Gauge slack/tight.
6. Cracks

The above-mentioned defects can be detected with the help of **Tyre defect gauge** and **Wheel gauge** meant for this purpose.



TYRE DEFECT GAUGE



STANDARD DIMENSION OF WHEEL

14.7 Thin Flange

When the flange thickness reduces to less than 16 mm for B.G., the flange is called a thin flange. It should be measured at the distance of 13mm below the flange tip (Fig.14.3).

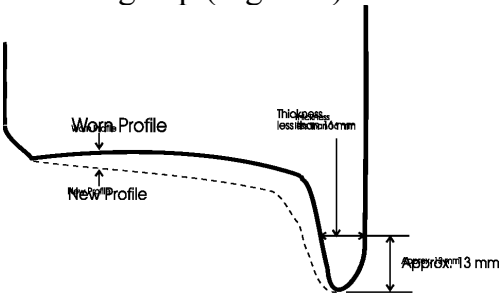


Fig. 14.3 Thin Flange

A thin flange increases lateral play between the wheel set and track and increases:

1. Lateral oscillations adversely affecting Y/Q and
2. Angularity of wheel set on run

14.8 Sharp Flange

This occurs when the flange wears in such a way that radius at the tip of the flange becomes less than 5 mm. The flange forms a fine sharp edge. Due to this, the wheel set can take two roads at slightly gaping point or wheel may ride over the chipped tongue rail (Fig 14.4).

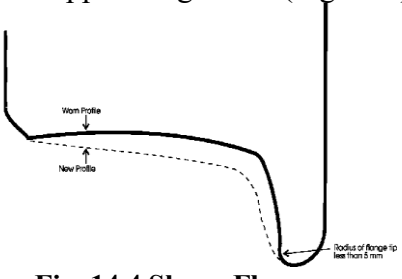


Fig. 14.4 Sharp Flange

14.9 Worn Out Flange

When radius at the root of the flange becomes less than 13 mm, it is called worn out flange. A worn-out flange increases the value of (Fig.14.5)

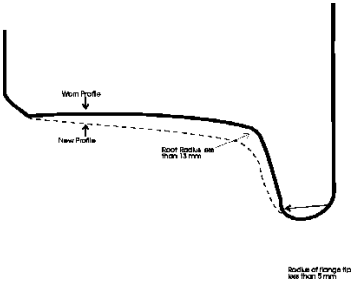


Fig. 14.5 Worn out Flange.

14.10 Deep Flange

When the depth of flange, measured from the flange top to a point on the wheel tread (63.5 mm away from the back of B.G. wheel), becomes greater than 35 mm, it is called a deep flange (35-28.5=6.5 mm) as shown in Fig. 14.6. Under this condition, the wheel flange would tend to ride on the fish plate and check-block and may damage the track components.

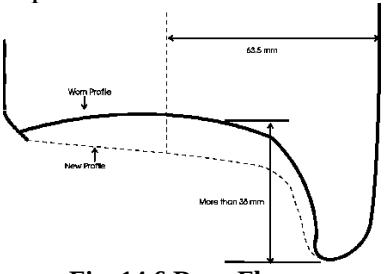


Fig. 14.6 Deep Flange

14.11 False flange/Hollow Tyre

When the projection of outer edge of the wheel tread below the hollow of the tyre exceeds 5 mm, the outer edge of the wheel forms a false flange, and the worn tread is called **hollow tyre** (Fig. 14.7).

The hollow tyre has the danger of developing a false flange. There is no effect on angularity or eccentricity but wear on tyres has the effect of increasing the conicity of the wheel tyre. This reduces the critical speed of the rolling stock beyond which excessive hunting and oscillations take place thereby - increasing the flange force 'Y' and the chances of derailment.

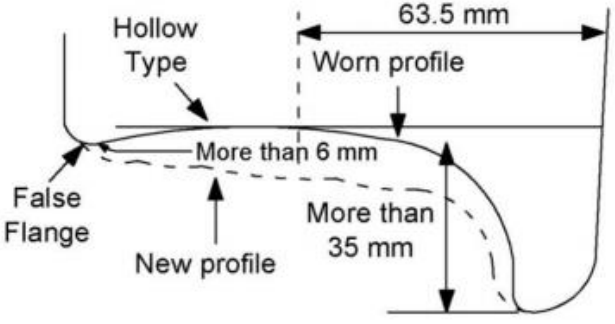


Fig. 14.7 False Flange/Hollow Tyre

A false flange may split open the points while travelling in trailing direction while negotiating the crossing (Fig.14.8). It may tend to get wedged in between the tongue rail and the stock rail.

The wheel going across the wing rail would then get lifted as instead of travelling on the tread portion, it would be travelling on the false flange. This will make the wheel to suddenly lift up and drop down near the nose of the crossing.

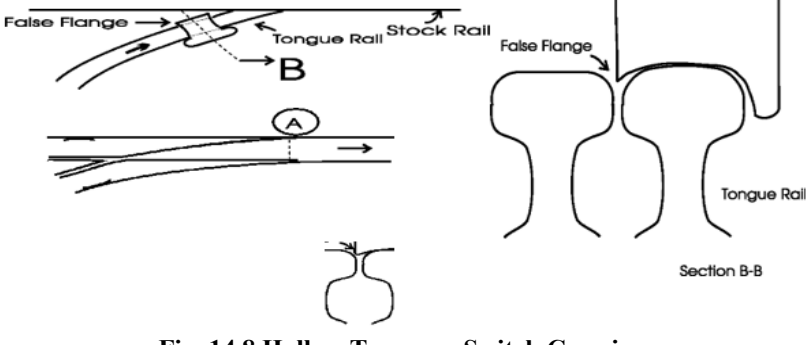


Fig. 14.8 Hollow Tyre on a Switch Crossing

14.12 False Flange

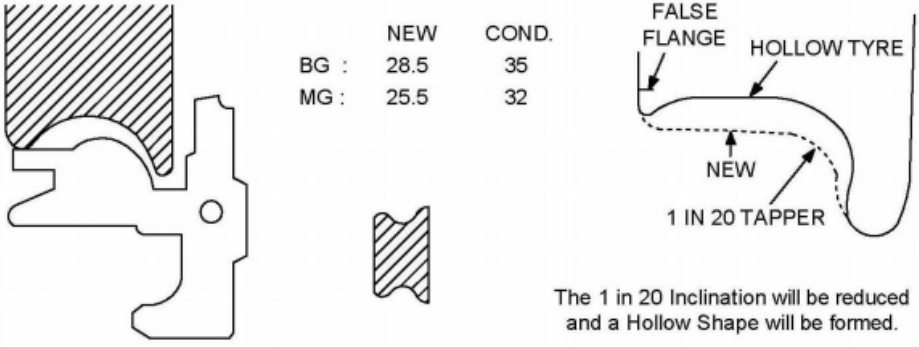
Wheels having flats on tyre damage the rails due to impact and cause high contact stresses. This may cause rail fracture leading to derailments.

Excessively worn-out tyre on tread is a hallow tyre and have developed 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. Thus, lifting the wheels and creating conditions favourable to derailment.

The 1 in 20 inclinations will be reduced and a Hollow shape will be formed. If the Hollowness is more than 5 mm with Hollow tyre, then it results in difference of wheel dia. with +ve angularity and the wheel may ride over the rails.



If the Hollowness is more than 5mm with hollow tyre, then it results in difference in wheel dia. with +ve angularity and the wheel may ride over the rails.

14.13 Thin Flange:

When the flange thickness reduces to less than 16 mm for BG, the flange is called a thin flange. It should be measured at the distance of 13 mm below the flange tip.

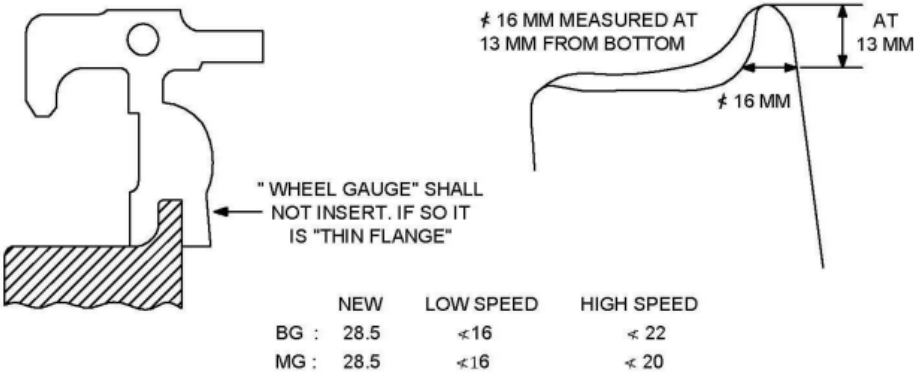
A thin flange increases lateral play between the wheel set and track and increases.

1. Lateral oscillations adversely affecting Y/Q and
2. Angularity of wheel set on run

a) Flange becomes thin by wear and tear of the tyre and flange and becomes unsafe when it is less than 16 mm.
b) This increases clearance between wheel flange and rail, which increases the derailment prone-ness.
c) Oscillations increase due to greater play between wheel set and track resulting in greater in-stability of the vehicle.
d) Angularity of the axle increases.
e) Rejection limit is 16 mm BG/MG measured at 13 mm from the

flange tip.

f) It also damages tongue rails due to less gap and more play.

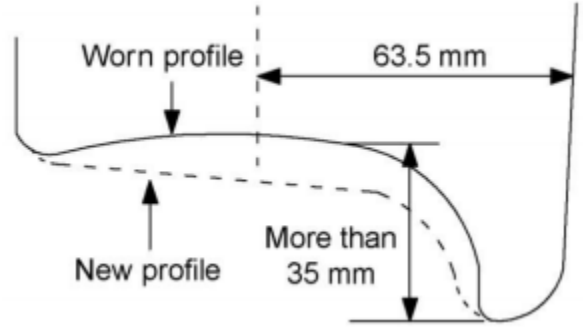


	NEW	LOW SPEED	HIGH SPEED
BG :	28.5	≮16	≮ 22
MG :	28.5	≮16	≮ 20

14.14 Deep Flange:

When the depth of flange, measured from the flange top to a point on the wheel tread (63.5 mm away from the back of B.G. wheel), becomes greater than 35 mm, it is called a deep flange (35 - 28.5 = 6.5 mm).

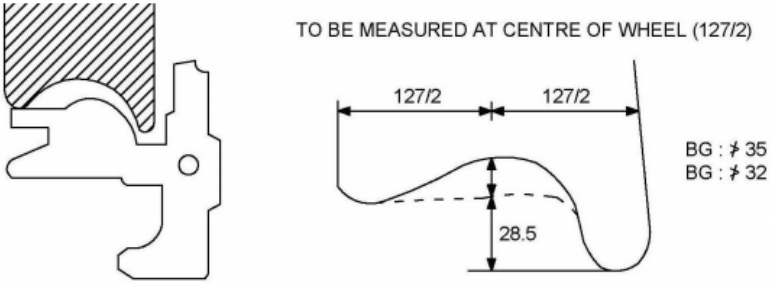
Under this condition, the wheel flange would tend to ride on the fish plate and check-block and may damage the track components.



Deep flange may hit track fittings like fishplate joints, lock bars, point and distance blocks.

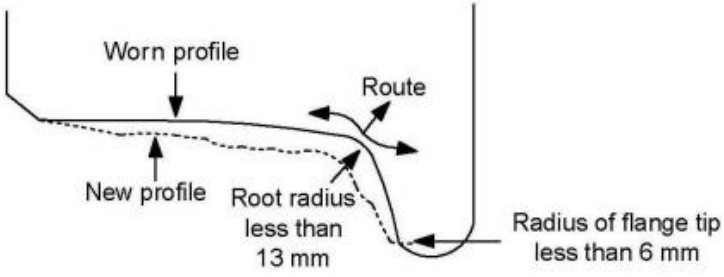
A deep flange tends to ride on fishplate and distant or check blocks and damage the track, particularly if there is vertical wear on railhead.

Rejection limit in depth of flange greater than 35mm (BG), 32mm (MG) measured at 63.5 for BG and 57 mm for MG away from back of wheel.



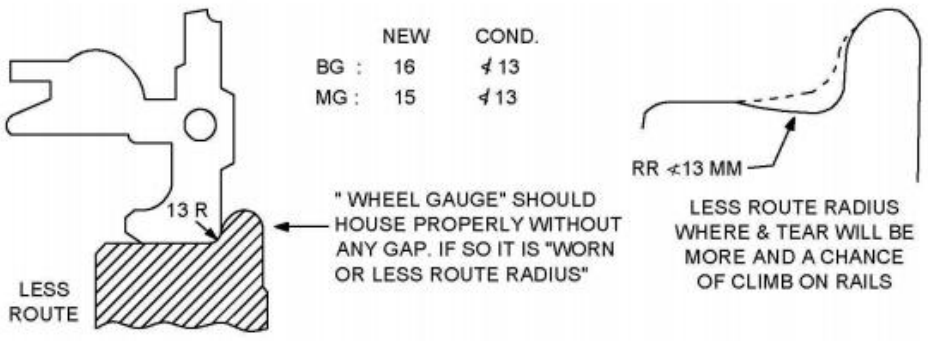
14.15 Worn Out Flange:

When radius at the root of the flange becomes less than 13 mm, it is called worn out flange.



When the radius of the root of the tyre is excessively worn and radius at root of flange is less than 15 mm then it is called worn root, and it may contribute to unsafe condition.

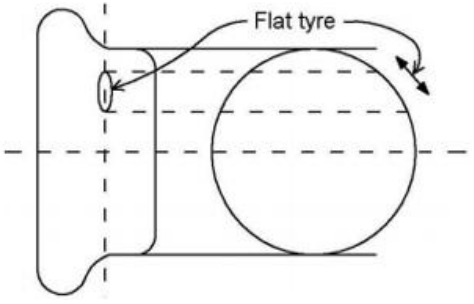
Worn-out Root increases the flange angle and increases the derailment proneness. Rejection limit is to get radius of the root curve between the thread and flange.



14.16 Flat Places on Tyre

The maximum permissible value of flatness on BG wheel tyres is as under:

a) Goods stock IRS - 60 mm
b) Coaching stock - 50 mm
c) FLAT TYRE∢

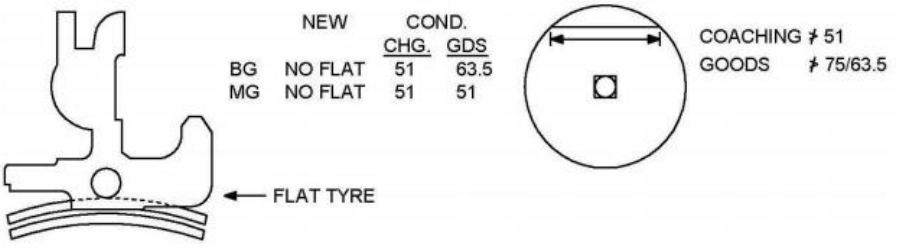


This may cause rail fracture leading to derailments.

Flat Type/Skidded Wheel

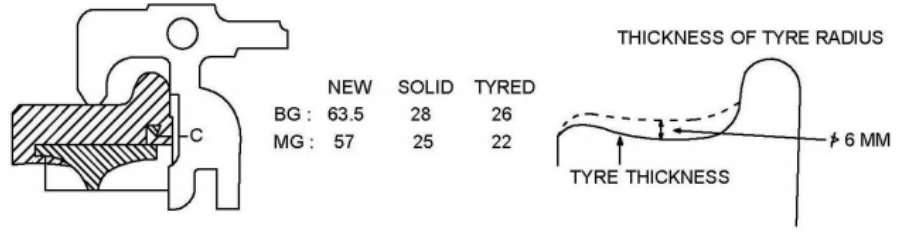
It may occur due to continuous brake binding, skidding, and brake block tilting and jamming against the tyre.

a) Flat of more than 2" (MG), 3" BG will cause passenger discomfort and may become unsafe.
b) Flat tyre causes greater hammering action on the rail/rail fractures.
c) Rejection limit is 75 mm (goods stock), 51 mm ( ) MG all stock = 51 mm.

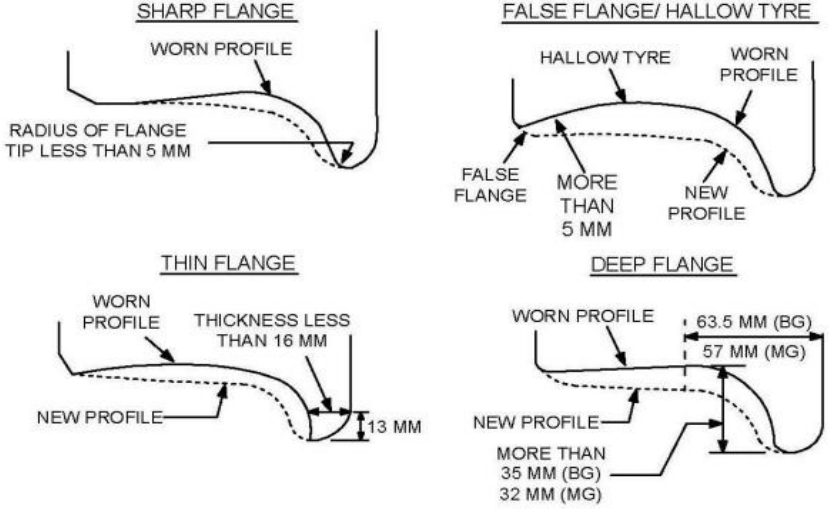


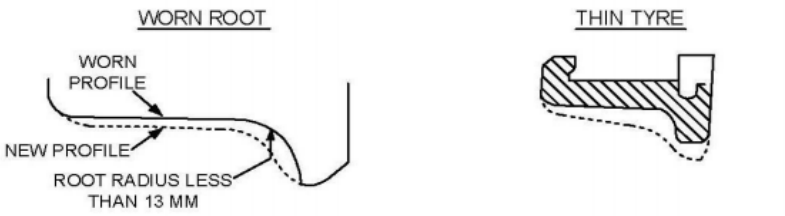
14.17 Thin Tyre

(a) When Thickness of the Tyre has gone below condemning size, there is a chance of bursting/ cracking of tyre throughout the periphery, resulting in derailment.

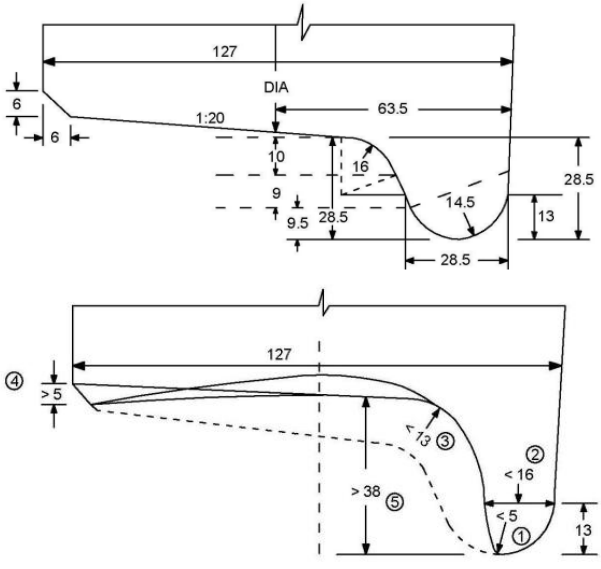


Different Shapes of Wheels with Defects



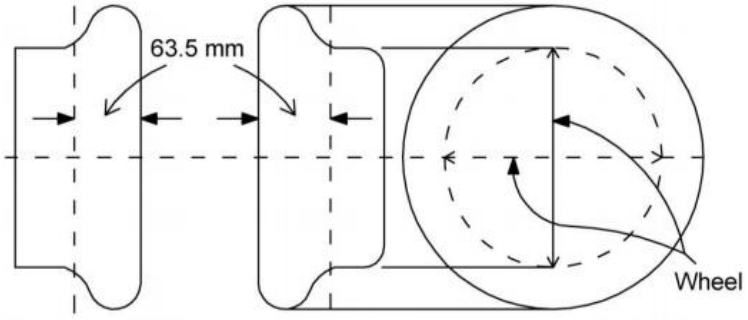


Sharp Flange**:**	Radius < 5 mm
Thin Flange**:**	Thickness < 16 mm
Worn Root**:**	Root Radius < 13mm
Deep Flange**:**	> 35 mm
False Flange**:**	> 5 mm



14.18 Difference of Wheel Diameter on Tread

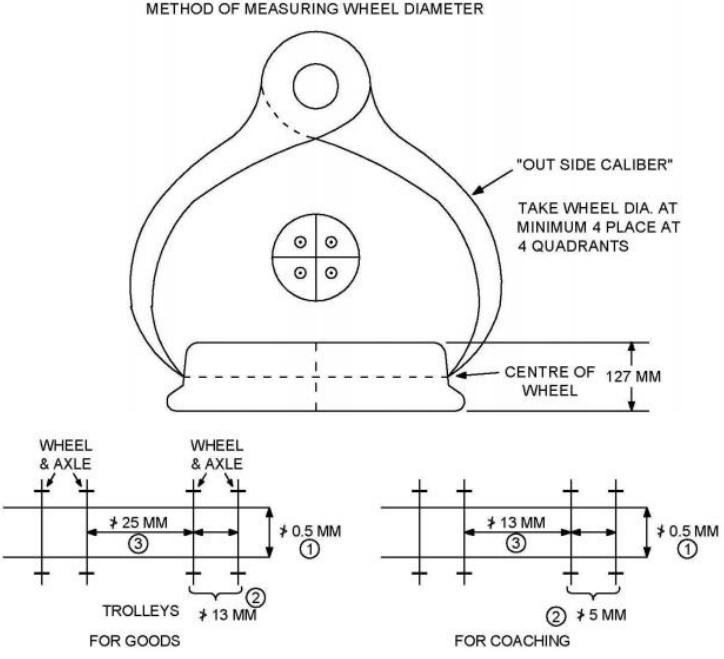
Wheel diameter is measured on the Tread at a distance of 63.5 mm from the inside face of the wheel in case of B.G. Two measurements 180 degree apart should be taken for each wheel.



The limit of variation of wheel diameters on the same axle during service is 1.5 maximum, vide Rly. Bd. letter No.86/M/(N)/960/8 Dated. 22-8-86.

The workshop leaving limits for the difference in dia. Workshop leaving limits for wheel Diameter on BG (All Dimension in mm)

Type of Wagon/Trolley	On same Axle	On same trolley	On same wagon
Four Wheeled Trolleys	0.5	13	13
Six Wheeled Trolleys	0.5	6	6
Six Wheeled Units	0.5	6	6
Four Wheeled Units	0.5	6	6



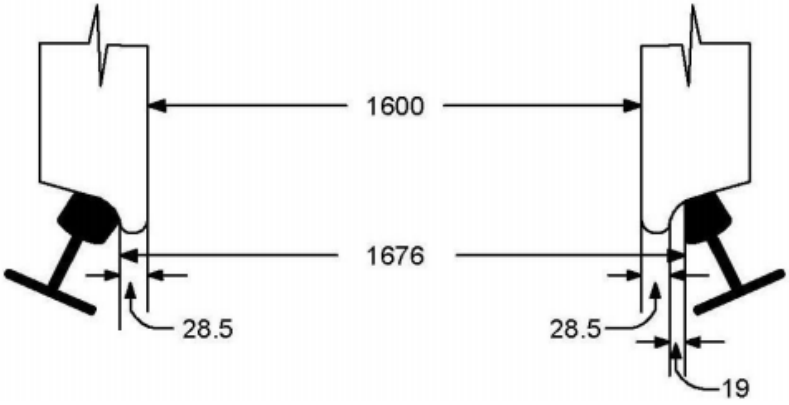
Type	Type of Wagon	Wheel Diameter in mm		Variation in Wheel Diameter in mm	
		New	Cond.	Within Trolley	On Coach / Wagon
Coaching	ICF coach	915	813	5	13
Goods	BEML coach	914	812	5	13
	IRS Wagon	1090	990	13	25
	CRC Wagon	1000	860	-	25
	BOXN/BCN	1000	906	13	25

Difference of wheel diameter between wheels of	Goods	Coaching
Same axle	0.5 mm	0.5 mm
Two adjacent axles of the same trolley	13 mm	05 mm
Different trolleys of the Bogies	25 mm	13 mm

Due to difference in wheel dia., there will be angular motion of the wheels.

1. Wheel with Less dia. will have positive angularity motion and will mount over rails and derail.
2. Wheel with more dia. will have negative angularity motion will increase wear and tear.

14.19 Effect of Play between Wheel Set & Track



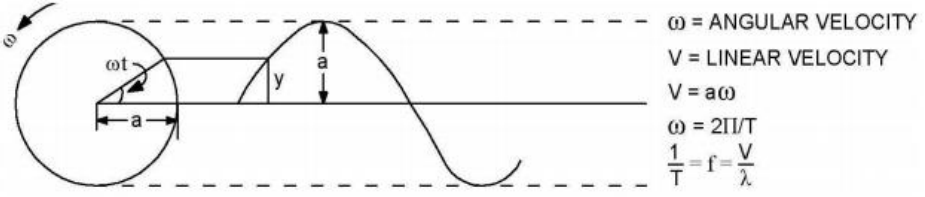
Wheel Flange Depth 28.5 mm can go up to 32 mm (Due to wear & Tear)

a) Standard Play = 19 mm
b) This will increase with wear of wheel flange & wear of rail.

c) With max. worn wheel flange, the play becomes 2 × 12.5 + 19 = 44 mm
d) Amplitude of lateral oscillation = 44/2 = 22 mm
e) As against 9.5 mm with standard play.

The lateral Acceleration & Y would increase in direct proportion. With slack gauge effect would be enhanced increase in play.

a) Increases lateral & vertical acceleration.
b) Increases flange force and
c) Decreases speed potential.



dy / dt = a ω cost ωt. = lateral velocity at time T lateral acceleration.

Wheel Defects and Parameters
All measurements in mm
Dotted lines**:** new profile. Full line**:** worn out profile.

14.20 Flat Places on Tyre

The maximum permissible value of flatness on B.G. wheel tyres is as under (Fig. 14.9):

- Goods Stock - 60 mm
- Coaching Stock – 50 mm

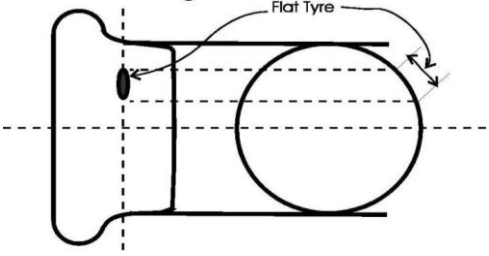


Fig. 14.9 Flat Tyre

14.21 Difference of Wheel Diameter on Tread

Wheel diameter is measured on the tread at 66.5 **mm from the outer face of the rim** in case of B.G. (Fig. 14.10) **(Railway Board Letter No. 92/M(C)/137/2 Vol. V dated 25.01.2011)** and 57 mm in case of M.G. Two measurements 180

degrees apart should be taken for each wheel.

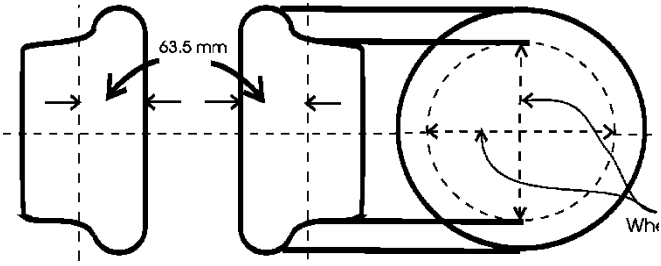


Fig. 14.10 Measuring Wheel diameter

Limits of wheel diameter variation on the same axle

The workshop leaving limits for the difference in diameter are indicated in Table 14.2.

Table 14.2 Workshop Leaving Limits for Wheel Diameter

Type of Wagon/Trolley	On the same Axle		On the same Axle		On the same Axle	
	BG	MG	BG	MG	BG	MG
Four Wheeled Trolley	0.5	0.5	13	10	13	10
Six wheeled Trolleys	0.5	0.5	6	6	6	6
Six wheeled units	0.5	0.5	6	6	6	6
Four wheeled units	0.5	0.5	- -	- -	25	13
BLC Wagon	0.5		5		13	

These limits of variations as prescribed in Rule No. 2.8.14.2 IRCA Part III and Rule No. 2.9.4 IRCA Part IV are to be observed at the time of fitment of freshly reprofiled wheels during periodic overhaul in workshops and repairs requiring wheel changing in sick lines. These limits do not form a part of train examination. The rejection of wheels worn beyond service limits will continue to be determined by the normal wear limits specified in IRCA Rules (Rly. Bd. letter No. 86/M(N)960/8 DATED 22.8.86).

Axle Box

(a) Bearing

(i) Plain Bearing

(ii) Roller Bearing.

(b) Play of Bearings at Journal



	Trolley	4 Wheels
BG	5mm -10mm	5mm-10mm
MG	3mm-6mm	3mm-10mm

If the play is excessive,
(i) Lateral oscillations will increase
(ii) Angularity of the axle increases
In General, in axle boxes there shall be
(i) No cracks,
(ii) No breakages,
(iii) No hot axle,
(iv) All rivets should be intact.

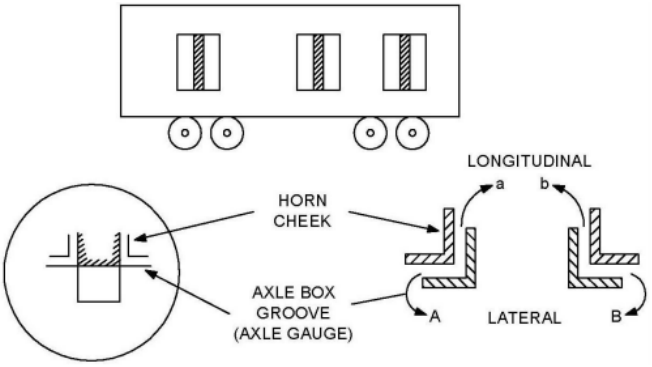
(c) Clearance between Axle Box Groove and Axle Ground (Horn Cheek)

Lateral Clearance

Goods & Coaching Bogies & 4 wheels	6 mm 10 mm (BG & MG)
Box Wagons	20 mm 25 mm (BG & MG)

Longitudinal Clearance

Coaching Bogies & 4 Wheels	3 mm 10 mm (BG & MG)
Goods Stock	Not specified but should be in good condition
Box wagons	12 mm 18 mm (BG & MG)



a + b should be between 12 -18 mm (or) 3 + 10 mm

A + B should be between 20 - 25mm (or) 12 - 18 mm

Horn Cheek is attached to the carriage frame axle guard is attached to the axle box.

(d) Spring Gear

(i) Leaf/Laminated Bearings

(Provided for CRC/BOX/BCX/BCXT/BRH/IRS wagons & 4 wheeler Tanks)

(ii) Helical springs

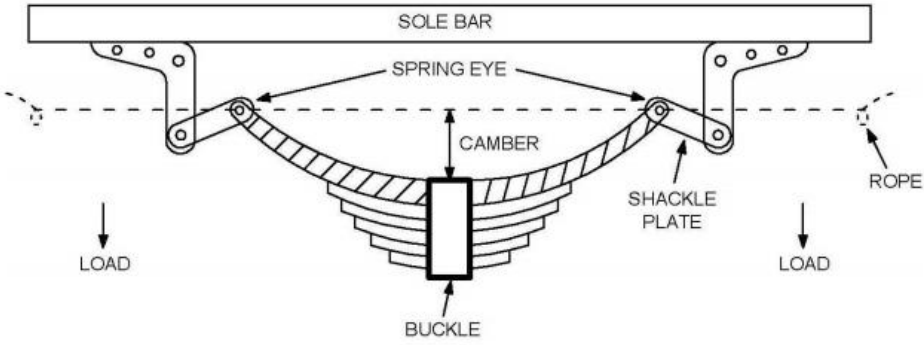
(Provided for all coaching, BOXN, BCN, BCRH)

(e) Leaf/Laminated Bearing Springs

Camber: It is the vertical distance between ropes drawn through centre of spring

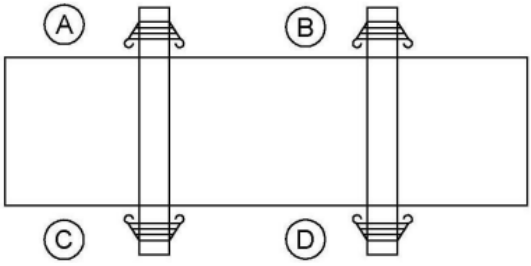
eyes and top of the buckle.

Free Camber: The distance measured when the spring is on the ground and new and not mounted. It shall be 58 mm.



The Tolerances allowed are:	
For Loco & Carriage:	0 + 3
Goods Stock BG:	0 + 6
Goods Stock MG:	0 + 5

Working Camber, the distance measured when the spring is mounted on the vehicle and with full load shall be 47 mm. Also the difference between free camber and working camber measured between any 2 springs out of 4 fitted on the vehicle shall not be more than 13mm.



Difference of Free camber and working camber between any two springs -13 mm

Working camber can be measured as it is free camber can be measured after releasing the springs.

Spring and spring gear Defects – Rejections

Goods and Coaching stock (BG and MG)

There shall not be any damage to the spring gear or to any part of it. Spring eye, shackle plate shall not touch the bottom of sole bar even with load or even while running check-up for any marks below the

sole bar. All the springs should be intact, and they shall not be shifted.

(i) Any plate of a laminated bearing spring or any coiled bearing spring cracked or broken. Bearing spring buckle loose, broken and cracked and/or packing plate loose or deficient.

(ii) Any plate or buckle loose and/or displaced from its central position by 13 mm or more.

(iii) Bearing spring buckle not sitting square in the axle box housing or crown packing where fitted.

(iv) Flange of any wheel within 25 mm of the bottom of a wagon. Incorrect type of bearing spring for the particular design of wagon. Scroll iron fractured, deficient of a rivet or fitted with a loose or wrong size rivet. Scroll iron shifted or out of alignment by more than 25 mm.

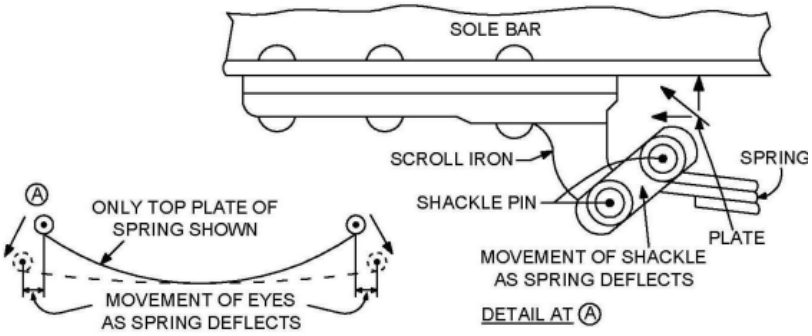
(v) Shackle or pin cracked, deficient, broken or of wrong size. Bearing spring hanger cracked or broken or nut or jib cotter deficient or detective. Bearing spring shackle pin not fitted with a split cotter.

(vi) On Meter Gauge wagon bearing spring shoe fractured or with a rivet, bolt or stud broken or deficient or bolt or stud of wrong size.

(vii) Bearing spring eye or shackle plate touching the sole bar (in static or dynamic condition).

(viii) This defect in dynamic condition can be confirmed by the presence of rubbing marks at the bottom surface of the sole bar. When a laminated spring deflects, it elongates, thereby causing the shackle plate to move up.

(ix) Thus, if movement of shackle plate is prevented, it in effect, prevents the deflection of the spring and renders it ineffective and hence derailment prone.



Under load spring eyes move outwards. For such movement of spring eye to be possible, shackle plate has to move, arcing outwards which results in vertical component of movement.

(f) Helical spring

Common Defects

(i) No crack or no breakage

(ii) Springs shall be intact and not shifted

(iii) It shall have spring action and not fully compressed

(iv) It should not lose its elasticity.

Axle Box Lateral and Longitudinal Clearances

Lateral Play between B/Brass & Journal collar.

Minimum - 5 mm; Maximum. - 10 mm

Total lateral clearance between Axle guard and Axle box grove- 10 mm max.

Lateral longitudinal clearance between axle box lug and horn cheek for box type trolly:

	Lateral	Longitudinal
Minimum. Maximum.	20 mm 25 mm	12 mm

Due to spring suspension, the lateral motion induced by track irregularities is dampened. Experiments have established that the lateral force due to hunting is much higher for a vehicle beyond above clearances. On the other hand, below minimum limits given above, freedom of wheels during run gets restricted beyond desirable limits.

Bent axle guards will not be able to move up and down freely and the axle

box will get jammed making spring assembly ineffective thus increasing proneness to derailment.

14.22 Buffing Gear

Buffer projection limits from head stock

	For long case buffers	for short case buffers
Max.	635 mm	456 mm
Min.	584 mm	406 mm

A. Buffer projection for POH stock should not be less than 625 mm for long case and 445 mm for short case buffers.
B. No dead buffers shall be permitted from the sick line. The buffers shall be considered dead when the projection is below the prescribed minimum Limits.
C. Buffer heights in BG Stock shall be within the limits shown above and it should be measured on level track.

Note: The measurement should be taken from the centre of the buffer socket to the top of the rail head. The buffer height should never be taken from the centre of the buffer face because it will not give correct value.

While recording buffer height, it should be ensured that buffer bolts are in tight condition and buffer is not drooping. If it is drooping, the amount of drooping should be measured and recorded.

To make up buffer heights to maximum permissible limits, a packing piece of required design and size may be inserted:

For Goods stock: between axle box crown & bearing spring buckles.

For ICF coaching stock: between lower spring (Dash Pot Spring) & axle box wing.

Common Defects

Buffer should be rigidly fitted. The height of buffer changes due to wear and tear of wheel set and whenever wheel set is replaced to maintain the height, packing pieces are provided. If the packing piece is missing, then the height of buffer will get change and there by the buffers of adjacent vehicles may get entangle or CBC coupling may get disconnect resulting in derailment.

Displaced Buffer

If Buffer displaced 35 mm in any direction from its normal position in case of goods stock and 38 mm for coaching stock are called displaced buffers.

If buffers of adjacent stock are not in the same level due to different conditions of loading or spring characteristics, the buffer draw gear takes an inclined position.

In case of sag on the track or brake application on a down gradient, the buffers exert compressive forces. It makes the lighter vehicle prone to derailment due to lifting because of vertical component of the - buffing force.

14.23 Spring and Spring Gear

In four-wheeler stock, laminated springs are normally used. However, in coaches now, mostly coil springs are used.

The defects in these can be classified into three main categories:

Defects affecting the functioning of springs.

If the defects are such that normal functioning gets hampered, the load transmission system is adversely affected. The wheel on which this spring bears can't adjust itself to any unevenness in the track and the wheel will become prone to derailment due to lack of dampening force.

Variation in performance of different springs on the same vehicle

The difference in working camber amongst the four springs under load should not exceed 13 mm. The springs having different cambers may cause derailment due to offloading effect.

Failure of springs

Failure of a spring may cause derailment as it results in loss of damping effect and shifts the centre of gravity of the vehicle.

Design Characteristics of Springs

TABLE 14.3 - B.G. WAGON HELICAL SPRINGS

Type of Rolling Stock, Drawing no. & location of spring	Free Height	Outer Dia.	Solid Height
CASNUB 22W - Drg. No. WD-83069/S-1			
Outer Spring	260 +/- 3	140	167.5
Inner Spring	262 +/- 3	86	168
Snubber Spring	294 +/- 3	98	165
CASNUB 22W HS - Drg No. WD-92058-S-5			
Outer Spring	260 +/- 3	147	137
Inner Spring	243 +/- 3	180	88
Snubber Spring	293 +/- 3	171	104

TABLE 14.4- B.G. WAGON LAMINATED SPRINGS

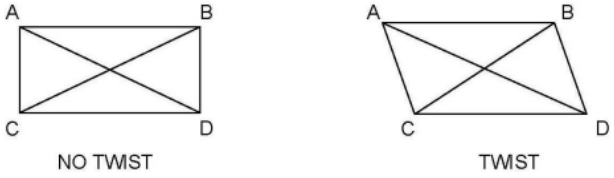
Type of Rolling Stock	Drawing No.	Free camber	No. of plates
BOX, BCX, BRH	**WD-86007-S/1**	47 +6/-0	10
CRT	**WD-87024-S/1**	58 +6/-0	9

TABLE - B.G. COACH HELICAL SPRINGS

Drawing No.	**Free Height**	**Test Load**	**Acceptable height under load**
ICF, RCF & BEML AXLE			
F-0-1-006	360	2000	279-295
WTAC-0-1-202	375	2800	264-282
WLRRM8-0-1-802	360	3000	277-293
RDSO/SK-84262	325	1600	278-291
WLRRM2-0-1202	372	3000	265-282
DL-0-1-002	372	3000	269-284
DD-0-1-001	337	2400	268-284
RDSO/SK-98017	315	1800	276-289
ICF, RCF & B	**EML B**	**LSTER**	
F-0-5-002	385	3300	301-317
WTAC-0-5-202	400	4800	291-308
WLRRM8-0-5-802	386	6700	306-322
RDSO/SK-84263	345	2300	300-313
WLRRM2-0-5-202	400	6100	286-304
DL-0-5-002	422	5500	291-311
DD-0-5-03(OUTER) EMU/M-0-5-004(INNER)	416 308	4200 4200	280-299 280-299
RDSO/SK-98018: B-15	393	6000	256-272
RDSO/SK-98018: B-16	286	6000	256-272

14.24 Twist in Under Frame of Wagon/Bogies

Longitudinal Twist



Normally AD = BC. If AD ≠ BC then longitudinal twist is present. It would cause the axles to remain persistently angular to which may increase the derailment proneness.

Vertical Twist

A vertical twist is detected by measuring the height of sole bar at the 4 corners of the under frame above rail level. All 4 readings should be equal. A vertical twist of 20 mm can appreciably increase the derailment chances. It is equal to a twist in track. When both combined the chances are furthermore.

14.25 CASNUB Bogie

General Description

This bogie was first fitted in BOXN wagons and was designated as CASNUB 22W. This was later modified as CASNUB 22W(M) to take care of high wheel wear reported on earlier version. Subsequently CASNUB 22NL (Narrow jaw) and CASNUB 22 NLB (Narrow jaw with fish belly bolster) versions were introduced. The CASNUB 22 HS bogie has been developed for high-speed operation with maximum permitted speed up to 100 km/h. All CASNUB 22W bogies are to be converted to CASNUB 22W (Retrofitted) by the maintenance depots and workshops. The various bogie versions developed are as under:

1. CASNUB -22W
2. CASNUB -22W (Retrofitted)
3. CASNUB -22W(M)
4. CASNUB -22NL
5. CASNUB -22NLB
6. CASNUB -22HS

These bogies are used in the following wagons: -

BOXN, BCN, BCNA, BRN, BTPN, BTPGLN, BOBR, BOBRN,

BOBY, BOBYN, BFK

Construction Details

The bogie comprises of two cast steel frames and a floating bolster. The bolster is supported on the side frame through two nests of springs. This also provides a friction damping proportional to load. A fabricated mild steel spring plank connects the side frames. A photograph of CASNUB bogie is shown in Fig. 14.6.

Fig. 14.7 shows the bogie general arrangement.

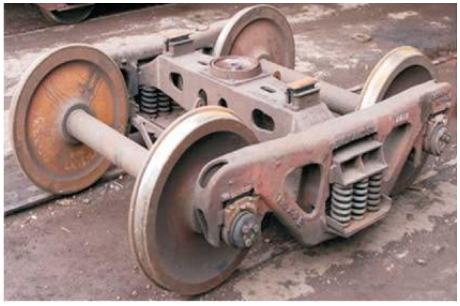
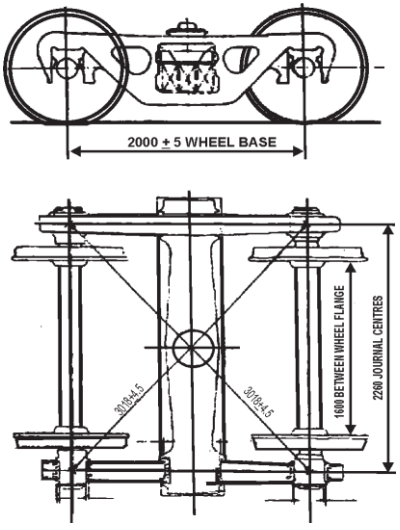


Fig. 14.6 CASNUB



CASNUB - 22NL, NLB, HS

Figure 14.7 CASNUB Bogie – General Arrangement

The salient features of CASNUB bogie are given below.

S.No.	Features	Description
1	Gauge	**1676 mm**
2	Axle load	20.3t, however all bogies except CASNUB 22 HS can be upgraded upto 22.9t
3	Wheel Diameter	**1000 mm** (New) 956 mm (New) for Retrofitted CASNUB 22 W
4	Wheelbase	**2000 mm**
5	Type of Axle bearing	CASNUB 22W & 22W(M) (i) Cylindrical Roller Bearing Axle Box in a limited number of CASNUB 22 W Bogies Only. (ii) Standard AAR Tapered Cartridge Bearing Class E

		suitable for 144.5 x 277.8 mm wide jaws. CASNUB 22NL, 22NLB & 22 HS standard AAR tapered Cartridge Bearing Class E suitable for 144.5 x 277.8 mm narrow jaw.
6	Distance between journal centres	**2260 mm**
7	Distance between side bearers	**1474 mm**
8	Type of side bearers	CASNUB 22W Roller type (clearance type) Retrofitted CASNUB 22, CASNUB 22W(M), 22NL, 22NLB Constant contact type (Mental bonded rubber pad, housed inside side bearer housing) CASNUB 22HS Spring loaded Roller type (Clearance constant contact type side bearer)
9	Type of Pivot	CASNUB 22W IRS type TOP Pivot- RDSO Drg.NO.W/BE-601 Bottom Pivot- RDSO Drg.NO.W/BE-602 or similar
10	Anti Rotation features	Anti rotaion lugs have been provided between bogie bolster and side frame.
11	Type of brake beam	CASNUB 22W, 22NL, 22NLB, 22HS: Unit type fabricated brake beam supported and guided in the brake beam pockets CASNUB 22W(M): Unit type Cast Steel brake beam suspended by hangers from side frame brackets.
12	Suspension details	Long travel helical spring
13	Elastomeric pads	On all types of bogies except SACNUB 22W

The CASNUB bogie assembly consists of the following components:

1. Wheel set with Cartridge Bearing
2. Axle Box/ adapter, retainer bolt & side frame keyassembly
3. Side frames with friction plates and brake wear plates
4. Bolster with wear liners
5. Spring plank, fit bolts & rivets
6. Load bearing springs and snubber springs
7. Friction shoe wedges
8. Centre pivot arrangement comprising of Centre pivot top,Centre pivot Bottom, Centre pivot pin, Centre pivot retainer& locking arrangement.
9. Side Bearers
10. Elastomeric Pad
11. Bogie Brake Gear
12. Brake Beam

1. Wheel set with cartridge bearing.

The initial batch of CASNUB bogie was fitted with cylindrical roller bearing axle box and matching wheel set. However standard AAR taper cartridge bearings have been subsequently standardized for these bogies. Maintenance requirement of cartridge taper roller bearing have been issued under Instruction for inspection and maintenance of Cartridge Taper Roller Bearing fitted on Cast Steel Bogies, Technical Pamphlet No. G-81 by RDSO.

Wheel diameter for new wheel is 1000 mm. However, for CASNUB 22W (retrofitted), maximum permissible wheel diameteris 956 mm. Condemning wheel diagram is 906 mm for all versions butwith suitable packing.

Axle

Axles have to be subjected to ultrasonic testing duringROH/POH or whenever the wagons are sent to the shops. Wheelsets whose axles have undergone ultrasonic testing shall be stamped on the hub fillet. Whenever axles are renewed, the workshop shall punch the following particulars in 5 mm letters on the axle end: -

1. Serial No.
2. Workshop code where pressing has been done
3. Date of pressing
4. Journal center
5. Pressing on pressure in tonnes (Both ends)

2. Axle box adapter, retainer bolt and side frame key assembly

CASNUB 22W

Initial lot of CASNUB 22W type bogies were provided with cylindrical roller bearing axle box on the wheel sets. However, cartridge taper roller bearing was soon standardized having adapter & adapter retainer bolt. The CASNUB 22W bogies are provided with wide jaw adapter as per RDSO sketch No. Sk- 78527 but without elastomeric pads with wheel sets to Drg. No.WA/WL-4902, Sk-68512 and WD-89025-S/1 with retainer boltsto Drg No. SK-69594.

CASNUB 22W(M)

Wheel sets are with wide jaw adapter, cartridge roller bearing and adapter retainer bolt (WA/WL-4902/WD-89025-S/1 for wheelsets).

CASNUB 22NL,22NLB & 22 HS bogies

Wheel sets are provided with narrow jaw adapter, cartridgeroller bearing (WD-89025-S/1 for wheel sets).

CASNUB 22W (Retrofitted)

Bogies are provided with modified wide jaw adapters, but these are not interchangeable with CASNUB 22W and CASNUB 22W(M).

Adapter

When a bogie is dismantled, the adapter is to be thoroughly inspected for soundness and wear. Wear at Thrust shoulder, Adapter bore (bearing seat), Adaptor crown lugs, Adapter crownseat, Adapter side lugs and Adapter sides is to be checked bycorresponding gauges.



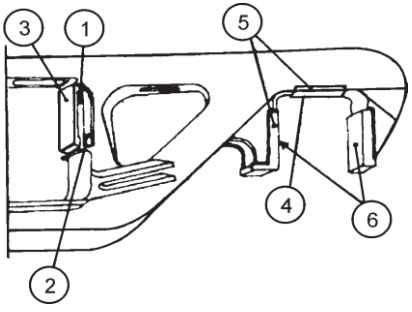
Fig. 14.8 Adapter

Side frames with friction wear plates

Wearing surfaces of side frame are shown in **Fig.** 14.9. The wear limits are given in Table 14.3.

Side frame column has been provided with 10 mm thickness Silico Manganese Steel wear liners to IS: 3885 Pt.-I Gr. IV welded on the columns. It must be ensured that liners are permitted inservice up to a thickness of 6 mm only.

The amount of wear on the outside and inside of the Side frame Column Sides is determined by placing the gauge centrally and inserting shims of appropriate thickness.



1. Side frame column sides 2. Anti-rotation lugs 3. Side framefriction liners 4. Pedestal crown roof 5. Pedestal crown side andpedestal sides 6. Pedestal jaw

Fig. 14.9 Locations of wear on side frame

The amount of wear on the Side Frame Anti-Rotation Lug is determined by placing the gauge centrally and inserting shims of appropriate thickness.

In a similar manner, the wear of Pedestal Crown Roof, Pedestal Crown Side and Sides of Pedestal and Pedestal Jaw is determined by use of appropriate gauges and shims.

The side frame should be checked for its wheelbase (distancebetween center lines of the jaw openings), and it should be ensured that the correct button marking is left on the side frame. Whilepairing the side frame for a bogie, it should be ensured that thereshould not be any difference between the number of buttons onthe two-side frames.

Bolster with wear liners

The wearing surfaces of the bolstar are shown in **Fig.** 14.10.(a and b) The wearing surfaces are Bolster pocket, Bolster LandSurface and Rotation Stop Lug and Bolster Column Gibs.

The wear limits are given in Table 14.3.

Bolster pocket has been provided with 8 mm thick Silico Manganese Steel Liners welded with pocket slope. Liners may be permitted in service upto a thickness of 3 mm.

No paint or grease should be applied on the plate.

Some bogie bolsters such as those of CASNUB 22NLB and22HS bogies have been provided with 5 mm thick wear liners on land surfaces and the same are required to be replaced after 3mm wear.

Spring plank, fit bolts & rivets

Spring plank is a member made of solid steel (flanging quality). It joins two side frames of CASNUB bogie by eight 24 dia rivetsand four M24 fit bolts to keep bogie frame square.

Spring plank should be examined for defects like loosening of rivets/cracks/bending, welding failure of spring spigot etc. Whenever spring plank is renewed, the leading dimension of thebogie

as per Drg no. SK-69599(W), WD-85054-S/6(22WM), WD-90042-S/1(NLB), WD-92058-S/7(HS) must be measured.

Load bearing springs and Snubber springs

The bogies are fitted with two groups of long travel helical spring nests. The spring details are shown in WD-83069-S/1 (Common for all versions except CASNUB- 22HS Bogie). Thespring details of CASNUB 22HS are shown in WD-92058-S/5.**Fig. 14.11** shows the group of springs provided at secondary suspension.

Spring is condemned based on Free height. Nominal and condemning Free Heights are as below-

Bogie	**Free Height (nominal)**	**Recommended free height (condemning)**
	(mm)	(mm)
All version		
Except CASNUB 22HS		
Outer	260	245
Inner	262	247
Snubber	294	279
CASNUB 22HS		
Outer	260	245
Inner	243	228
Snubber	293	278

It is recommended that springs having less than 3 mm freeheight variation should be assembled in the same group. Mixingof new and old spring must be avoided.

Excessive variation in the height of springs within the samegroup would result in unequal load on springs, resulting in Off- loading, adversely affecting safety.

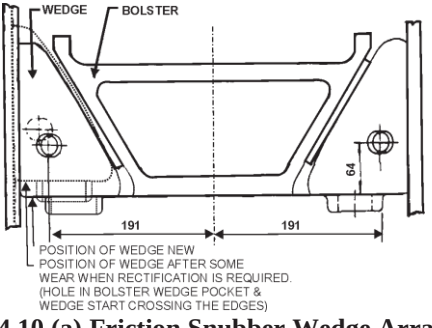


Fig. 14.10 (a) Friction Snubber Wedge Arrangement

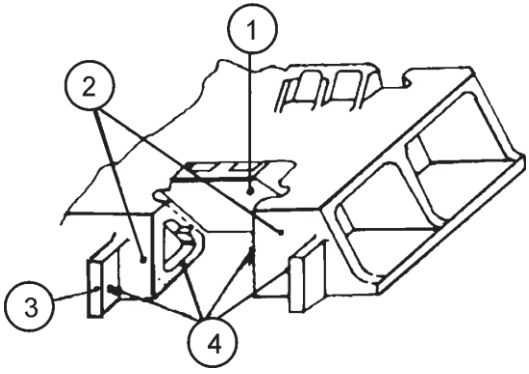
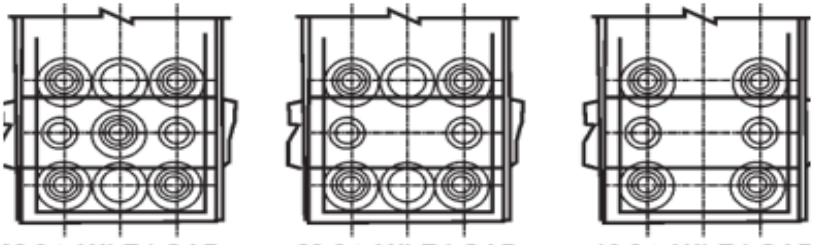


Fig. 14.10 (b) Locations to be reclaimed.



	Number of Springs		
Axle Load	Outer	Inner	Snubber
22.9 t	14	10	4
20.3t	12	8	4
20.3 t (22HS)	14	12	4
16.3 t	8	8	4

1. Bolster pocket slope surface liner 2. Bolster land surfaces
3. Rotation stop lugs/liner 4. Bolster columns gib (inner and outer)

Fig. 14.11 Details of Spring Group Arrangement

Damping System

The suspension is provided with load proportional friction damping arrangement with the help of manganese steel cast wedge supported on the snubber springs. Friction shoe wedgesare fitted on snubber springs. The arrangement is shown in Figure 14.10 (a).

The vertical surface of the wedge is in contact with the side frame and slope surface is in contact with bolster pocket liners. The dimensions are such that the snubber spring is under compression, and, in turn, it presses the wedge upwards. Thisresults in normal forces at both vertical and sloping surfaces. Relative movement due to oscillations generates friction at thesesurfaces, which causes damping.

Increased wagon load results in increased compression of bearing springs. This increases compression of snubber springas well, resulting in increased magnitude of frictional forces andhigher damping.

Wear limits on vertical surface and slope surface and nominal and recommended condemning dimensions are given in Table 14.3. Extent of wear and need of reclamation can be assessed inthe bogie in the assembled condition by observing the relativeposition of the hole in the bolster wedge pocket and the openingin the wedge (**Fig.** 14.10 (a)).

Investigation of proper working of the Damping System would be important in case of derailments, particularly at highspeeds. Defects such as a broken Snubber Spring and excessivewear should be observed.

Centre Pivot and Side Bearer arrangement

Centre pivot arrangement for CASNUB 22W bogie is as per RDSO Drg No. W/BE-601 for top centre pivot and W/BE-602 forbottom centre pivot for separate cast bottom pivot. For CASNUBbogies other than CASNUB 22W, centre pivot bottom and centrepivot top are as per RDSO Drg No. WD-85079-S/2.

Centre pivot pin for CASNUB 22W bogie is a headless pinwhile for other versions, a special type of pin is provided with castle nut/shackle lock for locking.

To determine the seat wear, the gauge should be placed inposition **(Figure 14.12**). If the pivot surface (vertical wall top) starts touching the surface on the gauge at any point, repair is to bedone by welding. The gauge should be moved on the complete worn surface to be measured. The surface after reclamation shall be the original dimension as per the respective drawings for

proper matching of surfaces with top center pivot. The repaired seat canbe checked by applying two 4 mm thick shims between the casting and the gauge surface marked as *, as seen in the Figure.

Wear of the vertical wall is checked by measuring the gap between the wall and the gauge in position. Repairs should becarried out if a 9 mm thick shim in CASNUB 22W bogie (7 mmthick for other bogies) can be inserted for the full depth between the worn surface and the gauge at any point on the vertical wall of the bowl.



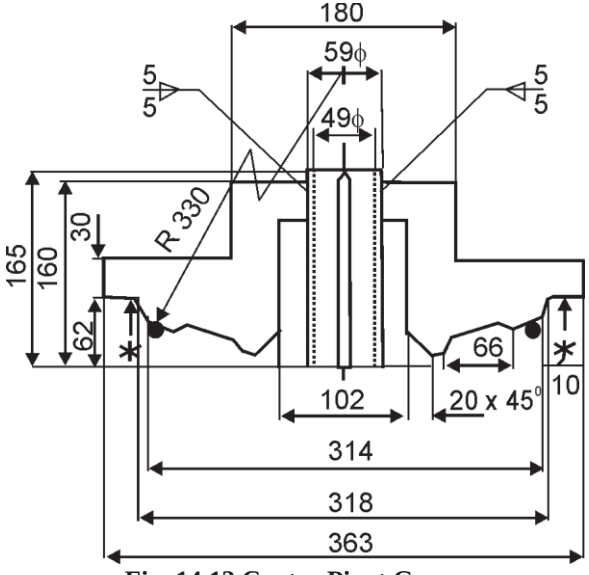


Fig. 14.12 Centre Pivot Gauge

Side Bearer

CASUNB 22W Bogies are fitted with roller type side bearers,which are free to move in cast steel housing, rivetted on the bogie bolster. CASNUB 22W(Retrofitted), CASNUB 22W(M), 22NL, 22NLB Bogies are fitted with constant contact type of side bearer rubber pads located in cast steel housing which isriveted to the bogie bolster. CASNUB 22HS Bogies are fitted with helical spring-loaded constant contact type side bearer,

riveted/bolted on the bogie bolster.

Condemning of Side Bearers is decided based on its physical condition. Criteria for condemning the Rubber Pad is as discussed in para below for Elastomeric Pad.

In case of investigation of derailment, magnitude of wear, pattern of wear and the condition of surfaces at the Center Pivot should be critically analyzed to assess if they cause any undue resistance to rotation of bogie with respect to the wagon. A lubrication of Graphite powder is provided for limiting the frictional resistance between the steel surfaces at the Center Pivot. Lack of lubrication and ingress of dirt/ dust etc. may cause a large frictional resistance to rotation, as the normal forces involved are high. Similarly, a large wear on Center Pivot seat would increase the normal force on the Side Bearer surface (which are not provided with any lubrication), increasing resitance to sliding, causing obstruction to bogie rotation. Uneven wear should also be analysed for similar effects. **Hindrance to bogie rotation is potentially a major cause of derailment in sharp curves, as it would result in a large angularity.**

Elastomeric pad

Elastomeric pads are provided in all versions of CASNUB bogie except CASNUB 22W. The main purpose of providing elastomeric pad is to reduce wheel flange wear.

Elastomeric pads to 95005-S/4, Wd-92058-S/8 (for HS) & WD-95005-S-1 and side bearer rubber pads to WD-85076-S/1 shall be condemned and replaced by new ones on the following grounds: -

1. If the top of the bottom plates or intermediate plate in case of side bearer pads show any crack in service.
2. If any crack of more than 50 mm is developed at any surface of rubber.
3. If a bond failure giving way more than 40 mm in any direction is developed in service.
4. If any sign of crushing of rubber is noticed.
5. When in free condition, the pad has taken a permanent set of the order given in Table 14.3.

Bogie brake gear

The brake gear mainly consists of Brake Beam (with brakehead and brake block assembly), equalizing levers, Push rod, End pull rod, Brake Beam hangers (in CASNUB 22W(M) bogies). The bushes provided are case

hardened or through hardenedand pins are made from steel.

The maximum permissible wear on the pin diameter and bush inside diameter is limited to 1.5 mm.

In service as the tread diameter of wheel decreases due to wear, pins located in End Pull Rod with under frame are to be relocated.

The standard brake shoe to Drg. No. WA/BG 6158 which, isused on BOX wagon, can be locked in position on the brake head by means of a key. The brake shoes should be replacedwhen worn to 48 mm thickness i.e. when 10 mm metal is left from the base of the shoe.

Brake beam (CASNUB 22W, 22NL, 22NLB & 22HS)

Bogies are fitted with unit type fabricated brake beams thatslide in the guide cavity provided in the side frame.

Cavities are provided with silico manganese steel liners. Thebrake heads are an integral part of the brake beam.

The brake beam is shown in WD-89033-S/1, however the brake block to WA/BG-6158 is common for all versions.

CASNUB 22W(M)

The bogie is fitted with unit type suspended cast steel brake beam. The brake head is a separate sub assembly which is fixed with brake beam circular end by means of pin passing through brake beam end and brake shoe adjuster along with spring loaded brake head.

Assembly provides rotational flexibility to brake head.

Details are as per Drg No. WD-85084-S/1, WD-88012-S/1& WD-86034-S/1.

Nominal Clearances

The nominal clearances and the tolerances of the bogie assembly are given below.

S.N.	Description	Type of CASNUB Bogie			
		22W & 22W (Retro)	22W(M)	22NL 22NLB	22HS
1	Lateral clearance between side frame& bolster	18mm	18mm	18mm	25mm
2	Lateral clearance between side frame& adapter	25mm	25mm	16mm	16mm

3	Longitudinal clearance between side frame & adapter	2mm	10mm	9mm	9mm
4	Longitudinal clearance between side frame & bolster	6mm	6mm	6mm	6mm
5	Clearance between anti-rotation lug & Bolster	4mm	4mm	4mm	4mm

Wear limits for various bogie components are given in Table 14.3. The maximum value of lateral and longitudinal clearances(S.N 1 to 5 above) will be a sum of the nominal clearance andwear limit on the corresponding surfaces.

TABLE 14.3

Wear Limits for Bogie Components (Dimensions in mm)

Sr. No.	Description	New or renewed	Worn	Wear limit
1	AXLE BOX Axle Box Crown lugs (Cylindrical Roller Bearings)	159	167	4
	Axle Box Crown seat (Cylindrical Roller bearings)	36.5	33	3.5
	Axle Box Side lugs (Cylindrical Roller bearings)	130	136	3
	Axle Box Sides (Cylindrical Roller bearings)	268	262	3
2	ADAPTER Adapter Crown lugs (Wide Jaw)	156	164	4
	Adapter Crown lugs (Narrow Jaw)	155.5	163.5	4
	Adapter Crown seat	3.5		
	Adapter bore seat to crown seat			
	Wide jaw adapter	48.5	45	3.5
	Modified wide jaw adapter Narrow jaw adapter	25.5 26.2	22 22.7	3.5 3.5
	Adapter side Lugs			
	Wide Jaw	130	136	3
	Narrow Jaw	97	103	3
	Adapter sides			
	Wide Jaw	268	262	3
	Narrow Jaw	181	175	3

3	Side Frames			
	Side frame wear friction plate	10	6	4
	Side frame column sides	216	206	10
	Side frame and rotation lug	522	528	6
4	Pedestal Crown roof			
	Key Seat to pedestal Crown Roof 22W	273	278	5
	Key seat to pedestal Crown Roof 22W (M)	318	323	5
	Key seat to Pedestal Crown Roof 22NL/NLB/HS	323	32	5
5	Pedestal Brown sides and Sides of the pedestal			
	All Bogies – Crown Sides	152	144	4
	Pedestal Sides 22W, 22W(M)	105	101	2
	Pedestal sides 22NL, NLB, HS	81	77	2
6	Distance between Outer & Inner Pedestal Jaw of CASNUB Bodies			
	22W & 22W(Retrofitted)	270	278	4
	22W(M)	278	286	4
	Pedestal Jaw (Short) for 22NL/NLB/HS	190	198	4
	Pedestal Jaw (Long) for 22NL/NLB/HS	236	244	4
7	BOLSTER			
	Pocket	35 degree on slope		
	Liner	8	3	5
	Bolster land surface Roatation stop lug	444 518	438 512	3 3
8	BOLSTER			
	Outer gib	234/ 241	244/ 251	5
	Inner gib	136	146	5
9	Centre Pivot			
	Wear limit vertical side CASNUB 22W	-	-	5.5
	Other	-	-	4
10	SEAT			
	CASNUB 22W	-	-	4
	Others	-	-	4
11	FRICTION SHOE WEDGE BLOCK			
	Vertical surface from Centre line of Spigot	61	54	7
	Slope surface by gauge			
12	ELASTOMERIC PADS			

	Type of pad	Nominal Dimension	Dimension after Permanent set
	Elastomeric pad	46	42
	Side bearer rubber pad	114	109

Rejection Rules

The revision committee of IRCA, New Delhi have finalized rejection rules for CASNUB bogie which are approved by Railway Board vide their Letter No. 87 M (N) 951/11 dated 7.4.93. The details aregiven below: -

Rejections - CASNUB Bogie

1. Bogie Truck

S Side Frame cracked/broken
S Bolster cracked/broken.
S Top/Bottom pivot cracked/broken
S Spring plank broken.
@ Any bush on the plank stripped out
S Side bearer housing cracked/broken.
S Side bearer housing securing bolts/rivets worked out orimproperly secured.

2. Bogie Suspension

S Any coil bearing spring cracked or broken.
@ Wedge cracked/broken

3. Bogie brake Gear Defects

S Brake block deficient (on wagons with operative brakecylinder) or thickness of brake block is less than 10 mm
@ Any defect in brake rigging preventing application orrelease of brakes
S Any safety strap/bracket/hanger nut missing inaccordance with rule 2.12.1.4
Any pin deficient/broken or free to work out in the brakegear
Brake block key missing or improper fitment
@ Brake gear adjustment not according to wheel diagram.

4. Cartridge Bearings

S Bearing running hot.
Bearing jammed/giving abnormal sound of broken cageor roller
@ Outer cup broken or cracked, causing leakage of grease
S Front/Rear seal leakage or seal damaged or leakage of grease on any account
S End cap screw loose or locking plate missing or tabs oflocking plate

not properly bent against the face of cap screw head.

@ Missing side frame key or adapter retaining bolts

5. Adapter

S Cracked/Distorted Adapter

6. Roller Bearing Axle Boxes

S Hot Box

S Cracked or broken axle box

S Bearing jammed or giving abnormal noise of broken cage/rollers.

S Axle cap screw loose or locking plate tabs not propertybent against the axle cap screw face.

7. Air Brake System

S Stock without air brake connection from coupling to coupling.

S Stock with deficient / damaged or inoperative, distributorvalve or its parts, common pipe bracket with control reservoir, cut off angle cocks, isolating cock, check valve, dirt collector brake cylinder, Auxilliary Reservoir and hosecoupling assembly for BP.

S Stock having excessive leakage from the system

@ Stock without RDSO approved APD for distributor valve

Stock with damaged pipes and pipe fittings

Brake gear empty load box defective or handle inoperative

@ Brake gear slack adjuster or any part of assembly deficient.

8. CBC Defect

Knuckle pin bent, broken or of wrong size

CBC striker casting cracked more than 25 mm at anylocation

S CBC yoke pin support plate missing, or its bracketbroken

CBC shank cracked or bent out of alignment

CBC shank wear plate or housing worn by 10 mm.Shank wear plate missing where originally fitted

CBC look lift assembly so defective that the couplercannot be coupled/uncoupled

Knuckle pin APD deficient

Overdue ROH/POH by more than one year

Any wagon loaded more than CC or permitted excess.

S Indicates safety items

@ shall be applicable for the stock being turned out fromWorkshops/ ROH depts

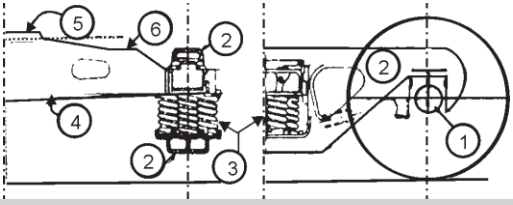
Amsted Bogie (RDSO Report No. M. 260)

Following are the common types of bogies in this category:

1. Mukund National SC-1 bogie (RDSOs Report No.M.262)

2. Sumitomo-SM-3 bogie (RDSOs Report No. M. 259)

The general arrangement of suspensions of the above bogiesare shown in **Fig.** 14.13 to 14.15.



1. Roller bearing axle box 2. Side frames 3. Main bearing helical spring nest 4. Bolster (with guide lugs) 5. Centre pivot 6. Side bearer

NB: Spring loaded friction snubber is not shown in the **Fig.**

Fig. 14.13 Suspension arrangement of Amsted bogie

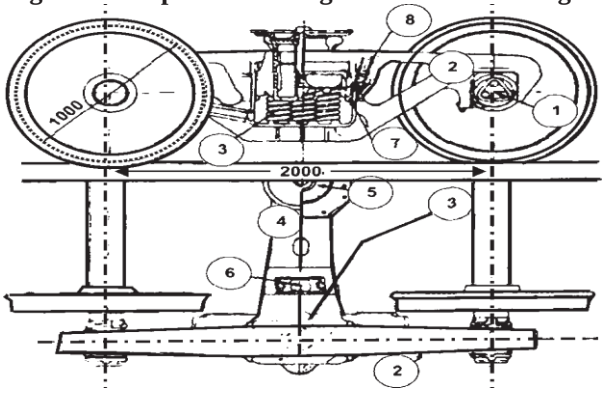


Fig. 10.14 Suspension arrangement of Mukund National SC-1 bogie

1. Roller bearing axle box 2. Side frames 3. Main bearinghelical spring nest 4. Bolster (with guide lugs) 5. Centre pivot
6. Side bearers 7. Spring loaded friction snubber shoe.
8. Friction snubber spring

NB: Spring loaded friction snubber are not shown.

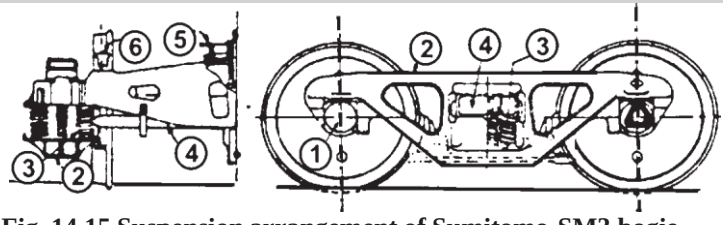


Fig. 14.15 Suspension arrangement of Sumitomo-SM3 bogie

Items and features to be checked during derailment investigation for defects in 3-piece trucks.

General

1. Defects in wheelsets, axle box assembly, bolster lug side frame members guide surfaces, spring gear, buffing gear and brake gear.
2. Clearance at the bolster lug-side frame member guide Particular
3. Surface of the center pivot for any hindrance to bogie rotation (also check the side bearers in this context)
4. Spring loaded friction snubbers.

(**N.B.** These bogies are prone to lozenging or parallelogramming effect while negotiating curves or turnouts.)

The suspension system of a 3-piece truck is similar to that of a diamond frame bogie, except that there is no inter-connecting spring plank between the two side frames. Each of the two spring clusters rests on an enlargement in the side frame itself.

The two side frames and the bolster-three in all are the only structural members, from which feature these bogies derive their name.

Due to this arrangement these trucks suffer from an inherent disadvantage, in that the axles can become angular to the side frames in a parallelogram fashion while negotiating curves or turnouts. This phenomenon is called lozenging or parallelogramming, which gives rise to high flange forces during curve negotiation (see **Fig.** 14.16). This aspect should, therefore, be kept in mind during the derailment investigation involving these bogies.

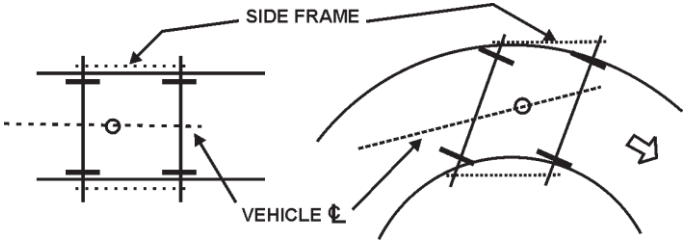


Fig. 14.16 Lozenging or parallelogramming of 3-piece truck

Table 14.4 gives the salient particulars of the above bogies.

Table 14.4
Salient particulars of 3-piece trucks

Description	Amsted	Mukund Natinal	Sumitomo-SM3
Axle load (t)	22.86	22.86	22.86
Bogie rigid wheel base (mm)	2000	2000	2000
Wheel diameter(mm)	1000	1000	1000
Type of axle bearing	AAR Standard cartridge type	AAR Standard cartridge type	AAR Standard cartridge type
Bolster springs (no. per bogie)	14 nests	14 nests	14 nests
Clearance between bolster and bogieframe			
Lateral (mm)	9	8	8
Longitudinal (mm)	4.5	4.5	4.5
Lateral clearance between bearing adaptor and sideframe (mm)	4.5	4.5	4.5
Centre pivot	AAR type flat	AAR type flat	AAR type flat
Side bearer	2 roller type	2 roller type	2 roller type
Damping	4 spring loaded friction snubber per bogie	4 spring loaded friction snubber per bogie	4 spring loaded friction snubber per bogie
Stable test speed (KMPH)*	110	110	95
Speed cleared (KMPH)	75	75	75

(***N.B.**: Tested under BOI wagon body. These bogies can also be used under other wagon bodies e.g. BOBS, BOX etc.)

New Type of Wagons

Following is some of the new types of special wagons fordifferent purpose –

BLCA/BLCB Wagons

BG Low Platform Container Flat wagons (BLCA/BLCB) are used for transportation of ISO containers. These wagons havehigh pay load (61.0 ton) and a high operating speed (100 kmph).Under frame of the wagon is of all welded construction and issupported over cast steel bogies suitable for 20.32 ton axle load. Low platform height has been achieved with the specific designof bogie frame, bolster and use of smaller wheel diameter. General arrangement of the wagon is shown in **Figure 14.17**. Five cars,one A car at each end and 3 B cars in the central portion, consist of a unit. A car is fitted with CBC coupler on the raised end and

Slack-less Drawbar on the other end. B car is fitted with Slack-less Drawbars on both ends. These five cars are to behandled as a unit in rake formation as well as for sending themfor ROH/ POH.

Bogie Container Flats are mounted on two cast steel high speed bogies of the type LCCF(C), similar in arrangement to CASNUB bogie (of BOXN /BCN wagon). Flat centre pivot andspring-loaded side bearers are provided on the bolster. In a CASNUB bogie, total load is borne by centre pivot. However, this bogie is prone to hunting at higher speeds. Load distribution between centre pivot and side bearers is optimised in LCCF(C) bogie to prevent hunting. Spring loaded side bearers bear 90 %of load under tare condition. 10 % of tare weight and full pay load is borne by centre pivot. The bottom pivot is integral to bolsterwhile the flat top pivot is bolted to the under frame. Manganesesteel liners are provided at the bottom and the verticals.

The wagons are provided with a smaller diameter wheel - 840mm (new), 780 mm (worn). Axles are fitted with Cartridge TaperedRoller Bearing.

Cars are provided with Centre buffer coupler (CBC) on oneend and Slack-less draw bar on the other end. B cars are provided with Slack-less draw bars on both ends. Heights of CBC and Slack-less draw bar from rail level are 1105 mm and 845 mm respectively. Thus, A-B and B-B coupling are through Slack-lessdraw bar and A-A and A-Locomotive coupling are through CBC.

Field data suggest that BLC wagons are extremely prone to derailment while entering a loop through 1 in 8 ½ turnout. A largebuff force is likely to be present while the train enters a loop onaccount of Slack-less Draw Bar system. Under a large buff force,the Slack-less Draw Bar is likely to have increased lateral rigidity, on account of frictional forces in the coupling system. This increased lateral rigidity in combination with a large angular run would increase derailment proneness of the wagon in the sharpcurve.

Maintenance Instructions are contained in Maintenance Manual of BLCA & BLCB, April 2002, by RITES Ltd.

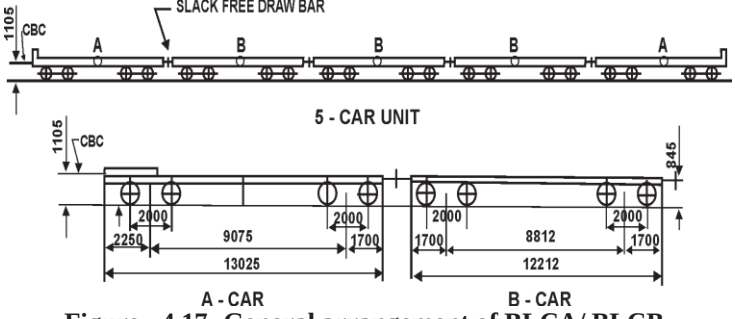


Figure - 4.17- General arrangement of BLCA/ BLCB

BOXNHA

Higher axle load wagon suitable for 22.1 t axle load and 8.25t/m TLD for coal loading. It has higher side walls as compared to BOXN wagon. Fit for 100 kmph.

BOXNHS

The wagon is a variation of BOXN wagon with operating speed of 100 kmph in empty and 100 kmph in loaded condition. In this wagon, high speed bogies have been provided. Other parameters of the wagon are the same as that of BOXN wagon.

BOXNHL

This bogie open wagon was designed for 22.9t axle load and 250mm longer than BOXNHS wagon. The wagon is manufactured using stainless steel and cold rolled sections. Maximum speed is 100 (empty)/ 75 (loaded) kmph.

BOXNEL

This wagon has been designed for transportation of iron ores, coal etc. BOXNEL wagons are fitted with Casnub-22NLC bogies with a maximum axle load of 25 t. Maximum speed is 60 (empty)/45 (loaded) kmph.

BCNA

This wagon is an improved BCN wagon having reduced length and increased height by keeping the volumetric capacity as the same. Also, the wagon has fully welded construction.

BCNAHS

This wagon is a variation of BCNA wagon with high-speed bogie CASNUB-22HS-BOGIE. The other parameter of this wagon is the same as of BCNA wagon.

BCNHL

This wagon was designed at 22.9t axle load in 2006 for transportation of food grain, fertilizer and bag quantities.

BRNA

This bogie rail wagon is an improvement of BRN wagon. The design is riveted cum welded construction. It has a higher pay to tare ratio as compared to BRN wagon.

BOBYN

This wagon is designed for transportation of ballast for the engineering department. It has two chutes at bottom for regulated discharge of ballast on both sides of rails.

BOXNCR

The wagon is a variation of BOXN wagon with its body in IRSM-44 steel. It's under frame is, however, made of mild steel. This has been done to provide better corrosion resistance to wagon body. All parameters of this wagon are the same as that of BOXN wagon.

BFKN

Broad gauge Bogie Container flat wagon type BFKN is modified version of BFKI wagons.

BFKNCR

Air Brake CASNUB bogie container flat wagons owned by container corporation LTD. (being converted from BFKI).

BCCN

This is Double Decker Bogie covered wagon for transportation of automobile cars. It has Low platform, 840 mm dia wheel, and is fit for high speed (100 km/h.).

BFNS

Special wagons for transportation of HR coil, Tare weight 23.6t, payload 57.7 t suitable for accommodating various sizes of coilsAdjustable stoppers have been provided for suitable placementof coil in the groove and preventing longitudinal shifting of coils.

BCW

It is privately owned by M/s. Bulk Cement Corporation IndiaLtd. and are based at Wadi, Sholapur Division of CR, to run between Wadi and Kalamboli (Mumbai Division). Axle Load = 20.32 t. The wagon is fitted with Air Brake.

BTPGLN

Bogie liquefied petroleum gas tank wagon. This wagon is avariant of BTPGL with air brake and CASNUB trolley.

Wagon Nomenclature

Open Wagon

Wagon Code	Full name	Remarks
BO*	Bogie Open Wagon	Bogie Open Wagon
BOC*	Bogie Open Wagon, Coal	Bogie Open Coal Wagon
BOXC	Box Open Wagon (81.28t)	Variation of general-purpose Open Box wagon with CBC couplings
BOXT	Box Open Wagon (81.28t)	Variation of general-purpose Open Box wagon with Transition couplings
BOX-SR	Box Wagon with Sliding Roof	
BOI	Bogie Gondola Wagon (81.28t)	Especially for the movement of high-density items like iron and manganese ore. The height of the body is reduced
BOZ	Bogie Open Wagon (81.28t)	An improvement over the BOX wagon,
BOY	Bogie Gondola Wagon (91.4t)	For transportation of minerals/ore in closed circuit with an axle load of 22.9t
BOXN	Bogie Open Wagon (81.28t)	20.32 t axle load, operation speed 80kmph (empty) and 75 kmph (loaded)
BOXHS	Bogie Open Wagon (81.28t)	Variation of BOXN wagon with high-speed bogie. Operation speed of 100 kmph in both empty and loaded condition
BOXNCR	Bogie Open Wagon (81.28t)	Variation of BOXN wagon with better corrosion resistance.
BOXNHA	Bogie Open Wagon (88.40t)	It has higher sidewalls compared to BOXN wagon, for transportation of coal toaxle load of 22.1 t.
BOST	Bogie Open Wagon (81.28t)	Designed for transportation of coal aswell as steel coils.
BOSTHS	Bogie Open Wagon,	This wagon is variationof BOST wagon with

	HIGH SPEED (81.28t)	high-speed CASNUB bogie.
BOXN(LW)	Bogie Open LightWeight Wagon	
BOXNHL	Bogie Open HigherLoad Wagon	Designed for 22.9t axle load and 250mm longer than BOXNHS wagon.
BOXNEL	Bogie Open Enhanced Loading Wagon	Fitted with CASNUB- 22NLC bogies with a maximum axle load 25 t., for transportation of iron ores, coal etc.
BOXNR	Bogie Open Wagon	Maximum axle load 22.9 t.
BOYEL	Bogie Open Enhanced Loading Wagon	Casnub-22NLC bogieswith a maximum axle load 25 t

Covered Wagon

Wagon Code	Full name	Remarks
BCN	Standard Covered Bogie Wagon	20.32 t axle load
BCNA	Standard Covered Bogie Wagon	Improved BCN wagonhaving reduce length and increase height
BCNAHS	Standard Covered High-Speed Bogie Wagon	Variation of BCNA wagon with high-speed bogie CASNUB-22HS
BCR*	Bogie CoveredWagon	With cast steel bogie,provided with narrow door opening.
BCX Mk-I	Bogie CoveredWagon Special	Includes special feature of BOX wagon and provided with widersliding doors.
BCX Mk-II	Bogie CoveredWagon Special	Includes all the special features of BOX wagon. It has provision of swing cum flap doors.
BCXC	Standard Covered Bogie Wagon	UIC bogie and centerbuffer coupler.
BCCN	Bogie CoveredDouble DeckerWagon	A set of five wagons consisting of two ends consisting of two endwagons known as 'A'wagon and three middle wagons known as 'B' wagon. Both the wagons are double decker having two floorsfor transportation of automobile cars.
BCCNR	Bogie CoveredWagon	For transportation of automobile withsingle tier system transportation.
BCNHL	Bogie CoveredWagon	22.9 t axle load
BCXN	Standard Covered Bogie Wagon	Modified form of BCX wagon provided with airbrake, CASNUB NLB bogie with center buffercoupler.

Flat Wagon Type

Wagon	Full name	Remarks

Code		
BR	Bogie Rail Wagon	16.3t axle load for transportation of rails,with cast steel bogie.
BRH	Bogie Rail Wagon, Heavy	20.3t axle load and plate fabricated bogie of BOX type for transportation of rails and heavy steel sections.
BRS	Bogie Rail Wagon, Special	Improvement over BR, end loading of special defense vehicles.
BRHC	Standard Bogie Rail Wagon Heavy	Similar to BRH wagon.Provided with stronger CBC and reduced coupling length.
BRN	Standard Bogie Rail Wagon Heavy	Improvement of BRH,with air brake and welded construction.
BRHT	Standard Bogie Rail Wagon Heavy	Like BRH wagon,with provision of transition screw coupling.
BRNA	Bogie Rail Wagon	Improvement of BRN wagon, having higherpay to tare ratio
BRNAHS	Bogie Rail Wagon (With High-Speed Bogie)	Like BRNA wagon,with High Speed CASNUB bogie.
BFNS	Bogie Flat SteelCoil Wagon	For transportation ofhot rolled/cold rolled coils, plates, sheets and billets etc.
BRHNEHS	Bogie Rail Wagon	For departmental use of Engineering department for Track Relaying Trains (TRT) especially loading RCCsleepers.

Hopper Wagon Type

Wagon Code	Full name	Remarks
BOB	Bogie Hopper Wagon	Conventional hopper wagon with side discharge system for ballast transportation, provided with diamond frame bogie.
BOBC	Bogie Hopper Wagon	Having center discharge system andcast steel bogie.
BOBX	Bogie Hopper Wagon	For transportation of ore etc. with center andside discharge system
BOBX (MOD)	Bogie HopperWagon	Identical with BOBX wagon. Modified reposeangle of hopper to 400.
BOBS (TALBOT)	Bogie Hopper Wagon Special	For transportation of
BOBS (ISW)	Bogie Hopper Wagon Special	For transportation of iron ore, with diamondframe ISW design bogie.
BOBSMK-II	Bogie HopperWagon	A variant to BOBS wagon with CASNUB bogie
BOBSN	Bogie HopperWagon	Variation of BOBS wagon with air

		brakesand CASNUB bogie
BOBR	Bogie Open Rapid Discharge HopperWagon	For transportation ofcoal with bottom discharge facility
BOBRN	Bogie Open Rapid Discharge Hopper Wagon	Variation of BOBR withair brake and has two doors.
BOBRNHS	Bogie Open Rapid Discharge HopperWagon	Variation of BOBRN with high speed CASNUB 22 HS bogie.
BOBY	Bogie HopperWagon	For transportation of ballast with regulateddischarge
BOBYN	Bogie Open Rapid Discharge HopperWagon	Variant of BOBYwith air brake
BOBYNHS	Bogie Open Rapid Discharge HopperWagon	Variant of BOBYN with high speed CASNUB 22HS bogie.
BCBFG	Bogie Covered Hopper Wagonfor Food Grain	For transportation of food grain in Bulk. Provided with CASNUB-22HS MOD-I. bogie,

Tank Wagon Type

Wagon Code	Full name	Remarks
BTAL	Bogie Liquid Ammonia Tank Wagon	
BTALN	Bogie AmmoniaTank Wagon	Provided withair brake
BTO	Bogie Oil TankWagon	
BTPN	Bogie Oil TankWagon	For transportation of petroleum products, provided with air brake.
BTPGL	Bogie L.P.G. Tank Wagon	fitted with UIC bogie, Vacuum brake, Transition coupling &Roller bearing.
BTALM	Bogie AmmoniaTank Wagon	Fitted with UIC bogie, Transition coupling & Vacuum brake.
BTPGLN	Bogie L.P.G. Tank Wagon	This wagon is a variant of BTPGL with air brake and CASNUB bogie.
BTCS	Bogie Caustic Soda Tank Wagon	
BTAP	Bogie AluminaTank Wagon	For transportation of Alumina powder. Fittedwith 22-NLB bogie, Single pipe Air Brake system & non transitionhigh tensile CBC.

Brake Van Type

Wagon Code	Full name	Remarks
BVZI	Bogie Brake Van	This 8-wheeled brakevan with ICF bogie.

Container Wagon Type

Wagon Code	Full name	Remarks
BLLA	Bogie Low Platform Longer Container Flat Wagon	For transportation of 22'24' & 45' containers along with 20' & 40' long ISO containers at an operating speed of 100kmph with LCCF 20'(C) Bogie. BLLA (A-Car)wagons are provided atextreme ends in formation of one unit of5-cars (with 3 BLLB wagons in middle).
BLLB	Bogie Low PlatformLonger Container Flat Wagon	
BLCA	Bogie Low Platform Container Flat Wagon	For transportation of 20' & 40' long ISO containers at an operating speed of 100kmph with LCCF 20 (C) Bogie. BLCA(A-Car) wagons are placed at extreme ends in formation of one unit of 5- cars (with 3 BLCB wagons in middle).
BLCB	Bogie Low PlatformContainer Flat	
BFKN	Bogie Container Flat Wagon	Modified version of BFKI wagons, Air brake & enhanced pay load
BLCAM	Bogie Low PlatformContainer Flat	Modified BLC wagons for carrying enhanced pay load, with axle load of 22t.
BLCBM	Bogie Low Platform Container Flat Wagon	Modified BLC wagons

14.26 Flat tyre:

If station staff observes hammering sound in the running train, he shall try to find out the exact reason of it and immediately inform the same to the station master of the station in advance and to the section controller to stop the train. The Loco Pilot, Guard and Asst. Station Master shall examine the train and the flatness of the wheel teared. If possible, the train should run to the next TXR or Loco Examination Censer with restrictive speed of 20 KMPH.

Permissible Flatness Limit:

Coaching Stock: 50 mm

Goods Stock: 60 mm

Engine: 50 mm

If the flatness exceeds the above limit the wheel is considered to be skidded. Flat tare damages the Rail, Weld Joint of the rail which leads serious accident. The concerned department should take every possible measure to avoid such damage.

BREAK BINDING, FLAT TYRE AND OTHER DEFECTS OF WHEEL AND ITS PREVENTION

15

15.1 Brake Binding/Flat Tyre

A) Setting of Empty/Load Device in Wagons-

The Empty/Load device in wagons if not set in correct position will cause brake binding and flat tyre.

1. To avoid cases of flat tyre /poor brake power, it should be ensured at the time of loading/unloading that Empty/Load Box lever should be put in correct position by Operating/Commercial staff i.e. On Empty Position - When wagon is empty or slightly loaded. On Loaded Position- When wagon is loaded.
2. This should be super checked by Guard at the time of starting train from originating point, and by TXR at the time of train examination.
3. Before movement of loads from loading/unloading terminals, it should be ensured by the Operating staff that, hand brakes are released.
4. While picking up load from Roadside stations, the train crew should ensure release of hand brakes.

B) Rolling out/Rolling in Examination of Passenger carrying Trains-

To detect unusual, especially brake binding/flat tyre, the C&W department has started rolling out and rolling in examination of passenger carrying trains at nominated points. T

- Guards of all trains should look back frequently at the nominated stations to see that; no danger hand signal is exhibited by Station staff/TXR staff deployed for rolling out examination and whenever any danger signal is shown the train should be brought to a stop immediately by using VHF communication available with the Driver and Guard by using the brakes available in SLR.
- The staff involved in shunting of coaches attached/detached enroute on Passenger carrying trains should ensure complete releasing of coaches before starting shunting in order to avoid any possibility of developing flat tyre on the coaches. Special attention should be paid at the stations, where regular attaching/detaching of sectional coaches is taking place.
- Shunting staff to ensure complete release of coaches/wagons after shunting, to avoid brake binding/flat tyre.

15.2 Detection of locomotive and rolling stock with flat tyre:

Flat tyre may cause extensive damage to track by causing rail fractures and weld joint failures, resulting into serious accidents. To avoid rail fractures/welded joints failures caused by flat tyres, the staff should be counselled to take necessary precautions as under-

15.3 Mechanical (C & W) Staff –

As per Railway Board's guidelines, the permissible flat on wheel tread is limited to 60 mm for Goods stock and 50 mm for the Coaching stock/Locomotives. All C&W Train Examination staff should be counselled to adhere to the provision of para 4.22 "Tyre

Defects" of Part –IV IRCA Conference Rules for Coaching stock and Para 4.18 of Part-III of IRCA Conference Rules, for Freight Stock. The TXR staff should be counselled not to allow any wagon/coach having length of flatness more than permitted as above under any circumstances. Such wagons/coaches should be detached immediately after being marked sick. The C&W Train Examination staff in C&W depots/sick lines must check the flatness of wheel tread with the help of Tyre Defect Gauge. The flatness of the wheel tread should invariably be checked during intensive examination.

15.4 TLC/DPC/C &W Controller

On detection of flat tyre, and after the locomotive/rolling stock involved has been checked by loco shed staff/C&W staff, they should arrange replacement of wheel at site in case of wagon/coach and in case of locomotive, the same should be worked to nearest loco shed having pit wheel/ lathe for attention and a speed restriction of 20 kmph should be observed till the loco is cleared to the concerned loco shed.

15.5 Driver and Guard of the Train

The train crew and shunting staff should be trained to release brakes whenever DV isolating cock is operated by them. The empty/load box device should be kept in the empty/loaded position depending upon empty/loaded condition of the stock to avoid skidding of wheels, resulting into flatness of tyre during the run. The driver and guard should also be vigilant in detection of hammering blows /sounds while on run and on detection of the same should observe a speed restriction of 20 kmph to clear the section up to next station where they should stop the train and advise control office regarding the flat tyre and ask for C&W TXR/Loco shed staff to attend.

15.6 Operating Staff

The station staff should also be counselled to detect the hammering sound if heard on a passing train. They must without fail intimate the approximate position of the wagon/coach to the next station and

also to Section Controller to stop the train and get it examined for detecting the locomotive/rolling stock with skidded wheels having flatness of the wheel tread. The train should be inspected by Driver, Guard and ASM and work with restricted speed of 20 kmph if possible, up to the next TXR/Loco examination station. All TIs and Safety Counsellors should counsel SM/ASM, Cabinmen, and Switchmen to keep vigilance check on the hammering sound to detect the flat tyre on a passing train and stop the same before it causes extensive damages.

15.7 Section Controller

The Section Controller should take the advice of flat tyre reported by stations seriously and should not allow running of the train for onward journey without ensuring proper examination by C&W/Loco staff. On advice the train should be stopped at the next station and should not be allowed to cause avoidable damage to track.

15.8 Engineering Staff and Gatemen

The Engineering staff and Supervisors at work sites or while doing trolley or foot inspection should also be counselled to be vigilant towards detection of flat tyre on the passing trains. In case of any such detect noticed on any passing train, the approximate position of the culprit wagon/coach should be immediately advised to the next station through emergency control phone or from the nearest level crossing gate. Similarly, the gatemen should also be counselled to be alert and vigilant in detection of hammering sound on any of the passing train and in case of such detection the gatemen should advise the Station Master to stop the train. Gatemen should also show red flag/danger signal to the crew of the train so that, the train be stopped before causing extensive damage.

15.9 Engineering Control

Engineering Control should organize a special check up to 50 kms in the rear from point of detection of flat tyre to ensure the safety of track subsequent to passage of train having flat tyre.

भारत सरकार (GOVERNMENT OF INDIA)
रेल मंत्रालय (MINISTRY OF RAILWAYS)
रेलवे बोर्ड (RAILWAY BOARD)

No.2015/CE-II/TK/14 New Delhi, dated 29.07.2021.

Principal Chief Engineers
All Zonal Railways

Sub: Safety at Worksite

Ref: Board's letter of even no. dated 11.10.19 & 25.07.2018

Instructions on ensuring safety at work sites have been issued and reiterated from time to time by the Board. However, accidents including derailments are still occurring at work sites of open line and construction organization including RVNL, etc., which is a serious cause of concern. Recent incidents of work site accidents have been viewed seriously by the Board.

Detailed instructions regarding action to be taken and implemented by Zonal Railways on work sites of open line have been issued vide Board's letter of even no. dated 11.10.19 (Copy enclosed). Zonal Railways are requested to follow the instructions in true spirit. Further, in order to ensure safety at worksites of doubling and other works being executed on running track or in close vicinity by Construction organization, RVNL etc., Joint Procedure Orders covering all aspects of inspection, monitoring etc. must have been formulated by Zonal Railways for adherence.

A Joint Procedure Order for ensuring safety at the worksite issued and being followed by Central Railway in this regard is enclosed for reference of Zonal Railways.

Zonal Railways are requested to take immediate action to ensure zero accidents on worksites, by formulating JPO if not done so far and following the instructions without fail.

Action taken by Railways in this regard should be appraised to Board at the earliest.

DA: As above.

(Pradeep Nagar)
Director Civil Engg. (P)
Railway Board

भारत सरकार (GOVERNMENT OF INDIA)
रेल मंत्रालय (MINISTRY OF RAILWAYS)
रेलवे बोर्ड (RAILWAY BOARD)

No.2015/CE-II/TK/14 New Delhi, dated 11.10.2019.

Principal Chief Engineers
All Zonal Railways

Sub: Safety at Worksite

Ref: Board's letter of even no. dated 06.11.2018 & 30.12.2015

Instructions on ensuring safety at worksites have been issued and reiterated from time to time by the Board. However, accidents including derailments are still occurring at work sites, which is a serious cause of concern.

In order to avoid any further incidence on above account, following actions are required to be taken & implemented by Zonal Railways: -

1. The presence of Competent Railway's and contractor's supervisors must be ensured at site.
2. Protection of work sites be rechecked for correct locations of caution boards, flagmen, etc.
3. Recording of "Assurance" at the time of closure of work for track fitness at given speed by Railway and contractor's supervisor. For this an Assurance Register shall be maintained at each worksite each page of which should be pre numbered.
4. Restoration of normal speed over worksite should be ensured within stipulated number of days, with machine packing & adequate ballasting.
5. Attempt should be to open less number of sites and progress work by pooling of resources.

6. A review of all worksites should be conducted periodically by inspections at minimum sectional DEN level for ensuring safety measures. Compromises found at work site to be taken up severely with working agencies & supervisory staff. Conduct such review in next 7 days to cover all sites.
7. Adequate manpower with proper tools & equipment should be ensured for each site for achieving desired progress per day/week/month.
8. Track renewal activities should be taken up using track machines only. Prior Board's approval should be taken for manual execution of track works if it is inescapable to resort to manual renewals.
9. At Deep Screening/TSR location, proper ramping is required to be provided. Proper packing of sleepers at this location with correct track parameters at close of work is the key to safety. Railway and Agency supervisors must be sensitized about it. The location of curves requires special attention w.r.t Versines & Cross levels.

Senior officers including SAG from HQ should make it a point to inspect the worksite during their inspection to cross check above.

Action taken by Railways in this regard should be appraised to Board's office at the earliest.

(Pradeep Nagar)
Director Civil Engg. (P)
Railway Board

CE CIRCULAR NO. 190

Sub: Procedure order for ensuring safety at work site.

A number of Engineering, S&T and Electrical works in connection with gauge conversion, doubling, thin line, railway electrification, RVNL, and traffic facilities are progressing on various divisions which require excavation/ digging, movement of vehicles/ equipment near the running tracks. While carrying out these works in the vicinity of running tracks, there is a possibility of to track geometry, damage to electrical /S&T Cables, infringement of moving dimensions which may result into un-usuals resulting into dislocation of traffic accidents, and therefore, need was fell to issue a circular on this subject.

Hence forth, Live Following instructions shall be followed by the Open Line and Constriction Department, while Panning and carrying out such works which involve earth work to build formation, digging/excavation, movement/operation of vehicles/ equipments near the running tracks, so that the in Lances of disturbance to track geometry, infringement of moving (dimensions and damage to the electrical / S&T Cables, which may result into accidents or visuals can be avoided

I. Undertaking any type of work adjoining the running tracks.

1.1 Before undertaking any work adjoining the running track, Engineer In-charge should submit written information to the Open Line SSE/SE (P. Way), ADEN, sectional Sr. DEN before start of the work giving the following details:

1.1.1 Nature of work, location, and Name of the executing agency.

1.1.2 Approximate duration of work.

1.1.3 The list of type of vehicles and approx. number of vehicles to be deployed.

1.1.4 Details of location where vehicles are likely to work.

1.1.5 Certification regarding

i. Availability of Railway's Supervisor and Competent authorized supervisor of the contractor.

ii. Training to supervisor/driver (staff) of contractor and Competency certificate issued as given in IRPWM Para 826 (IV) Annexure 8/5, by Assistant Engineer in charge of the site if required to be issued.

iii. Imposition of Caution orders, OEHS, WF instructions etc. whenever required.

iv. Giving information to concerned departments supervisors i.e. Elect., or S&T if required.

1.2 While executing the work of excavation adjoining the track, the Engineer in-charge should ensure the following things.

1.2.1 The excavation is not causing any damage to formation of the cess, …… settlement to the running track and obstruction to the running track and obstruction to the damage or the existing drains of track.

1.2.2 Ther is no infringement to the maximum moving dimensions of safe running of trains.

1.2.3 There is no damage to equipments & cables or any other installation.

1.2.4 In case of deployment of mass labour, the caution order of, observe engineering had signals & whistle freely (OEHS & WF) shall be issued of the duration of work.

1.2.5 The concerned Open Line department supervisors (i.e. Engineering, S&T, TRO, etc.) shall be advised to depute their staff as and when required.

1.2.6 The supervisor of contractor and railways supervisor in-charge of work should visit the site to assess the precautions to be taken while working. The detailed planning of work including protection of track and safety measures proposed to be adopted should be listed out.

1.2.7 A register shall be maintained at the site regarding "Safety Measures", being taken at site and all the precautions being taken shall be logged. Inspecting officials shall check various safety measures being taken during their inspection and record the observations.

II. Carrying out earth work in embankments, digging/excavation involving movement/ operation of vehicles/equipments:

2. After ensuring the above, the Executive/Assistant Engineer in-charge of the working department i.e. construction, electrification, S&T, etc. shall ensure that following Site Preparations Before permitting the execution of works where it is necessary to use road vehicle/machinery.

2.1.1 The engineer In-charge of the work will personally examine and certify the road vehicle/equipment, counsel the driver, Protection man and supervisor and will give written permission to Contractor giving number and type of road vehicle, (driver and supervisors to be deployed on the work location, period, and timing of the work. The contractor shall not be allowed to work on site without prior written permission from the Engineer In-charge.

2.1.2 The click list given in Annexure-II shall be used to ensure that all the requisite measures have been taken before the start of the work.

2.1.3 The engineer In-charge of the work should ensure following Site preparation as applicable.

2.1.3.1 In case, work has been planned to be executed beyond 6.0 mts from center line of the nearest running track. The adjacent land strip where road vehicle/machinery is to ply for the work shall be demarcated by 150mm wide line with lime in advance at the distance of Gints from the center of existing track and acknowledge by the contractor so that the vehicle/machinery to not cross this line and do not come closer tian 6.0 mts of running track.

2.1.3.2 In case, work has been planned to be done between 6.0 mts to 3.5tes from center line of rack, it shall be ensured that:

I. Demarcation of land is done by bright coloured ribbon/ nylon chord suspended on 75 cm high wooden/ bamboo posts at distance of 3.5 m from center line of nearest running track.

II. An authorized railways representative is present during the plying of vehicles or working of machinery.

III. Suitable caution order to whistle freely is issued to Drivers of approaching train about road vehicles plying or machineries working close to running tracks. Whistle boards shall be provided whenever considered necessary.

2.1.3.3 In case, work is planned to be done within 3.5 m of center line of running track, it shall be ensured that the work is done under block protection only and necessary safety precautions for protection to track as per Para No. 806 and 807 of IRPWM are taken. The presence of Railway Supervisor of minimum …… rank should be ensured at work site.

2.1.4 The worksite shall be suitably demarcated to keep public and passengers away from work area. Necessary signage boards such as “Work in progress” etc. shall be provided at appropriate locations to warn the public/passengers.

2.2 In unusual circumstances, where operator apprehends infringement to track while working track/machinery near running track, following action shall be taken:

i. The contractor/supervisor/ vehicle operator immediately advise the situation to railway official and assist him in protecting the track.

ii. Protection shall be done as per Para. 8006 & 807 of P. Way Manual as the case may be.

2.3 Individual vehicle/machinery shall not be left unattended near the track. If it is unavoidable and becomes necessary to stable the road vehicle/machinery & plant near the running track, these shall be properly secured against any possible roll-off.

2.4 When a road vehicle is reversed, do ensure the following:

I. The location where vehicle is to take a turn is properly demarcated.

II. The road vehicle drive should always face the railway track during the course of turning r reversing his vehicle.

III. Presence of an authorized railway's representative is ensured at such location.

2.5 Communication facilities where necessary should preferably be provided at worksite.

2.6 In case of obstructions protection of the site should be ensured as per G&SR Para. 15.09

2.7 The check list given in Annexure III shall be used to ensure that all the requisite measures are being taken during the execution of the work.

III. Undertaking the work on the running track/existing lines

3.1 The Engineering work such as insertion of turnout sleeper, laying of glued joints, etc., is being done on the running tracks, that portion of the track shall be taken over temporarily by the Engineer In-charge of the work as per Joint Engineering & Construction Circular No. 148 and the same shall be handed over back to the sectional in-charge after relaxing the caution order. During this period, the Engineer in-charge of work should ensure that safety of the truck.

3.2 The Draft Circular Notice shall be published by the Engineer In-charge of the work if required.

3.3 While executing the work protection of track should be ensured as Para. 806 & 807 of IRPWM.

3.4 Speed restriction should be relaxed only by the open line sectional supervisor.

3.5 Released materials such as rails, sleepers, etc., should be stacked clear of infringement from the running track. Stacking areas should be pre-identified in consultation with PWI Open line.

IV. Additional precautions to be taken while working IN or ON top of cutting.

4.1 Shifting of machines within Railway boundary should be carried out under Railway supervision and track protection / traffic block wherever required.

4.2 No movements of earth handling machine and lipper should be permitted once the train enters the block section and till the train passed the work site.

4.3 No loose boulders or sleep slope having potential of slipping should be allowed to ……. Before permitting the train to pass the work spot.

V. Following Circulars containing the safety precautions various specialized works may also be referred.

5.1 For carrying out blasting work, work of widening of cutting or extension of bridges etc., the procedure and precaution laid down in Jt. Circular no. 116 by engg, & electrical departments may be referred issued form file no. W. 742.TM.19.

5.2 Jt. Circular No. 148, by Engg. Open Line and Construction department which includes the safety precautions for the works affecting the safety of the track like extension of bridges, widening of cuttings etc. works should be followed.

5.3 Handbook on "Safety at Construction work sites" has been circulated to all construction officers by Construction Organization vide letter No. EW/187/R/465/Comp./Cir dt. 09.02.2004.

5.4 Railway Board vide CRBs D.O. letter No. 2001/Sig/G7/ dt. 17.12.07, has circulated JPO Ni 1/Sig/2004 for undertaking digging work in the vicinity of undertaking signalling, electrical and telecommunication cables. Provision of the JPO should be followed.

(B.D. KUMAR)
PCE, C. Rly

HOT AXLE IN ROLLING STOCK

[CARTRIDGE TAPERED ROLLER BEARING (CTRB)]

16

Hot axle box in a railway vehicle occurs when inadequate wheel bearing lubrication or mechanical flaws (bearing failure) cause an increase in temperature. If undetected, the bearing temperature can continue to rise until there is a bearing "burn-off" which may cause a derailment.

A hot box is the term used when an axle bearing overheats on a piece of railway rolling stock. The term is derived from the journal bearing trucks used before the mid-20th century.

16.1 The symptoms of Hot Axle

Hot Axle is a phenomenon which causes due to breakage of ball bearing of wagons or coaches which is moving on the rail track. It arises due to the overloading and faulty condition of the bearing. During Hot Axle the wheel become very hot and the movement or the train stops due to jamming of bearing. General symptoms of hot axles are as under:

1. Smell of Burning grease.
2. Splashing of grease on wheel disc & Dis-colouring of grease.
3. Light smoke from axle box.
4. Dis-colouring of face plate.
5. Axle box cover cut, bulged missing.
6. Hotness of axle box by feeling.
7. Axle may get locked and wheel skidding.
8. Marks of splashing of grease on wheel and axle box visible at low speed or at stationary.
9. Discolouring of paint surrounded the axle box concerned.
10. Red glows during the night-time only.
11. Metallic noise after grease has worked out and roller have seized.
12. skidding of wheel at last stage.
13. Tilting of Spring.
14. Burning out of molten front cover in case of coaches.

Hot Axle in plain Bearing: -

1. Axle becomes hot.
2. Whistling sound.
3. Burning smells of grease/ Lubricant oil.
4. Smoking.
5. Fire on Axle.

Hot Axle in roller Bearing: -

1. Oozing out of grease.
2. Burning of grease.
3. Decolourization of Axle box.
4. Smoking from Axle box.
5. Axle Box becomes red hot and clearly visible red glow during night.
6. Metalling Noise.
7. Skidding of wheel and fire on rail.
8. Tilting of spring.

16.2 Causes of Hot Axle

The Hot Axles can be caused by as under:

a) Defects of Lubricant
b) Mechanical disorder
c) Irregular loading
d) Miscellaneous

a) Defects of Lubricant

1. Bad quality of grease.
2. Excessive quantity of grease.
3. Non availability / Inadequate quantity of grease.
4. Foreign material contained with grease.

b) Mechanical disorder

1. Defects in journal
2. Defective bearing
3. Defects in Axle box
4. Cage broken.
5. Oozing out of grease due to perished rubber seal

c) Irregular Loading

1. Uneven loading
2. Overloading Miscellaneous
3. Derailment
4. Defects in rail track
5. Excessive speed

d) Miscellaneous

1. Derailment
2. Defects in rail track
3. Excessive speed
4. Inadequate and insufficient lubrication
5. Incorrect fitment
6. Improper mounting
7. Improper handling
8. Excessive temperature or heating
9. Excessive or uneven loading
10. Impact loading
11. Excessive Vibrations due to component wear and tear

12. Contamination (foreign particles, moisture)
13. Earthing not proper for welding work.
14. Poor engineman ship.
15. Land slide or stone hitting.
16. Sudden change of signal expects.
17. Poor maintenance of P. Way.
18. Wagon involved in Flood.

16.3 Detection of Hot Axle

During Rolling in Examination and Axle Box filling

While in Slow motion / Not in motion

S.N.	Day Time	Night-Time
1	Smell of burning grease	Light smell of burning grease/EM pad
2	Splashing of grease on wheel disc & discolouring of grease	Axle Box cover becomes Red Hot
3	Light smoke from Axle box	Glowing of Axle Box
4	Discolouring of face plate	Hotness of axle box by filling/non-contact thermometer.
5	Burning of EM pad over Axle Box	
6	Hotness of Axle box by feeling/Noncontact Thermometer	

While Run Through

S.N.	Day Time	Night-Time
1	Screeching sound	Screeching sound
2	Axle may get locked and wheel skidding	Axle Box cover becomes Red Hot
3	Discolouring of Axle Box face plate	Sparks on Rail due to skidding
4	Smell of burning grease	Burning of EM pad and flame over Axle Box
5	Vibrations of wagon /trolley	







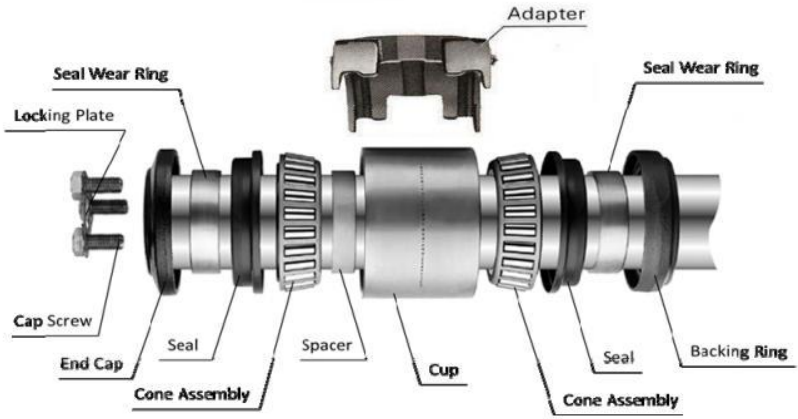




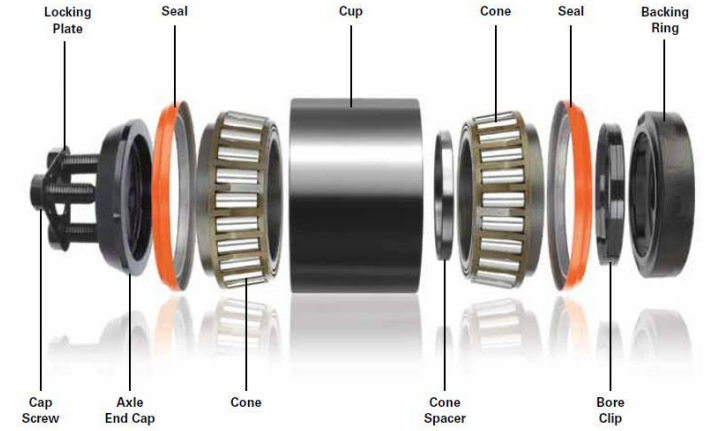




Expanded view of Cartridge Tapered Roller Bearing (CTRB)



Timken Roller Bearing



16.4 Process of Hot Axle CTRB Failure Investigation

The stage wise process of hot axle CTRB failures of investigation will be as under:

1. The hot axle CTRB will be received at wheel shop.
2. The dismounting of CTRB at wheel shop.
3. The cleaning of CTRB components.
4. The data be recorded as per RDSO format.

5. The cleaned CTRB will be sent to Chemical and Metallurgical lab (CMT) lab for further failure analysis.

16.5 The visual inspection of cup

Cup is inspected visually to detect different defects i.e., dent, flaking, spalling, brinelling, rust, peeling heat discoloration etc.





16.6 Visual Inspection of CTRB Components at CMT Lab

1. **Seal**

   Seal is inspected visually to detect different defects i.e., damage, deformation, rubber seal etc.



Damage Seal

2. **Spacer**

   Spacer is inspected visually to detect different defects i.e., dent, flaking, brinelling, rust, peeling, spalling etc.



Spacer

3. **Cone Assembly**

1. Consists of cone, cage, and rollers.
2. Cone assembly is inspected visually to detect different defects i.e., dent, flaking, brinelling, rust, heat discoloration.



Roller (deformed)



Cone



Cage (Broken)

16.7 Temperature on Non Contact Thermometer

CTRB Axle box/ Adopter temperature	State of bearing operating conditions	Action to be taken
Up to 38 °C Above ambient	Normal	Wagon allowed
Temp. of bearing above 90°C	Excessively warm/Hot	Wagon to be detached

Special instructions for Axle box temperature of coaches

1. If temperature is 80°C or beyond than coach should be detach from the train
2. Difference of temperature in same axle

S.N.	Difference in temperature	Action Taken
1	Up to 10°C	Allowed in same condition
2	10°C to 15°C	Inform to next C&W Examining point
3	16°C to 20°C	Accompany with coach by C&W staff up to destination



Non-Contact Thermometer

16.8 Precautions to avoid hot axle during ROH & POH

1. Earthing in wagons for welding should be done properly and very close to the welding area so that electric current does not pass through bearing, it will cause arcing between the rollers and raceways leading to failure.
2. Work with clean tools in clean surroundings.
3. Keep bearings wrapped in polythene sheet when not in use.
4. Apply clean grease and keep grease in closed container when not in use.
5. Grease seal and locking plate should be replaced by new.
6. RDSO approved brands of grease should be used.
7. Never mix up the different greases of different grades or even different makes of same grade.
8. Don't reuse locking plate.
9. End cap screws properly tighten with the help of torque wrench at specified torque of 40 kg – meter (290 foot-pounds).
10. Each and every time lateral play of bearing must be check and UST of all Axles should be done.
11. Load wear Zone area of bearing must be changed during fitment.
12. All tabs of locking plate are properly bent up against the flats of the cap screw heads.
13. Damaged outer cup bearing should not be allowed in service.
14. It must be ensured by stamping particular of grease seal that the CTRB would not complete more than 72 months by the time it becomes due for next POH/ROH.

15. The dismounting of bearing by oxy cutting strictly prohibited, as above such defects are considered very prone to generation of fatigue during service.
16. Overhauling cycle of new CTRB to take place of 72 months interval.
17. Bearing Mounting force to be maintained 55 ±5 ton.
18. Quantity of grease is used 400+30 gms now a days in place of 430 ±30 gms.
19. AAR approved Lithium base quality of grease must be used.

16.9 Duties of railway servants in case of Hot Axle/ any unusual condition on Running Train: -

1. Any railway servant, observing a hot axle, any hanging part, broken spring, and load shifting etc. on a running train must do everything in his power to stop the train and warn the train staffs.
2. Take immediate steps to short down the electric supply of OHE in electrified section.
3. If all attempts fail to draw attention of the train staffs, the Station Master/ Cabin Master/ ASM/ Switch Man shall inform the SM of the station in advance to stop and examine the train and shall inform the section controller.
4. On receiving the massage "Stop and Examine the Train" the SM shall not admit the train directly at station unless he is satisfied that the train has come to a stop at the first stop signal. Then only the approach signals shall be taken OFF for admission of train on Main Line.
5. In the event of the main line being not available and the train is to be received on a loop line, the SM, after ensuring that the train has come to stop outside the first stop signal, shall arrange to advise the LP of the train of the reason of the train being so stopped through a Station Staff/Points Man. The speed of train, while admitting on loop line, shall not be more than 10 KMPH.
6. The LP on being so advised shall examine the train to ascertain if it would be safe to work the train up to the station negotiating the crossover for entry into the loop line. The train, thereafter, shall be piloted up to the station after fixed signals have been taken OFF and

it has been ascertained by the LP that it is safe to do so. The LP while negotiating the facing points shall observe the speed restriction, which under no circumstances, shall exceed 10 KMPH.

7. The vehicles/wagon with hot axle must not be worked onward with the train, instead they would be detached from the train or repaired.
8. If an axle box is observed to be running hot in the block section the train must be brought to a stand immediately and the axle box is examined by the LP. The LP should exercise his discretion with regard to the restricted speed at which it is safe for the vehicles or wagons to travel. On arriving at the first block station with detaching facilities the vehicles or wagons must be detached from the train.
9. Water must not be poured on the Hot Axle for to cool it but wait until it gets cooled by itself. If there is fire on the hot box then fire extinguisher, sand, soil can be used to extinguish the fire.
10. The vehicles/wagons with hot axle shall be detached from the train on arrival at the station. And it will be entered in the Wagon Exchange Register and the concerned TXR shall be informed about it. BWM-4.10 shall be followed for other instructions.

16.10 The responsibility of Station Master exchanging all right signal.

The SM must carefully watch each train as it passes the station to ascertain that everything is alright with the train. If the SM observes anything unusual with a train, during its passage, such as signals of alarm by a passenger, doors open, goods or some parts of the vehicle falling off, a vehicle on fire, hot axle box, head light and marker light unlit, without whistling and exchanging hand signal and train entering the section without Authority to Proceed or other mishaps likely to foul or obstruct the railway line, and he has not been able to stop it by showing danger signal or by putting back the departure signals. The station master will take further action as under:

1. Give “stop and examine the train” signal to the station in advance.
2. Place all fixed signals at ‘ON’ at his station to stop any train proceeding in the opposite direction if he has reason to suspect that the other line may be obstructed.
3. Till such time the affected train has completely arrived at the station in advance the SMs on either end of the block section shall not allow

any train or trains running on adjacent line or lines to enter the section.

4. Advice the controller on the controlled area and the station master in advance on telephone the cause of sending the "stop and examine the train" signal.

The SM in advance shall take the following action promptly after getting information as under:

1. He must acknowledge the signal and immediately place or maintain all fixed signals at ON for any train coming from or going towards the station from which such signal was received.
2. In case of hot axle/hanging parts, the train must be examined carefully at the first stop signal at its stoppage there only. On the train coming to a stand at the station, the SM will examine the train carefully and take steps to rectify the defect.
3. If the SM is unable to ascertain after examination of the train why the signal was sent, he must inform the Loco pilot traveling in the opposite direction of the circumstances and give him a caution order.
4. Should any train going in the opposite direction be stopped by either SM, it may be allowed to proceed after it has been ascertained that the line on which it is to run is not obstructed.
5. If the SM observes goods or some parts of the vehicle falling off and believes that they might have fallen off before the train arrived within his station limits, he shall also advice the SM in rear. When such action has been taken, similar precaution will be taken for running of trains between his station and the station in rear. However, exchange of such information shall be between the station which apprehends between such danger and adjacent block station in rear.

TRAIN PARTING

17

Train parting is unforeseen division of a train into two or more portions while the train is on the run or just about to move. Train Parting is a common unusual occurrence affecting train movement adversely. Freight train operation by crew and maintenance of wagons are the two major activities involved in train parting. There are many contributing factors towards train parting such as inadequate maintenance, material failure, improper driving & improper marshalling etc. When the train is uncoupled and separated into parts while on run or at the time of starting or at the time of stopping, then the situation is called "Train Parting "and this incident is treated as accident.

Train Parting is an accident falling under the category of **'Equipment Failure'** and classification 'J' of Accident Manual. Prominent reasons for train parting are equipment failure or engineman ship.

Train parting can be caused by following reasons-

1. Sudden jerk and sudden application of brake by Driver / Guard.
2. Lack of co-ordination in between two Drivers when two locomotives are working in rising gradient.

3. After stopping, Driver starting the train without full release of brakes.
4. On rising gradient locomotive wheels slip due to bad weather when the sanders of loco are not working or due to non- availability of sand in sanders. This will cause sudden jerk on the train.
5. Slack or loose coupling.
6. Flaw in material.
7. Reduction in cross- section of coupler body or any part of screw coupling.
8. Manufacturing defects in component like defective material, improper heat Treatment, blow holes or air inclusion in casting.
9. Improper securing of screw coupling with Draw bar.
10. Working out of Transition coupling.
11. Improper fitment of CBC lock.
12. Working out of CBC head due to droppage of yoke pin.
13. Breakage of yoke pin support plate.
14. Breakage of CBC shank due to excessive wear.
15. Dropping down of CBC head.
16. Breakage of knuckle improper locking of the knuckles, in effective anti-creep Mechanism.
17. Due to defects in lock and lock assembly of CBC, train parting is classified under two main heads.

17.1 Types of Train Parting: Train parting is classified under two main heads.

Vertical Parting: -

Vertical parting takes place due to excessive CBC height variation. The main reasons for variation in CBC height are:

1. Loose/ low rail joints
2. Mud pumping under the rail joints
3. CBC drooping– excessive wear and tear of coupler shanks and striker casting/bearing piece.
4. Excessive overloading in the wagons.

Horizontal Parting: -

Horizontal train parting takes place due to following reasons:

1. uncoupling of CBC.

2. Breakage/ wear of CBC components due to inherent defects.
3. Failure of draft gear.
4. Bad engineman ship

17.2 Uncoupling of CBC:

The most common causes of train parting are, uncoupling of CBC on run (without any breakage of any parts), breakage of knuckle failure of draft gear and working out of CBC. The reasons of uncoupling and preventive measures taken to avoid uncoupling are described as under –

1. **Lock not properly engaged –**
   In most of the cases, the lock does not drop down to the full locked position inside the coupler head. This may result in slipping up of the lock during run causing uncoupling.
2. **Ineffective anti-creep device –**
   Lock may slip up due to jerking and jolting during run if the anti-creep feature is not effective.
3. **Operating handle dropping on run –**
   This is caused by breakage of supporting bracket resulting in operating handle falling down on run and hitting the ballast. This tends to turn the handle leading to lifting of the lock piece and uncoupling.
4. **Excessive play between anti–rotation lug and bearing piece slot:**
   Due to excessive play between anti-rotation lug and bearing piece slot, operating handle can operate on run due to jerks and can cause uncoupling. Anti-rotation lug is made out of square cross section MS bar with standard dimensions of 16 mm x 16 mm and slot width in bearing piece of 17.5 mm.
5. **Unauthorized tempering with operating handle –**
   This is believed to be a common incidence by many Railways. Since, uncoupling lever is situated alongside the wagon and is easily accessible, it is easily prone to unauthorized and mischievous manipulation.
6. **Uncoupling due to vertical slipping out of knuckle –**
   This may occur due to abnormal relative vertical movement between the two coupler heads causing slippage of one knuckle

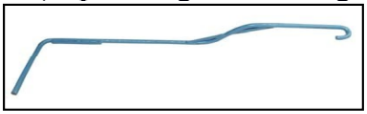
out of the other. This situation is very unlikely to arise but there may be a possibility in the event of combination of number of adverse factors like maximum difference in coupler heights & unevenness on rail joints.

17.3 Guidelines for Preventing CBC Uncoupling: -

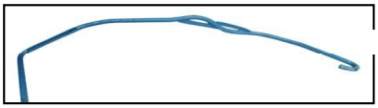
The cases of uncoupling of freight trains on the Railways have increased. On thorough analysis, it came to light that required attention is not being paid during ROH and Yard examinations. It is also observed that, the knowledge of the technicians is not sufficient. It is therefore necessary to impart training to technicians on the subject matter in the C&W BTCs. The following guidelines with pictorials of the defective parts of CBCs are given for ready references: -

17.4 Operating Handle:

The correct geometry of the operating handle is very essential. The operating handle should not be bent. The photograph of proper and improper (bent) operating handle is given as under.



Standard operating handle



Bent operating

The length of the operating handle are different for different types of wagons. The length of the operating handle wagon wise are given as under.

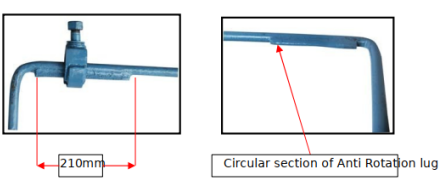
S.No.	Type of wagon	Standard length in MM
1	BOXN/BCN	1414
2	BLCA/BLCB	1063
3	BTPN	1414
4	BVZI	1414
5	BVZC	1450

17.5 Anti-Rotation Lug:

There should be no excessive wear in **Anti rotation lug**. The lug length and all the dimensions of the lugs are very important as there should not be any excessive play between the bearing piece and anti-rotation lug. The standard section of the anti-rotation lug is **16 mm x 16 mm.**

The circular section on anti-rotation lug should not be permitted at all. The operating handle provided with the photograph of operating handle with circular section lug is given as under.

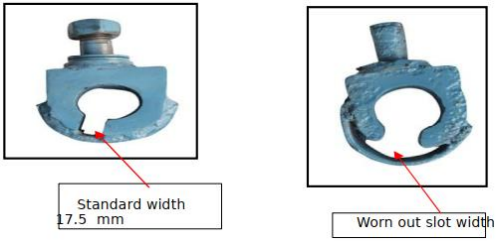
Photograph of new rotation lug Photograph of circular section of rotation lug



Slot:

There should not be any excessive wear in the **bearing piece** slot. The standard width of the slot is 17.5 mm. The photographs of the bearing pieces with standard slot width and worn-out width are given as under.

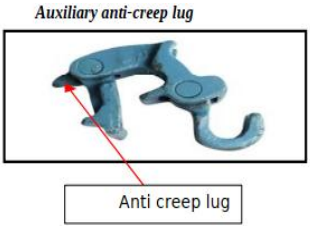
The bearing piece pin should be properly welded to hanger bracket. The photograph of the correctly welded bearing pin is given as under.



Articulated Lock Lift Assembly:

The components of Lock Lift Assembly such as **toggle, lever connector and lever hook** should be properly riveted. The photograph of Lock Lift Assembly is given as under.

Ensure that anti creep lug of the lever connector is not excessively worn out. There is no gauge specified for measuring the wear. However, it should be checked with worn sample which can serve as a comparator.





Effects of train parting

1. Safety hazard.
2. Detention to the affected train in the section and at station for clearing and attending or detouching the affected coach for repair.
3. Detention to coaches' other trains due to blockage of the section.
4. Loss of section capacity.
5. Detention to coaches for repairs at the station or to send the nearest sick line for repairs.
6. Loss of revenue to the Railway due to the coaches' days lost on account of the above.
7. Loss of power due to stoppage of the train, chunting etc.
8. Increase in the workload for the running and maintenance staff.
9. Additional cost of labour and materials for repairing the affected Coach/Wagon.
10. Inconvenience to the passengers, due to detention and late running of train.
11. Loss of passenger/customers on account of delay or non-punctual trip of goods.

The Rules & Instructions to Be Followed during Train Parting

Following are the consolidated summary of rules and regulations required to be followed by various designated staff based on the guidelines issued under GR&SR 6.08, 2.11, Appendix II of G&SR, BWM and Accident Manual.

Role of Station Master (GR&SR 6.08, BWM)

1. When the SM notices a train running through the station is incomplete, he shall not exhibit stop hand signal; instead, he should show green flag /white light during day / night vertically as high and as low as possible (train parting/divided signal) to the GLP.

2. He may also shout on walkie-talkie and try to attract the attention of the train crew.
3. He shall give 000000 – 000 bell code to SM in rear (train divided signal) and 000000 – 00 bell code to SM in advance (train passed without tail board /lamp).
4. The SM shall not grant / obtain line clear for a train. In the case of Podanur push-button Tokenless block instrument on single line sections, he shall remove the 'shunt key' and prevent the SM in rear from taking line clear without his knowledge.
5. On double line / twin single line / multiple line sections, the SM shall ensure no train is entering on the adjacent unobstructed line.
6. If it is confirmed that there was a train parting and the parted vehicles have not reached either to his station or to the station in rear, the SM shall arrange to send a relief engine with T/A 602 authority after a lapse of 30 minutes more than the running time of the slowest Goods train which has to be calculated from the time of the receipt of the bell code 000000 – 000.
7. If the parted vehicle/s are closely following the front portion, the SM shall place 3 detonators on the line to attract the Guard's attention who may apply handbrakes in the BV and stop the second portion/s and also, if possible, set the points to vacant line / siding.
8. The SM shall inform the occurrence to the SCOR, make red ink entry in the TSR and entry in the Station Diary.

Role of Loco Pilot (GR&SR 6.08)

1. The design of the braking system will ensure stoppage of both the portions.
2. However, as soon as the LP comes to know about train parting on run, if possible, the LP should keep the front portion in motion till the rear portion comes to a halt to avoid possible collision. This does not mean that he can pass Gate Signal / IBS / Station Signal at 'on'; in other words, he must obey the aspect of the signal.
3. The LP shall alert the Guard and station staff by sounding the engine whistle code of one long, one short, one long, one short. If

there is a banker engine, the LP of that banker engine shall apply the brake and stop the rear portion.

4. If both portions of the parted train have come to a halt and is possible to couple, the same shall be coupled up.
5. If not possible to couple the formation/s, the train can be worked as per 'divided train working' rules. However, divided train working is not permitted for passenger carrying trains.
6. If the train is running without Guard, the duties devolve on Guard is applicable to the LP.

Role of Train Manager (GR&SR 6.08)

1. On hearing the engine whistle code of one long, one short, one long, one short, he shall apply hand brake of the BV and ensure stopping of the second portion.
2. He shall exhibit the green flag / white light by day / night vertically as high and as low as possible to indicate train parting.
3. Once the rear portion is stopped, he shall protect both in front and rear as per GR 6.03.
4. After stopping both the portions and is possible to couple up, the Guard shall jointly check along with the LP, the formation as per the VG including tonnage before restarting.

Role of Gatemen (Appendix II of G&SR)

1. On noticing a train parting, the Gateman shall never exhibit 'danger' signal.
2. Instead, he should show green flag / white light during day / night vertically as high and as low as possible to the train crew.
3. He should shout, whistle, and attract the attention of the LP and Guard.
4. If there is sufficient time between two portions, he shall place 3 detonators to attract the Guard in the second portion.
5. Inform the SM on the telephone about the unusual noticed.

Role of any Other Railway Servant (GR&SR 2.11)

1. On noticing a train parting, shall never exhibit 'danger' signal.
2. They should try to attract the attention of the crew by shouting and at the same time put both their hands together above their head and separate them smartly as an indication of train parting.

UNDERSTANDING LOCOMOTIVES
(DIESEL & ELECTRIC)

18

The terms diesel or electric, so far as locomotive is concerned, mainly refers to the traction unit. Presently Indian Railways is using two types of locomotives, Diesel & Electric locomotives. In a typical diesel locomotive, the tractive effort is either generated by a Diesel engine or Traction Motors utilizing the electrical energy produced by on-board Diesel Engine- Generator. In electric locomotives, the tractive effort is generated by traction motors utilizing the electrical energy tapped from 25 KV overhead equipment

Transmission of power to driving axles in the case of diesel locomotive is commonly electric or hydraulic. The locomotive is accordingly called Diesel-Electric or Diesel-Hydraulic.

Main line diesel locomotives on Indian Railways are mainly Diesel Electric. Diesel-hydraulic locomotives are generally used for shunting only.

In diesel-electric locomotives, the diesel engine produces electric energy through a diesel generator onboard. The electric energy is transmitted via cables to electric traction motors, which drives the axles & produce tractive effort.

In the case of electric locomotive, transmission of power to axles is met through electric traction motors, which are run by electric energy drawn from 25 KV overhead equipment.

Physically any locomotive can be divided into two basic parts- Underframe & Superstructure. The Underframe consists of Wheels, Axles, Bogie, Traction Motors, Brake riggings, Cattle Guard etc. The Superstructure consists of Powering Units, Control System, Auxiliaries & Driver Cab.

On the Indian Railways, axle-hung nose suspended type traction motors, powering individually each axle (i.e. one traction motor for each axle) or fully suspended traction motor is used for high-speed diesel and electric locomotives. In these type of traction motors configurations, motor is fixed with motor suspension unit (MSU) which is mounted on axle through and thus is hung from the axle at one end while the other end (nose) is supported on the bogie frame. The gear of the motor meshes with the gear on the axle and drives the pinion (**Fig.** 18.1).

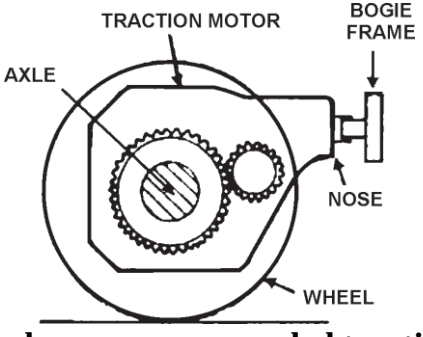


Fig. 18.1 Axle hung nose suspended traction motor

18.1 Nomenclature of Locomotives

There are four parts of nomenclature of locomotives. These parts are denoting for the Gauge, Power Source, Service and Version respectively.

Gauge, Power source and Service

Type	Symbols used are
Gauge	
BG	W
MG	Y

NG	Z
Power source	
Diesel	D
Electric,dc	C
Electric,ac	A
Electric, dc/ac	CA
Service	
Passenger traffic	P
Mixed traffic	M
Goods traffic	G
Shunting	S

For instance, WDM stands for B.G., Diesel, Mixed traffic locomotive. The designation also carries a suffix which indicates a particular design or version in the relevant group, e.g. WDM2, WDM4, WCG2 and so on.

18.2 Nomenclature of Locomotive Bogie

Numerals stand for number of axles in each bogie which also includes non-driving axles, the function of which is only to carry a part of the locomotive superstructure weight and not to develop any tractive effort. Alphabets (capital) stand for number of axles (in each bogie) which develop tractive effort, e.g.

A =1; B = 2; C = 3

Independently driven axle is suffixed

Some examples of designations from consideration of wheel and traction arrangement are shown in **Fig.** 18.2.

The high-speed diesel and electric locomotives on the Indian Railways are mainly of Bo-Bo or Co-Co arrangement.

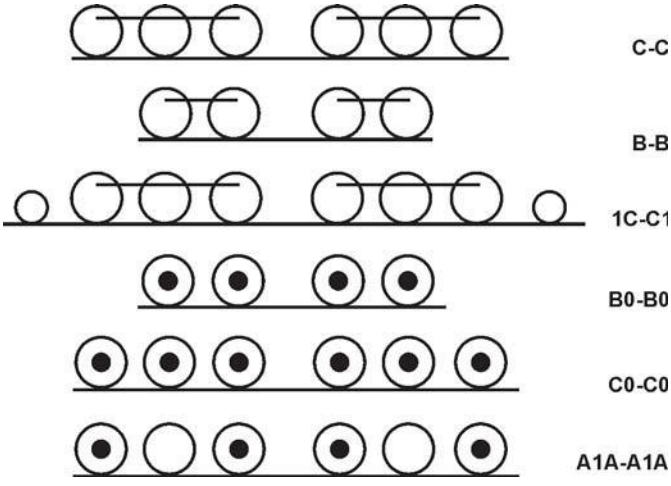


Fig. 18.2 Axle and Traction Arrangement

18.3 Locomotives and bogie type

There is various type of locomotives on the Indian Railways. They may be functionally different or their features, such as bogie design, number and type of traction motors etc. may be different. Study of the features and critical maintenance parameters of locomotive bogies is of prime interest from the point of view of derailment.

The design of bogies plays a vital role in the performance of the locomotive. List of bogies and the locomotives on which they are provided, for the common locomotives on the Indian Railways is given in Table 18.1.

Table 18.1
Bogie type for different locomotives (Check Data) + New Loco

Sl. No.	Bogie Type	Locomotive	Remarks
1.	CO-CO Tri-mount Bogie	WDM2	Max speed 120 kmph (WDM2 (modified)), 2600/2400 HP. Many WDM2 have been converted to WDM3A
		WDM3A	Max speed 120 kmph
		WAM4	Max speed 110 kmph, 3600 HP, WAM 4P (being heavily used) and 4B were regeared versions for passenger / goods

		WAG5	3850HP, Varriants: WAG-5A (Alstom motor), Max speed 100/105 kmph, WAG-5H (Hitachi motor) max speed 80 kmph, WAG-5P (fast passenger traffic), Variants usedfor mixed operation
2.	High Adhesion Bogie	WAG7	Max speed 100 kmph,5000 HP
		WDG3A	Max speed 100kmph, 3100 HP
		WDM3D	Max speed 120 kmph, 3300 HP
3.	Mitsubishi	WAM2/ WAM3	Imported (in 1960s), condemned after completion oftheir codal life.
4.	Flexi coil Mark I Castbogie	WDM4	CO-CO bogie (GM design), Max speed 130 kmph, Was runon Howrah Rajdhani. Since phased out
		WAP1	CO-CO bogie, WAP1-HE (Hitachi) - 3900 HP, Maxspeed 130 kmph
		WAP4	WAP1 (5000 HP) was renamed WAP4 max speed 140 kmph
5.	Flexi coil MarkIV bogie	WAP3	CO-CO fabricated bogie.All WAP3 have been converted to WAP4
		WAP6	CO-CO fabricated bogie.All WAP6 have been converted to WAP4
6.	Bo-Bo fabricated bogie (ABB)	WAP5	5500 HP, Max speed 160 kmph, upgradable to 220 kmph. Imported from ABB and now being manufactured at CLW with TOT.
7.	HTSC bogiefor GM EMDLoco	WDG4	4000 HP, Max speed 105kmph.Imported from General Motors and now manufactured at DLW
		WDP4	4000 HP, Max speed 160 kmph,(designed for 180 kmph)
8.	Co-Co Flexi coil fabricatedbogie (ABB)	WAG9	6000 HP, Max speed 100 kmph.3-phase loco imported from Bombardier and now manufactured at CLW with TOT
		WAP7	6000 HP, Max speed 140 kmph.Same design as WAG9, with changed gear ratio.

18.4 Wheel wear and General

Important items of the Instruction Bulletin on 'Wheel Wear and Application Management' No. MP.IB.BD.02.16.01 (Rev.01) dt. 31.12.2009 are as follows-

1. Brake cylinder pressure is to be maintained as stipulated to avoid excessive thermal loading of wheels due to repeated application.
2. Dynamic brake is provided on all locomotives on IR (except for WAP4). They should be used, specially while operating in a ghat section, Use

of loco brake should be limited tothe minimum.

3. Matching of spring based on free height parameter is not adequate. They should be matched as per height under working load. Springs should be colour coded as per instructions of the specified Instruction Bulletins.
4. Pins and bushes of the Equaliser beam in Trimount/ High Adhesion bopgie should be of recommended design andthese should be renewed as specified in the Maintenance Instruction. Otherwise, inter-axle load transfer gets affected.
5. Locomotives having wheel guidance through pedestal are provided with liners at pedestal as well as on axle box. Lateral and longitudinal clearances to be maintained and the corresponding reference documents are specified inthe Instruction. Proper record of these clearances is tobe kept for all specified schedules.
6. Wear adapted profile as per RDSO Drg. No. SK. DL-2561 (Alt.8) shall be applicable to all BG Diesel& Electric locomotives irrespective of speed or IRS Thick flange profile as per CSL-3040 would be applicable beyond 110 kmph(**Fig.** 18.3 and 18.4).
7. Correct cause of biased wear on a wheel should be identified considering Brake block shifting, Excessive lateral or less Longitudinal clearance between axle box and pedestal, Misalignment of bogie frame and excessivewheel diameter variation.
8. Variation in diagonal dimensions of bogie should not be more than 3 mm in order to prevent misalignment.
9. General limit of variation in wheel diameter is specified as below (Note- Any other specific instruction, if issued, may be followed)

Location	At **wheel turning**/change (mm)	**Service limit**(mm)
On same axle	0.5	2.5
On same bogie	2.0	8.0
On same loco	15.0	25.0

The Instruction includes limits of wheel diameter for various locomotives.

10. Limits of root, flange and tread wear are given for various locomotives.
11. Permissible variation in Wheel gauge is as below new assembly: 1596 (+- 0.5) mm

Service limit: 1596 (+3, -0.5) mm

12. Recommended time for application and release of Full service and Emergency brake application, brake pressure and suitable brake application practice are specified forreducing wheel skidding.

Limits of Wheel diameter, Variation in wheel diameter, Wear limits of Root, Flange and Tread and Lateral and Longitudinal clearances at the axle box for different locomotives, as specified in the Maintenance Instruction, are reproduced as **Annexure- I** to this chapter.

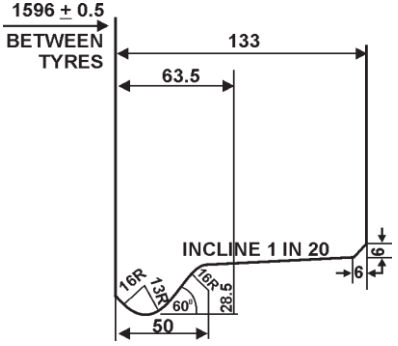


Fig. 18.3 Thick IRS Tyre Profiles for BG Loco

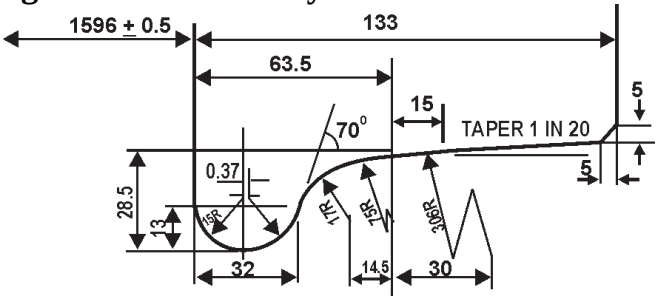


Fig. 18.4. Wheel Tread Profile (Wear adopted) for BG loco

18.5 Locomotives Bogies

Bogies of common locomotives on the Indian Railways are discussed along with some basic features of locomotives in the following paras.

18.6 CO – CO Tri-mount bogie

WDM2 (RDSO Report No.M.195)

This diesel-electric locomotive with Co-Co bogies has been

designed for mixed traffic service with a rated horsepower of 2600/2400 HP. The transmission system consists of six axle-hung nose-suspended traction motors, one for each axle, and the motor torque is transmitted to the wheels through reduction gears. The design is adapted from ALCO (American Locomotive Company, U.S.A.)

The general arrangement of the bogie is shown in **Fig.** 18.5 (a) and (b). The bogie, which is of ALCO special tri-mount type, has a center pivot and two side bearers which form a three-point support for the superstructure weight. The pivot carries 60% of the vertical load and also transmits tractive and braking forces. The two side bearers working in oil bath carry the remaining 40% of the vertical load equally distributed. The bogies are so oriented that the side bearers are located towards the center of the locomotive.

The tri-mount bogie design incorporates a single stage suspension. The spring system consists of four groups of two nests of springs, each nest consisting of one outer and one inner helical oil.

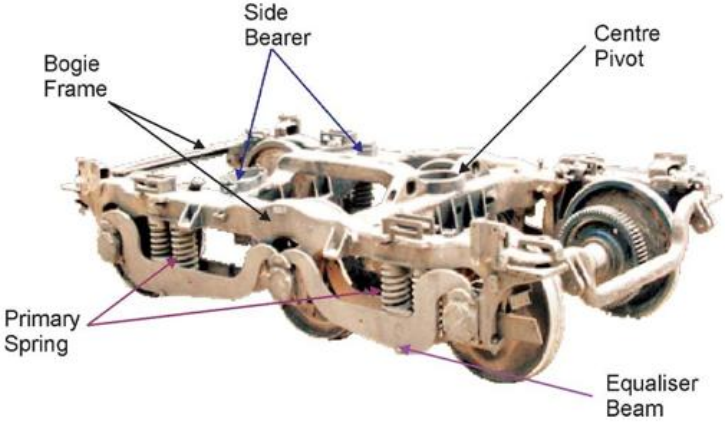
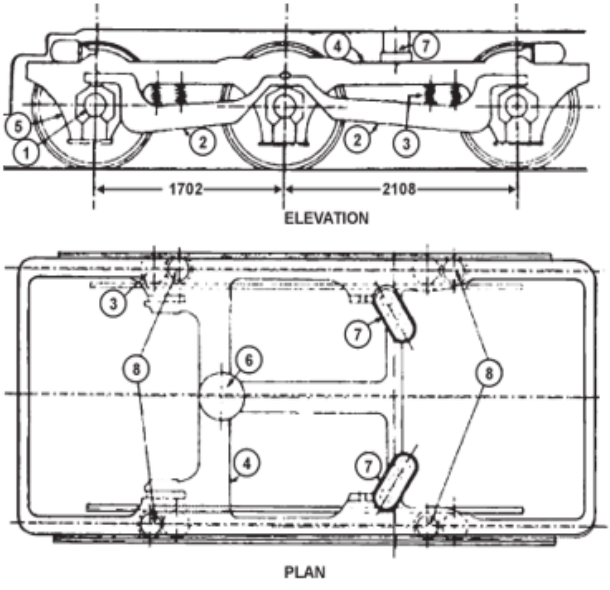


Fig. 18.5(a) WDM2 Locomotive



1. Roller bearing axle boxes.
2. Equalising beams.
3. Main bearing springs (helical).
4. Bogie frame-cum-bolster.
5. Horn-guides or bogie pedestals.
6. Centre pivot.
7. Side bearers.
8. Spring loaded friction snubbers (working inside main springs).

Items and features to be checked for defects during deraliment investigation :

General * Defects in wheelsets, axle box assembly, horn guide axle box assembly, spring gear. buffing gear and brake gear. * Clearances and play at axle box level.

Particular * Surfaces of the centre pivot and the two side bearers-for any hindrance to bogie rotation. * Spring loaded friction snubbers.* Equalising beams whether swivelling freely at their points of support axle boxes.

Additional for WDM$_2$ (modified) locomotive bogie :

* Resilient thrust units in the axle boxes of outer axles of each bogie.

Fig. 18.5(b) Suspension Arrangement WDM2 Locomotive



Fig. 18.6 Spring Loaded Friction Snubber

The spring nests are mounted on equalizer beams which in turn rest on axle boxes. The cast steel bogie frame containing axle-hung nose suspended traction motors and gearing rests on the spring system.

Equalizing beam arrangement is such that the vertical load is equally transferred to all the three axles. For achieving this, the beam is supported at the correct location on the manganese steel liner

welded on top of the axle box.

Damping is provided by four units of spring-loaded friction snubbers working in conjunction with one of the inner coils in each spring group. The snubber assembly consists of 3 alloy steel friction shoes working up and down in a case-hardened sleeve (**Fig.** 18.6). The shoes are pressed against the sleeve by 3 pre-compressed springs equally spaced. Rubbing up and down, the sleeve provides a constant force of about 500 kg per snubber unit. Principal design particulars of the locomotives are given in **Table** 18.2:

Table 6.2

Principal design particulars of WDM2 locomotive	
Horsepower	2600/2400
Wheel arrangement	Co-Co
Wheelbase	
a) Total locomotive	**12230 mm**
b) Bogie	3810 mm
Wheel diameter	1092 mm
Tyre Profile	Wear adopted
Maximum overall dimensions	
a) Height	**without chimney Extension (As per RDSO Drg no. SKDL-3591)**
b) Width	**3070 mm over hand brake clevis (As per RDSO Drg no. SKDL-3591)**
c) Length overall	**17164 mm over Buffers**
d) Length over headstocks	**15862 mm**
Driving arrangement	One traction motor per axle
Axle load	18.8 t

The axle boxes are guided vertically and laterally between pedestals cast integral with the bogie frame. To provide negotiability over curves and turnouts transverse play has been provided between the axle boxes and the bogie frame.

To get safe train operation from these locomotives, specific clearances between axle boxes & horn guides has to be maintained

which are measured in the locomotive sheds during their routine maintenance.

A transverse play ranging from 6 mm minimum to 12 mm maximum is available between axle boxes and horn guides in the case of outer axles. Transverse play between the center axle boxes and the horn guides ranges from 25 mm minimum to 31 mm maximum. The total longitudinal clearance is 0.363 mm in all cases, the maximum permissible being 1.9 mm. With Cylindrical roller bearings fitted on the journals, there is no lateral play between the axle and axle boxes.

The wheel profile is wear adopted.

This locomotive has been tested and found stable at only up to 115 km/h, and has been cleared for a maximum operational speed of 110 km/h.

Defects

Apart from the defects discussed for rolling stocks in general, following needs particular mentioning:

1. The surfaces of the center pivot as well as of the two side bearers should be checked to see if there is any tendency for causing hindrance to bogie rotation. Crack in the oil bath leading to leakage of oil and lack of lubrication in the center Pivot are common defects.
2. The condition of the spring-loaded friction snubbers should be checked to see whether damping is adequate or not.
3. The equalizing beams should swivel freely at their points of support on the axle boxes, otherwise off-loading of one wheel will not be shared by the adjacent wheel or wheels. It can be checked by rotating the roller pins by hand, which should rotate freely in position.

WDM2 (Modified)

Beyond 115 km/h, WDM2 locomotive exhibits unsatisfactory riding characteristics in the lateral mode. To increase the speed potential of this locomotive, certain modifications were carried out and the modified version is called WDM2 (modified). The main modifications are:

1. Provision of resilient thrust units at the axle boxes of outer axles of each bogie. This comprises an annular rubber cone which when fitted has a precompression of 2 mm equivalent to 1 T force. This

resilient restraint improves lateral stability on the straight as well as negotiation around curves and turnouts.

2. The middle axle has been given a free float (lateral freedom) of 10 mm either way, enabling the locomotive to negotiate curves of 174 m radius in conjunction with the 5 mm permissible compression of the rubber cones in the outer axles.
3. Lateral clearances between the bogie pedestals and axle boxes have been reduced.

With the above modifications, the WDM2 (modified) has been cleared for a maximum operational speed of 120 km/h (having been tested and found stable up to 140 km/h).

It will be obvious, that when the rubber cone in the resilient thrust unit wears out, the beneficial effect would be lost, and the locomotive would behave as if it were WDM2 only for which the maximum speed is only 110 km/h. In WDM2 (modified), therefore, the resilient thrust unit should particularly be checked without fail in case the locomotive was scheduled for running at maximum speed of 120 km/h.

WAM4 (RDSO Report No.336)

WAM4 type ac electric locomotive, designed for operation on 25 kV ac single phase 50 Hz overhead lines, has a rated horsepower of 3600 HP. The bogie and the suspension details are identical to those of the WDM2 locomotive.

Nominal and maximum limits of transverse play between axle boxes and horn guides for different axles are given below:

Axles	Nominal	Maximum
Outer axles	6 mm	12 mm
Middle axles	25 mm	31 mm

No axle play has been provided between the journal and the bearings. Total longitudinal clearance per pedestal is 1.5 mm nominal, maximum permissible being 5 mm. Salient particulars of this locomotive are given in Table 18.3.

Table 18.3

Design particular of WAM 4 locomotive	
Horsepower	3600
Wheel arrangement	CO - CO
Wheelbase	

a) Total	14898 mm
b) Bogie	3810 mm
Wheel diameter (new)	1092 mm
Tyre profile	Wear adoptedMaximum overall dimensions
a) Height	4162 mm
b) Width over body panels	3055 mm
c) Length over buffers	19974 mm
Axle load	18.8 T

This locomotive has been cleared for a maximum operational speed of 110 km/h. However, some of the Railways have reported severe hunting tendencies in this locomotive at speeds around 80-90 km/h, particularly when coasting down a gradient. Improvement in running characteristics has been reported by removal of the traction motors links which were provided between the traction motors and the bogie frame.

The defects to be checked for during derailment investigation would be the same as those in case of WDM2 bogies.

YDM4 and YDM4A (RDSO Report No. M-317 and C-138)

The wheel arrangement and suspension system of these locomotives is more or less similar to that of WDM2.

YDM4

The YDM4 diesel-electric Co-Co type locomotive (design of M/s. ALCO Products Inc. U.S.A.) is an M.G. mixed traffic service loco, with a rated horsepower of 1400. Power transmission is through six axle-hung nose-suspended traction motors, one for each axle.

The locomotive has a single stage vertical suspension with helical springs. Each bogie has a center pivot and two side bearers which form a three-point support (tri-mount) for the superstructure weight. The bogie pivot carries 64% of the vertical load and also transmits tractive and braking forces. The remaining load is shared equally by the two side bearers. Damping is provided by a set of friction snubbers in each spring group. Each spring cluster, consisting of two spring group, is provided with one snubbers spring group.

YDM4A

This locomotive (design of M/s. Montreal Locomotive Works, Canada) is identical to the YDM4, in all principal features, except in regard to the transfer of load of the superstructure to the bogie.

The body weight is transferred to each bogie through three load bearing pads. Two of the pads are located on either side of the bogie pivot while the third pad is located along the longitudinal center line of the bogie frame towards the inside axle of the bogie. The two load pads on the sides are each designed to carry 33 per cent of the total weight over the bogie and the inner pad carries the remaining 34 percent. The bogie pivot is not designed to carry any vertical load but acts only as a center of rotation for the bogie and also transmits the tractive and braking forces.

These locomotives have been cleared for a maximum operational speed of 96 km/h

(N.B.: On M.G. for speeds above 75 km/h, track has to be maintained to tolerances laid down in RDSOs Report No.C-138).

Same defects should be looked for, as in case of WDM2 locomotive, except that the surfaces to be checked for any hindrance to bogie rotation would be those of

1. the center pivot and two side bearers in the case of YDM4 locomotive.
2. the three load pads in the case of YDM4A locomotive.

18.7 High Adhesion Bogie

WAG7

WAG7 is a 5000 HP, 100 kmph locomotive provided with High Adhesion Fabricated CO-CO bogie. These locomotives have been a working horse for freight traffic on the electrified sections. The bogie achieves a higher tractive effort through better adhesion characteristics with reduced weight transfer.

This is a 3-axle type bolster less bogie with two stage suspension, floating pivot and uni-directional arrangement of axle hung, nose suspended traction motors. Bogie frame is of straight and fabricated box type construction with three transoms to carry nose suspension. The general arrangement of bogie is shown in Figure 18.7.

The locomotive body is supported on bogie frame through four rubber side bearers. Shims have been provided below outer side bearers to distribute load on side bearers in the ratio 60:40. Centre Pivot does not take any vertical load and is used only for transfer of tractive/ braking forces.

The bogie frame is in turn supported on helical coil springs mounted on equalizer beams. The equalizing mechanism consists of equalizers hung directly on end axle boxes and supported on middle axle box through a link and compensating beam arrangement. The equalizing arrangement enables achievement of equal axle loads and reduces weight transfer at start. A typical photograph of the Primary suspension arrangement of High Adhesion Bogie is shown in Figure 6.8.

The bogie has two stage suspension with helical coil at primary and rubber sand-witch (side bearers) at secondary stage. Lateral stiffness of the rubber springs is utilized to provide lateral guidance at the secondary stage. The total static deflection (vertical) is 119 mm, 102 mm primary and 17 mm secondary.

Four vertical hydraulic dampers of 750 kg at 10 cm/sec capacity are provided, one with each nest of primary springs. Two lateral hydraulic dampers are provided, capacity 1150 kg at 10 cm/sec, at secondary stage, to supplement the damping provided by side bearers in lateral and yaw mode.

The lateral spacing of side bearers provides stability against tipping forces on curves and damping provided by them prevents nosing at high speed.

Four lateral rubber stops are provided on each bogie on either side of middle axle to limit lateral movement between bogie and locomotive underframe. Vertical stops are provided on bogie frame to limit vertical movement between axle boxes and bogie frame.

Some important design and maintenance data are as below-

1. Axle load: 20.50 Ton
2. Length over buffers – 20394 mm
3. Bogie wheelbase – 3800 mm

4. Height of side buffers from rail level -1080 - 1105 mm
5. Primary spring – Total deflection 102 mm, Stiffness – Outer (40.80 kg/mm), Inner (15.46 kg/mm)
6. Secondary spring – Outer- deflection 17 mm, Inner – deflection 12 mm
7. Wheel tread diameter – 1092 mm (nominal), 1016 mm(service limit)
8. Difference in wheel tread diameter (service limit) – On same axle 2.5 mm, on same bogie 8.0 mm, on same loco 25.0 mm
9. Pedestal clearance (service limit) – Lateral clearance: End axles 30.7 mm, middle axles 11.5 mm; Longitudinalclearance: 6.0 mm
10. Centre pivot housing (service limit) – 366 (+-) 1 mm
11. Centre pivot pin (service limit) – 360 +1/ -0 mm

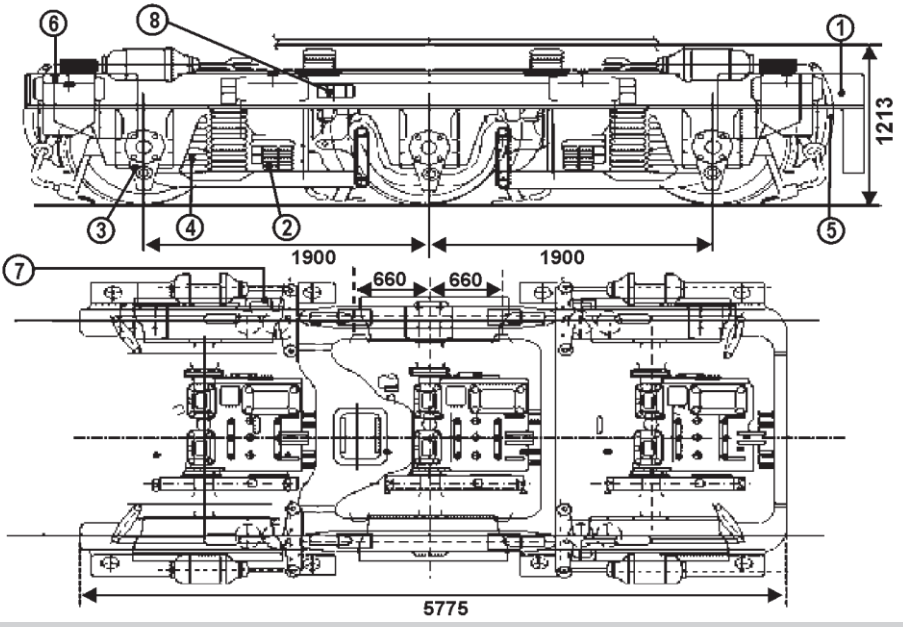


Fig. 18.7 WAG7 bogie: General Arrangement

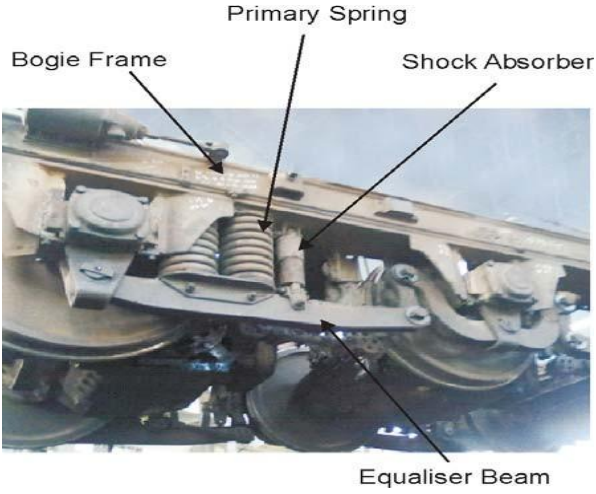


Fig. 18.8 High Adhesion Bogie: Primary suspension

WDG3A locomotive (old nomenclature WDG2 class) is provided with High Adhesion Bogie, having the same arrangement as of WAG7 locomotive.

WDM3D

WDM3D is a 3300 HP Mixed traffic Diesel locomotive, with maximum permissible speed of 120 kmph. It is provided with High Adhesion Fabricated CO-CO bogie, similar to that of WAG7.

The bogie has two stage suspension with helical coil at primary and rubber sand-witch (side bearers) at secondary stage. Inner spring of Primary stage has a stiffness of 15.46 kg/ mm, Free height of 512 mm (permissible variation +/- 9 mm) and working height of 407 mm (permissible variation + 4 mm, - 6 mm and working load 1629 kg). The springs are to be grouped and colour coded as A (Two Metallic Band) and B (One Metallic Band) based on the working height range of 401 – 407 mm and above 407 – 411 mm, respectively. Outer spring of Primary stage has a stiffness of 40.8 kg/ mm, Free height of 552 mm (permissible variation +/- 9 mm) and working height of 452 mm (permissible variation + 4 mm, - 6 mm and working load 4096 kg). The springs are to be grouped and colour coded as A (Two Metallic band) and B (One Metallic band) based on the working height range of 446 - 452 mm and 452 - 456 mm,

respectively. Spring of same working height (group) are to be used on the same bogie.

Height of the Side bearers is 165 mm. Its defects are Crack of 40 mm length or more on rubber surface, Bond failure of 40 mm length or more, Crushing or Crumbling of rubber and Permanent set of 10 mm or more.

The height of the Side Buffer is to be maintained between 1105- and 1085-mm. Shims are provided at Primary Spring seat to ensure this height. Whenever shims are used, height at all spring seats is to be checked to ensure equal load distribution on springs.

Service limit for Wheel gauge is 1596 (+3, -0.5) mm

Service limit for Centre pivot housing is 369 +1/ -0 mm

andCentre pivot pin is 358 +1.5 - 0.5 mm.

With increasing demand of mixed traffic on Indian Railways, a new high adhesion high speed bogie (HAHS) has been developed by RDSO for high horsepower locomotives to achieve higher tractive effort at start. This bogie has been provided on a modified version of WDM3D and WDM3E and WDM3F locomotives. The Equalizer beam has been eliminated in this bogie design. Transfer of vertical load in this modified design of bogie takes place directly from bogie frame to axle box (wing type) through a pair of helical springs located thereon. Primary suspension arrangement of the bogie is shown in the photographat Figure 18.9.



Fig. 18.9 Modified WDM3D Bogie

These locomotives are fitted with cylindrical roller bearings.

Movable axle journal boxes are mounted between pedestals or horns. Lateral play for negotiating curves and turn-outs is obtained by the movement of axle boxes in horns. End axle boxes are provided with rubber thrust pads to cushion lateral thrust, while 10 mm lateral play is provided on middle axle boxes.

In order to reduce the lateral forces between the rail-wheel in locomotive bogies at high speed, axial resilient thrust pad is incorporated in Axle Box of end axles of the bogie. The axle boxes of central axles of the bogie do not have Axial Resilient Thrust Units. Arrangement of end axle box is shown in **Fig. 18.10.**

The lateral thrust passes through the conical rubber thrust pad (C) held between inner and outer thrust collars (A) and (B).

The center axles are not provided with resilient thrust units. Adequate clearance has been provided in the bearing of these axle boxes to negotiate the sharpest curve. In actual service, the axle will be more or less 'floating' within 10mm lateral clearances.

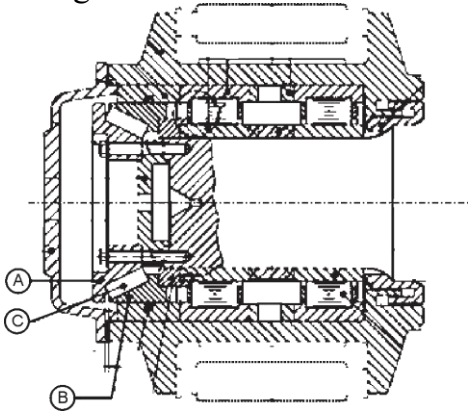


Fig. 18.10 End Axle box- With Resilient Thrust Unit

Primary suspension springs are to be checked for Free height and Working height at specified load. Permissible limits and colour coding scheme are as below-

Free height – maximum 553.9 mm, condemning 531.7 mm

Working height – Working load 3942 kg, nominal ht 441 mm, maximum ht 444 mm, condemning ht 431 mm

Colour code – Brown 441 – 444 mm, Blue – 438 – 441 mm, Green – 431 – 438 mm

Springs of the same group is to be used on a bogie. Springs with green colour code are to be used with shims such that their static height is in the range of Blue colour springs.

Side bearers (rubber spring) are to be checked for cracks ordamage and permanent set. Side bearer shall be replaced, if ithas completed a service life of 4 years, any of the metal platesshow cracks, cracks of 50 mm length or more on the rubber surface, bond failures of 40 mm length or more, crushing or crumbling of rubber and a permanent set of 10 mm or more.

18.8 Flexi-coil Bogie Mark-I

WAP1/ WAP4

Flexi-coil Mark-I bogie was designed by RDSO for operation of Rajdhani Express on electrified section, which were being hauled by imported WDM4 locomotive on diesel section. The design principles of this bogie are same as that of WDM4 loco bogie (General Motor design). WAP1 was inducted for hauling Rajdhani Express on NDLS – HWH section in 1981, at a speed of 130 kmph. Later on, the locomotive was cleared to operate at 140 kmph.

A higher tractive effort version of the locomotive has since been developed (5000 HP) and the loco has been renamed WAP4.

The bogie frame and bogie bolster of "FLEXICOIL" bogie Mark- I are of steel casting box type construction. The locomotive body weight is transferred to the bolster through a center pivot. The bowl is fitted with phenolic oil lubricated vertical and horizontal liners which provides rotational freedom between body and bogie in operation.

The cast steel "H" type bolster is supported on cast steel bogie frame at four corners, by pair of helical springs placed in spring pockets of main longitudinal member of the bogie frame. The bolster is located with respect to bogie frame by upright pedestals which are an integral part of the bogie frame. This arrangement

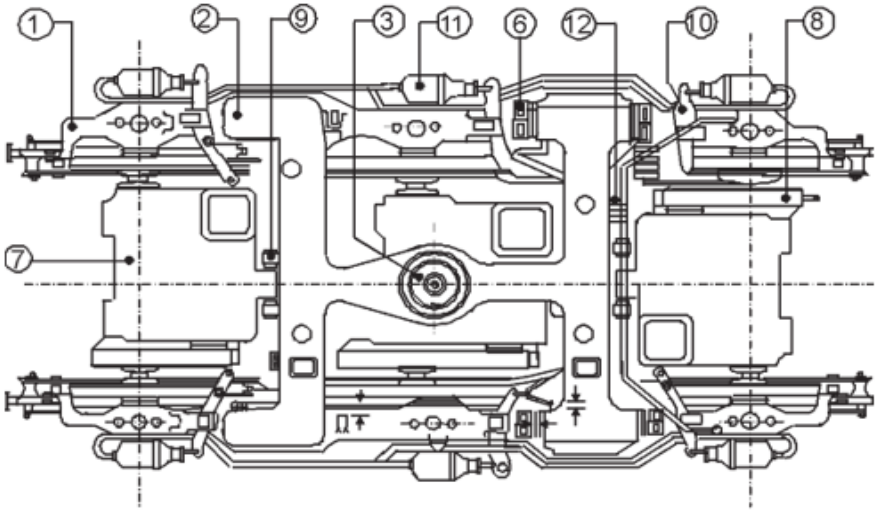
serves to transmit force from bolster to the bogie frame and vice versa. Spring loaded snubbing piston (2 nos. per bogie) made of phenolic material are provided to have high friction between bolster and bogie frame for damping in both vertical and lateral modes of oscillation. Lateral stops are also provided on the bolster as well as on the bogie frame to limit the side movement by flexing action of the springs, which is of the order of 32mm. General arrangement of the bogie has been shown in **Fig.** 18.11 (a) and (b).

Flexicoil bogie Mark-I has two stages of [vertical] suspension in which helical springs have been used at both primary and secondary stages. Loco flexibility on the primary and secondary stages are 0.75mm/t and 1.13mm/t, respectively. Total static deflection is 150 mm, comprising 66.0mm in primary and 84.0mm secondary. The transverse flexibility between the body and the bogie has been achieved by flexicoil action of the helical spring at the secondary stage. The support of the bolster springs has been placed on wider arm to give better stability in rolling. Shims of various thickness, already provided on the bogie frame and bolster below the spring seats of primary and secondary suspension, are to be retained and ensured during assembly since they are matched to get equal working heights of springs after calibrations.

The bolster spring friction device consists of a phenolic piston, steel washer and a spring contained within a cylindrical housing in the bolster. A suitable fixture and a jack may be used to apply or remove the friction piston. After the piston is installed, a safety stop is welded in position **(Figure 18.12).** After continued use, the wear on the friction piston will reduce its length and lessen the effect of the spring on the piston. The piston can be continued in use until the piston length 70mm is reached. This dimension will allow 16mm wear on the piston. However, when the piston reaches a dimension of 80mm or 6mm wear, a compensating washer 6mm thick is added to the standard 10mm washer.

In place of conventional pivot liner, "phenolic" synthetic liners are used in the Centre Pivot of this bogie. The load on these parts and

the relative movement between them cause the parts to wear. The outside diameter of the underframe pivot assembly and inside diameter of the bolster bowl should be checked to determine the total clearance between these parts. The condemning limit of this clearance is 6.0 mm. Lubricant is applied to the outside diameter of the vertical liners and then the liners are fit in the bowl 90 deg from the longitudinal center line of the locomotive. The re-used and condemning limits of these liners are shown in SK.MI-90/80/032. Condemning limit of thickness of horizontal liner is 6.5 mm. Phenolic liners are oil lubricated. The oil level to be maintained is 10mm above the horizontal liner top surface (**Fig. 18.13).**



PLAN

Fig. 18.11 (a) Flexi-coil Bogie Mark-I: General Arrangement

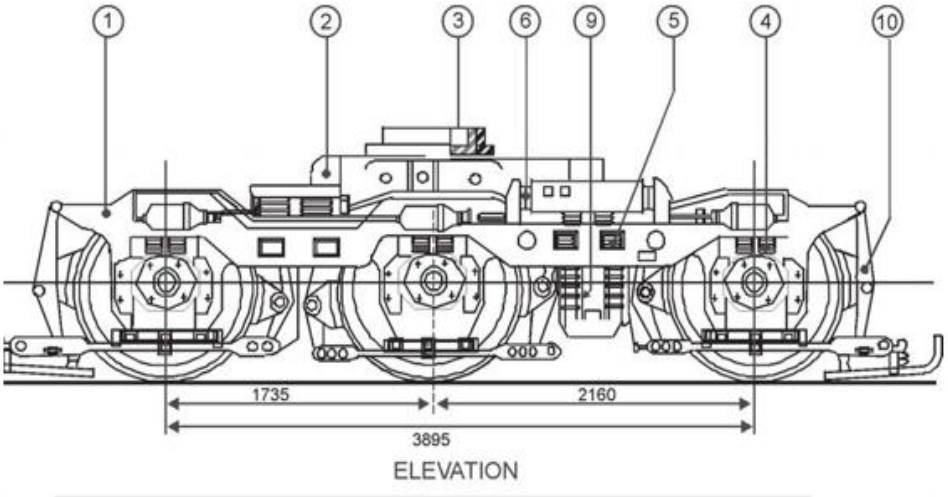


Fig. 18.11 (b) Flexi-coil Bogie Mark-I: General Arrangement

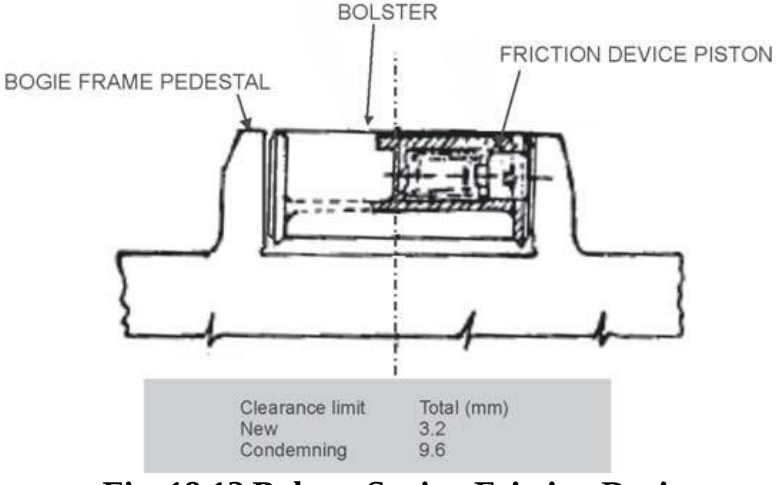


Fig. 18.12 Bolster Spring Friction Device

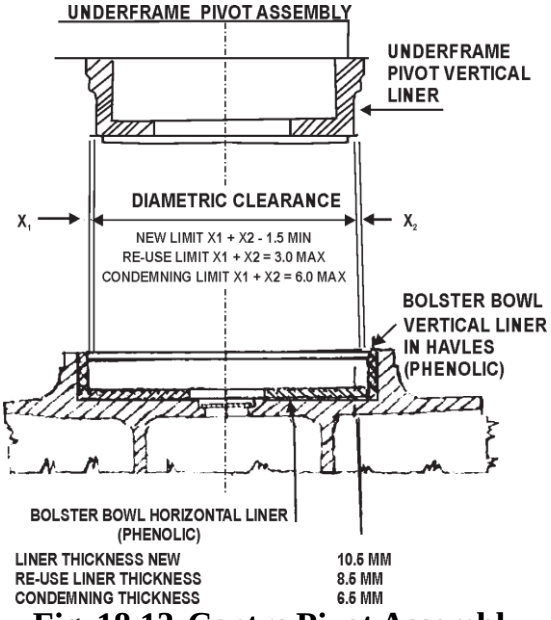


Fig. 18.13 Centre Pivot Assembly

All suspension springs are pretested for proper load/ deflection characteristics as per specified value. Springs are grouped as per variation of loaded height (with respect to nominal) of new spring and colour coded as brown (+5 to +1.6) mm, blue (+1.6to -1.6) mm and green (-1.6 to -5) mm. The service limit for loaded height is (-5 to -8) mm, and a white colour code is to be applied for use of used springs in this range. White coloured springs are to be used with proper shims such that overall static height falls within the limits of brown, blue or green colour codedsprings.

18.9 High Tensile Steel Cast (HTSC) GM Bogie WDG4/ WDP4

WDG4/ WDP4 locomotives of EMD (Electro-Motive Division, General Motors) design are provided with High Tensile Cast Steel (HTSC) bogie. These 4000 HP locomotives were originally imported from M/s General Motors, USA and are now manufactured by BLW, Benaras. The maximum permissible speed of WDP4 loco is 160 kmph and that of WDG4 is 100 kmph.

Unlike conventional rigid trucks/bogies, in which axles are held in

parallel with each other, the HTSC truck/bogie is designed as a powered "bolsterless" unit. Although the bogie or truck frame itself is rigid, the design allows the end axles to move or "yaw" within the frame. This movement will allow the wheels to position themselves tangent to the rails on curves for reduced wheel and rail wear. Traction loads are transmitted from the truck or bogie to the locomotive underframe through the car body pivot pin assembly.

The bogies are equipped with three axles. All three axles are powered by AC traction motors in case of WDG4 (Co-Co arrangement), whereas, in case of WDP4, only two axles are powered (AA1-1AA arrangement). The driving force is transmitted to the bogie frame through traction rods attached to the journal bearing adapter and the frame.

The un-sprung weight of the locomotive car body is transferred directly to the bogie frame through four rubber "compression" spring assemblies. These four spring assemblies are located at corner positions formed on the bogie where the side beams and cross beams intersect, thus providing the yaw stiffness for tracking stability. The soft primary suspension, made up of twelve single coil journal springs (two at each journal), is designed to provide ride quality and equalization of wheelset loads for operation over track irregularities. The bogie is equipped with vertical primary shock absorbers (6 no.) and lateral secondary shock absorbers (2 no.) for high-speed operation. General Arrangement of the bogie is shown in Figure 18.14. (a) and (b)

The journal bearing adapters transmit the vertical load from the springs to the axles. Cartridge type grease lubricated journal bearings are provided. These cartridge type bearings are self- contained, preassembled, pre-adjusted, pre-lubricated, and completely sealed. The adapter serves to position the journal springs between the truck/bogie frame and the axle to transmit the vertical loads. It also provides the means to position and control the axle laterally within the frame, as well as longitudinal control through the attached traction rod.

Rubber deflection pads on the adapters and nylon wear plates on the frame control the lateral thrust loads of the axles within the bogie frame. These pads and wear plates are renewable and provide the means by which the lateral clearances can be maintained within limits. Nominal Limits of total lateral clearance are 0.38 "(9.6mm) for end axles and 0.62" (15.7mm) for middle axle for WDG 4. These values for WDP4 are 0.24" (6.1mm) and 0.62" (15.7mm) respectively. The service limit of these clearances is 0.62" (15.7mm) and 1.0" (25.4mm) for WDG4 and 0.5" (12.7mm) and 1.0" (25.4mm) for WDP4. The arrangement is shown in **Fig. 18.15.**

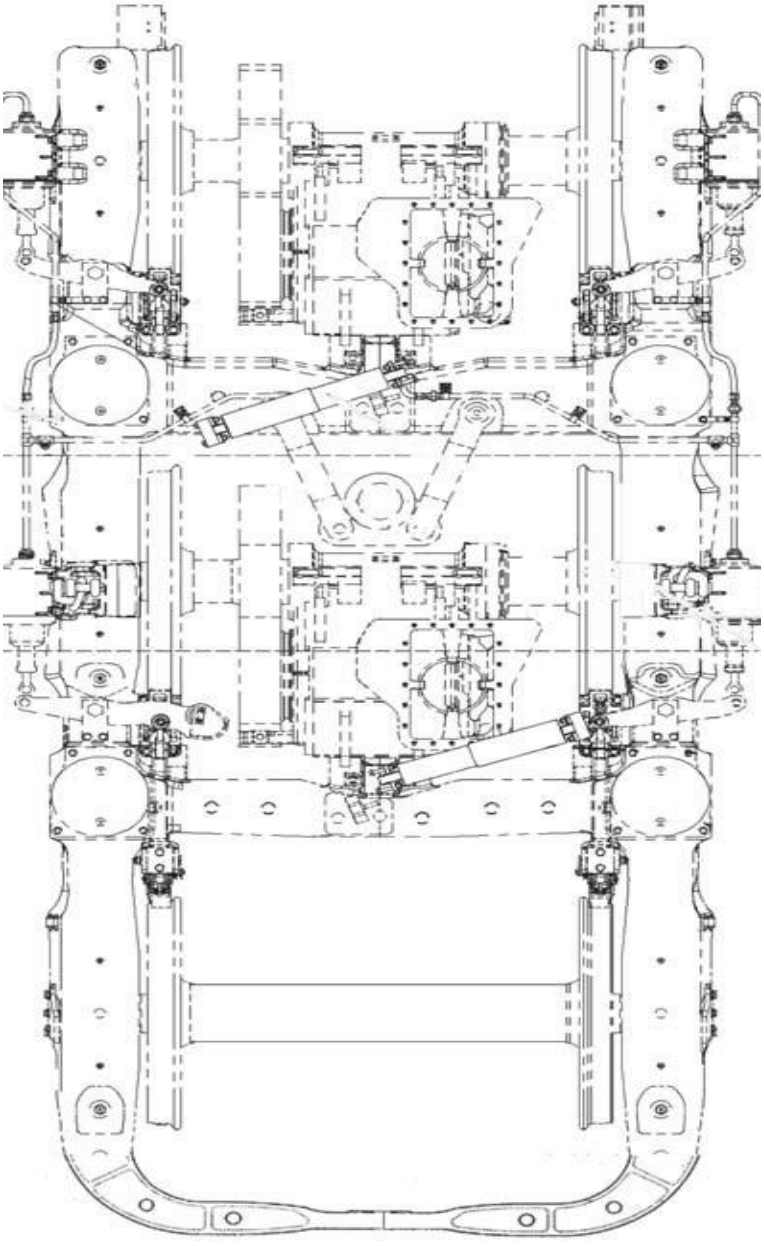


Fig. 18.14 (a) HTSC bogie – General arrangement

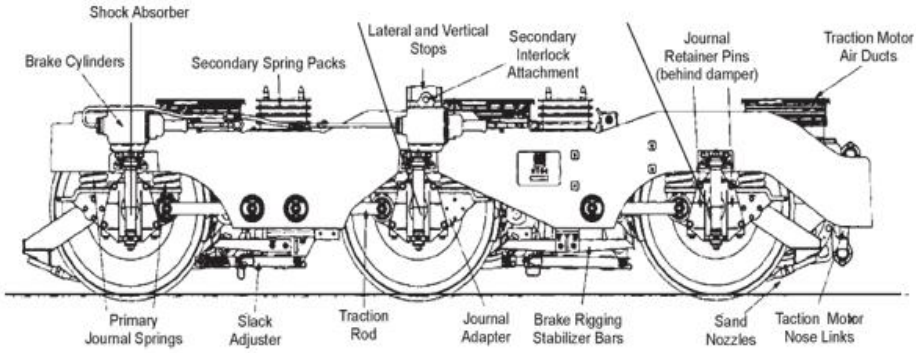


Fig. 18.14 (b) HTSC bogie – General arrangement

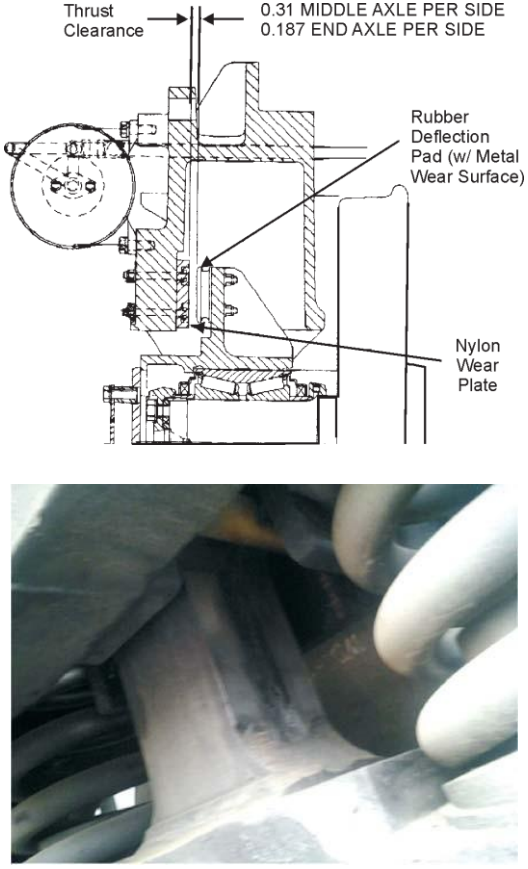


Fig. 18.15 Arrangement for lateral thrust load

The bogie frame is equipped with lateral stops at the center axle position to limit the lateral movement between the bogie and the locomotive underframe. Vertical stop clearance is established between the bogie frame and the underframe at (0.62" +/- 0.12") using shims under the four rubber compression springs and at locations inward of the lateral stops at the center axle position. All shims are tack welded in place (**Fig.** 18.16).

The car body pivot pin assembly (**Fig.** 18.17) is lined with two Nylon bushing halves. The pivot pin assembly requires regular inspection. The pivot pin is to be sprayed with a bonded type of spray lubricant any time the bogie is overhauled, or the locomotive car body is lifted from the bogie. The condition of the wear ring and bushing halves is to be checked whenever accessible and replaced if worn excessively or damaged.

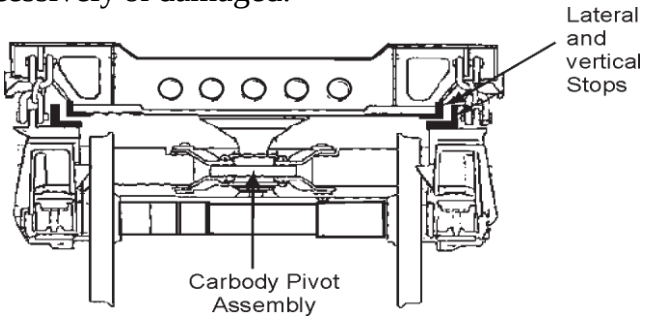


Fig. 18.16. Lateral and Vertical Stops



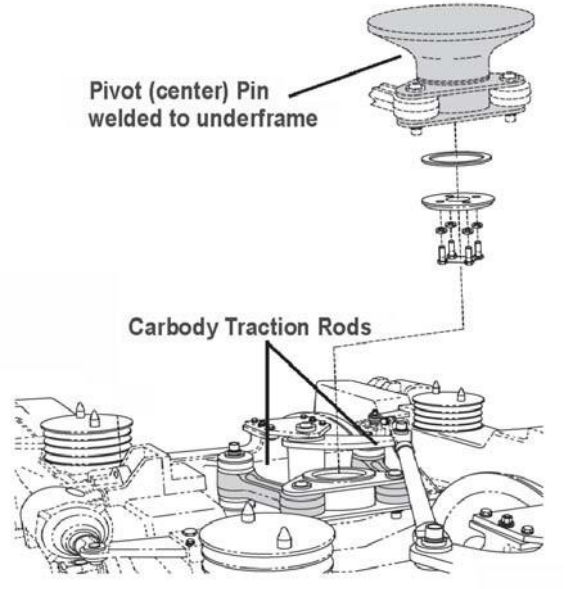


Fig. 18.17. Car Body Pivot Pin and Socket arrangement

Single coils are used in primary suspension that provide for large amounts of deflection. This assists in wheel load equalization, and aids in allowing yaw movement of the traction motor/axle wheel assemblies within the bogie. In order to secure the coil springs on the journal spring adapters, spring pilot tubes are used along with pilot wear plates between the springs and the adapter. Spring pilot pins and shims are also located in the bogie frame spring pockets to perform the same function (Figure 6.18). The pilot plates and shims are chosen to maintain 434.8- mm (17.12") installed spring length. These, along with the shims used between the underframe and the rubber compression secondary springs, serve to maintain proper locomotive height for clearance from the rail to the underframe. This maintains proper coupler height and distributes equal axle loads.

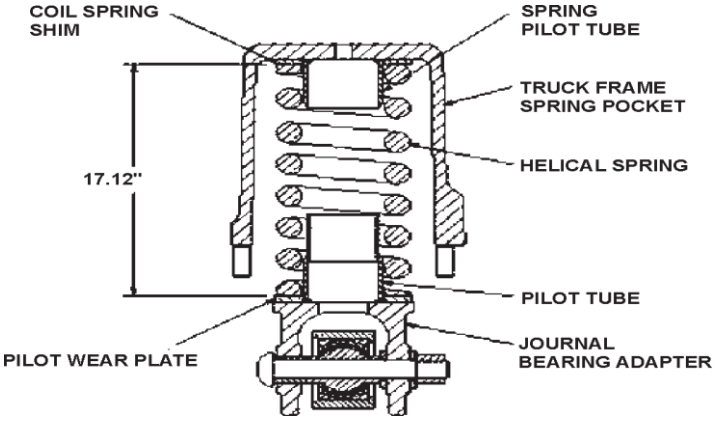


Fig. 18.18. Coil Spring Seat

Other than the specific items mentioned above, common items of rolling stock defects, should be checked in case of derailment of these locomotives.

18.10 CO - CO Flexi-coil Fabricated Bogie (ABB) WAG9/ WAP7

WAG9 locomotive is a 6000 HP, 3-phase loco having maximum permissible speed of 100 kmph, imported from Bombardier and now being manufactured at CLW with transfer of technology. WAP7 locomotive has the same design as WAG9, with changed gear ratio for passenger service, having maximum permissible speed of 140 kmph.

The bogie frame consists of two longitudinal sections, which form the side members, and three lateral transoms, which form the cross members. The cross members are welded to the side members forming a rectangular frame. Isolation and absorption of shock loads and vibration is performed by the primary and secondary suspension. General Arrangement of the bogie is shown in **Fig.** 18.19.

The primary suspension (**Fig.** 18.20), located between the axles and the bogie frame, is provided by twin coil springs on the axle journal box fore and aft of the axle line. Vertical hydraulic dampers on the end axles are used to dampen the rebound rate of the

springs. Each end axle (wheelset) has four coil springs. The middle axle has an inner and an outer coil spring situated on the axle box fore and aft of the axle center line. Each middle axle (wheelset) has eight coil springs. This "Flexicoil" arrangement permits lateral movement of the axle. Longitudinal control of the axle, and the transmission of tractive and braking effort to the bogie frame, is provided by guide rods connected between the axle journal boxes and bogie frame. Spheribloc rubber bushes in the guide rods allow the axle lateral movement without undue restriction.

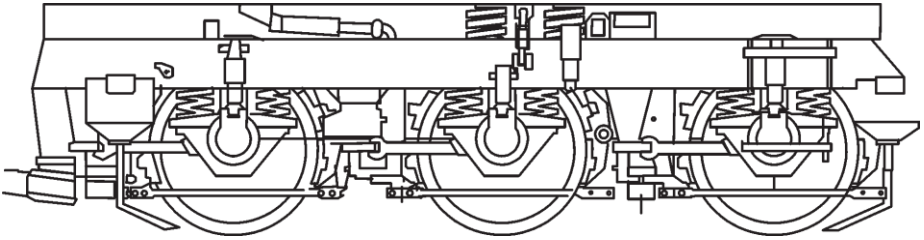
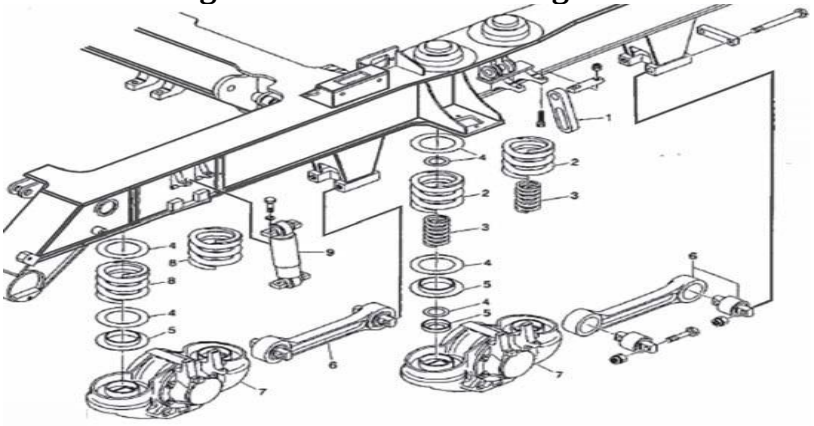
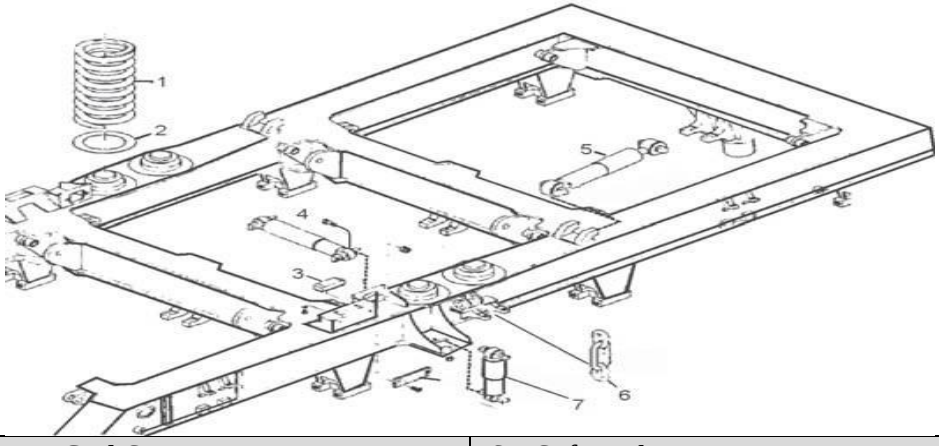


Fig. 18.19 General Arrangement



1. Middle Axle Safety Link	6. Guide rod
2. Middle Axle Outer Coil Spering	7. Axle Box
3. Middle Axle Inner Coil Spring	8. End Axle Coil spring
4. Compensating Plate	9. Vertical Damper
5. Insulating Base	

Fig. 18.20 Primary Suspension



1. Coil Springs	6. Safety chains
2. Compensating Plates	7. Vertical Hydraulical Dampers
3. Vertical Bump Stops	
4. Lateral Hydraulic Dampers	
5. Yaw Hudraulic Dampers	

Fig. 18.21 Secondary Suspension

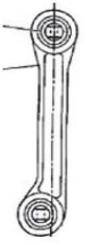
Secondary suspension (**Fig.** 18.21) is also provided by coil springs and vertical hydraulic dampers located between the bogie frame and the locomotive underframe on each side of the bogie. The weight of the locomotive car body is carried by the secondary suspension springs. The "Flexicoil" arrangement of the secondary suspension allows the locomotive car body to move both laterally and vertically within certain limits relative to the bogies. Although the springs allow movement in any direction, lateral buffers and dampers limit the amount and rate of lateral movement, while rebound limit chains and vertical dampers limit the amount and rate of the vertical rebound of the locomotive car body. Longitudinal (yaw) dampers are provided to dampen the rate of pitch of the car body. Push-pull link rod, connected between the bogie transem and locomotive underframe, control the fore and aft movement between the bogies and the locomotive and transferthe logitudinal forces.

Slowing or stopping the locomotive is achieved by use of electrically regenerative braking or pneumatically operated drum

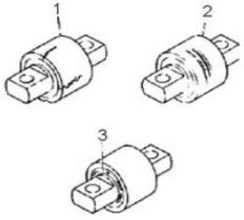
brakes. During regenerative breaking, the kinetic energy of the train is converted into the electrical energy which is fed back to the 25 KV overhead equipment. The brake cylinders and rigging are positioned to the end. The Co-Co bogie is fitted with wheel flange lubrication equipment to minimize wheel wear and sanding equipment is installed to provide additional traction between the wheels and rail when required.

The Guide Rod, which is bolted to the axle box housing and to the bogie frame, provides a longitudinal guide for the axle box housing. The guide rod is fitted with spherical rubber joints (Spheriblocs) at each end, which provide positive longitudinal guidance while allowing negligible resistance to lateral movement.

The Spheriblocs in the axle guide rods are critical to maintaining wheel alignment. No damage or wear is permissible on either the metal or rubber parts. During maintenance, damaged or suspect components are to be replaced with new parts. Where one spheribloc on a bogie is deemed unfit for service it is good engineering practice to thoroughly inspect all Spheriblocs on the bogie. Spheriblock Axial Wear Test of is prescribed in the Maintenance Manual, wherein an axial load (of 1500 kg) is applied on the cross pin and then released. Amount of residual displacement is restricted to 0.6mm, else, the spheriblock is to be replaced. Common damages of spheriblock are shown in **Fig.** 18.22.



Guide Rod



1. Spheriblock collar – crack
2. Spheriblock collar – gouge
3. Rubber element- tear, crack, disintegration

Figure 18.22 Guide Rod and Common damages of Spheriblock

Stipulated heights corresponding to different load for Primary Spring are given in **Table** 18.4. During maintenance, the free height of

spring is measured, and it is replaced if below the stipulated. Further, the spring is tested in a testing fixture. Loads are applied, as in the table and heights are measured at each given load. Any spring not within specification is replaced.

Table 18.4

Spring	Spring condition / Item	Unloaded	Static load	Load at stop	Load at solid
End axle spring	**Deflection (mm)**	0.0	46.8	76.8	91.2
	Spring ht. (mm)	238.8	192.0	162.0	147.6
	Load (kN)	0.0	40.6	66.6	79.1
Mid axle outer spring	**Deflection (mm)**	0.0	66.6	96.6	113.7
	Spring ht. (mm)	258.6	192.0	162.0	144.9
	Load (kN)	0.0	31.5	45.7	53.8
Mid axle inner spring	**Deflection (mm)**	0.0	64.4	94.4	110.5
	Spring ht. (mm)	252.4	188.0	158.0	141.9
	Load (kN)	0.0	9.3	13.7	16.0

Similar action is taken during maintenance with Secondary Spring. Data for these springs is given in **Table** 18.5.

Table 18.5

Spring condition	Deflection (mm)	Spring Height (mm)	Load (kN)
Unloaded	0	733.2	0
Static load	158.2	575.0	96.8
Load at stop	195.2	540.0	118.2
Load at solid length	250.9	482.3	153.6

All springs vary slightly from batch due to the manufacturing process. The springs used on WAG-9 locomotives are marked with one or two aluminum bands to identify their tolerance range. The number of bands also corresponds to the number of compensating plates below the springs. All the primary and all the secondary suspension springs on the bogie must be of the same tolerance range. Springs of different tolerance ranges should not be mixed.

Adjustment of individual wheel loads is performed by adding

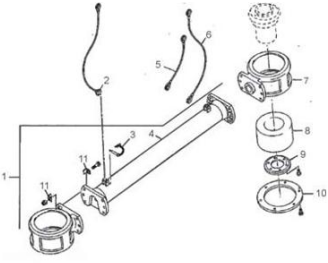
compensating plates between the axle boxes and primary suspension springs. Wheel loads for a bogie are measured on weighbridge. The adjustment compensates for twist within the bogie frame or variations in spring lengths or stiffness. After the load adjustment, the distance between the axle and bogie frame must be within the range of 27-35 mm.

Adjustment of individual axle loads is performed by adding compensating plates between the bogie frame and the secondary suspension springs. The adjustment compensates for variations in the bogie frame, locomotive underframe and spring lengths or stiffness. After the load adjustment, the clearance between vertical bump stops and locomotive underframe must be within 32-60mm.

The nominal axle load is 20.5 tonnes. Axle loads must be within 2% of the nominal axle load and the wheel loads must be within 4% of the measured axle load.

During maintenance, the correct number and location of compensating plates is required to be ensured. Vertical and lateral bump stop arrangement is to be inspected for wear and damage, and exceedance of the clearances.

The **Traction Link** transmits traction and braking forces from the bogie to the locomotive superstructure (underframe). Although the traction link maintains the relative longitudinal position of the bogie to the locomotive underframe, it permits lateral movement between the two structures. The link rod is situated between two pivot points, one on the locomotive underframe the other on the end transom of the bogie, permitting lateral movement but restraining longitudinal movement. A pivot head, situated at each end of the link rod, has a ring of pliable material between the pivot post and head. The rings are secured to the pivot head by an outer retaining ring and a retaining plate bolted to the post **(Figure 18.23).**



1	Traction link	7	Pivot head
2	Safety cable, bogie end	8	Ring
3	Chain	9	Inner retaining plate
4	Link rod	10	Outer retaining ring
		11	Locking tab

Fig. 18.23 Traction Link Arrangement

Physical examination, such as crack, breakage, deterioration of material etc. is important for the assembly. The maximum permissible inside diameter of the pivot head is 251.5mm. Thering is to be replaced if there is a deterioration of material or depth of damage exceeds 10 mm.

Some of the other important features of the locomotive bogie are

Nominal Axle load	20,500 kg
Wheelbases	1,850mm
Overall length	6209mm
Overall width	2962mm
Overall height	1240mm

Service limits of clearances

Vertical clearance between box and bogie frame.	27 - 35 mmaxle
Lateral clearance between box and bogie frame.	15 - 22 mmaxle
Vertical clearance between frame and under frame	32 - 60 mmbogie (Ref. TC 82 rev.1)
Lateral clearance between frame and under frame	45 - 55 mmbogie

18.11 Bo-Bo Flexi-coil Fabricated Bogie (ABB)

WAP5

WAP5 is 5500 HP, high speed (Max speed 160 kmph, upgradable to 220 kmph) locomotive. It was imported from ABB (now Bombardier) and is now being manufactured at CLW withtransfer of technology.

Basic features of this bogie are similar to that of WAG9,

discussed above, except that it is a BO – BO design.

Bogie frame is a fabricated steel structure. The wheelbase is 2.800 m. Primary Suspension comprises of twin coil spring anda hydraulic damper on each axle box. Longitudinal control of the axle and transfer of longitudinal forces is done by Guide Rods connected between axle box and bogie frame. Flexi-coil action of primary springs permits lateral movement of axle with respectto bogie frame. The system is similar to WAG9 locomotive.

Vertical and lateral movement between wheel set and bogie frame are limited by vertical and lateral bump stop clearances (Figure 18.24). Limit of clearances between bogie and axle boxare 27 to 35 mm for vertical (A) and 15 to 20 mm for lateral (B).

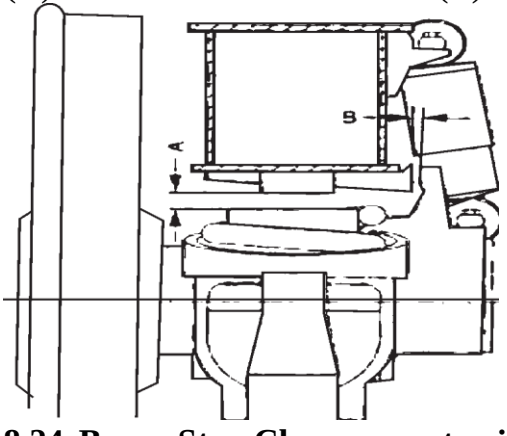


Figure 18.24 Bump Stop Clearances at primary stage

Primary spring height at specified loading is shown in **Table** 18.5

Table 18.5

Spring condition	Deflection(mm)	Spring Height (mm) (min – max)	Load (kN)
Unloaded	0	228.2 – 231.0	0
Static load	53.2	175.0 – 177.8	41.1
Load at stop	83.2	145.0 – 147.8	64.3
Load at solid length	95.0	133.2 – 136.0	73.4

Secondary Suspension comprises of coil springs and vertical, lateral and yaw dampers. Secondary suspension arrangement is shown in Figure 18.25. Vertical and lateral movement between locomotive

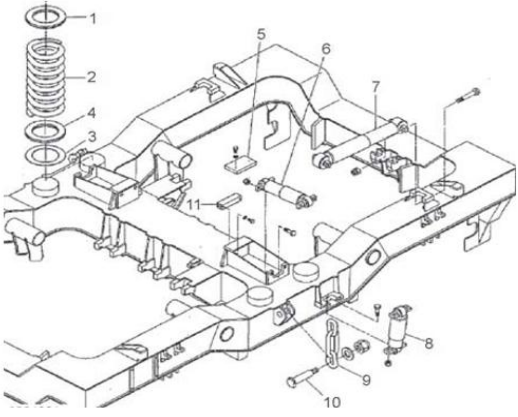
body and bogie frame are limited by buffer and chain arrangement. Limit of clearances between bogie and under frame are 30 to 40 mm for vertical (D) and 20 to 40 mm for lateral (C)(**Fig.** 18.26).

Secondary spring height at specified loading is shown in **Table** 18.6

Table 18.6

Spring condition	Deflection (mm)	Spring Height(mm)	Load (kN)
Unloaded (nominal)	0	664.5	0
Static load Group 1* (min-max)	184.5	480 - 490	61.5
Static load Group 2* (min-max)	184.5	470 - 480	61.5
Load at stop (nominal)	219.5	445	73.2
Load at solid length (nominal)	286.1	378.4	95.4

*Group 1 – one band, Group 2 – two band



1.Insulating bases top 2.Coil spring 3.Compensating plate 4.Insulating base bottom 5.Vertical bump stop 6.Lateral hydraulic damper7. Yaw hydraulic damper 8.Vertical hydraulic damper 9.Safety chain 10. Pin 11. Lateral bump stop

Figure 18.25 Secondary suspension

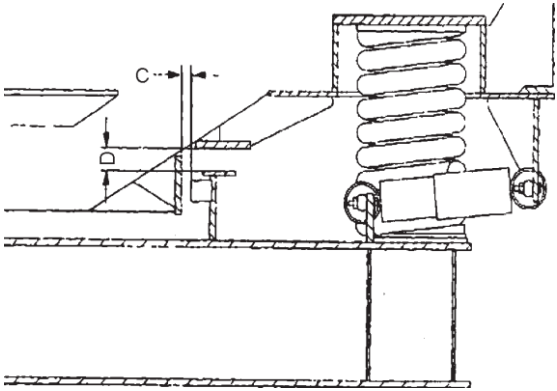


Figure 18.26 Bump Stop Clearances at secondary stage

Arrangements of Guide Rod and Traction Link are similar to that in WAG9 locomotive discussed above.

Table 18.7 and 18.8 show some important parameters of different diesel and electric locomotives, respectively.

Table 6.7 (Diesel locomotives)

Class	Wheel Arrangement	Power kW	Speed km/h	Weight tonne	First built	Mechanical Engine		Transmission
Broad-gauge								
WDM2 (mod)	Co-Co	1790	120	112.8	1962	DLW	Alco/V251B	EBHEL
WDM3A	Co-Co	2310	120	112.8	1994	DLW	Alco/V-251B/ Upgraded	EBHEL
WDM3A	Co-Co	2310	100	123	1996	DLW	Alco	EBHEL
WDP1	Bo-Bo	1715	120	80	1995	DLW	Alco	EBHEL
WDM4	Co-Co	1965	120	113	1962	GM	GM567D3	EGM
WDM6	Bo-Bo	895	75	70	1981	DLW	DLW/251.B	EBHEL
WDM7	Co-Co	1475	105	96	1987	DLW	DLW-Alco/251-B 12Eye	EBHEL
WDS4	C	520	65/27	60	1969	Mak/CLW	Mak/CLW/6M282A(k)	H/HM KPC VOITH L4v2U2
WDS4A	C	490						H
WDS4B		520						H
WDS4D		522	65	60	1968	CLW	Mak/6M282A (k)	H Voith
WDP3A	Co-Co	2310	160	117	1998	DLW		L4r2uDLW
WDG4	Co-Co	2984	100	126	2000	GM/DlW	GM/DLW	
WDP4	Co-Co	2984	160	126	2001	GM/DlW	GM/DLW	

WDS5	Co-Co	~~795 / 794~~	109	126	1967		Alco/251-B	EGE
EDS6	Co-Co	1,045	62.5	126	1977	DLW	Alco/DLW/251D	EBHEL
Metre-gauge								
YDM1-1R	B-B	470	80	46.6	1955	Mak/CLW	Mak/CLW/6M282A	H Voith
YDM2	B-B	520	75	48	1986	CLW	CLW/mak/6M282A(k)	H Voith
YDM3	B-B	~~1,055~~	80	58.5	1961	GM	GM 12 567c	E GM
YDM4	Co-Co	1,045	96	72	1961	Alco/DLW	Alco 251-D	E BHEL
YDM4A	Co-Co	~~1,045 /~~	96	72	1964	MLW Canada	MLW/25 1-D	E GE Canada
YDM5	**C-C**	**1,035**	80	69	1964	GM	GM 12 567c	E GM
Narrow-gauge								
NDM1	B-B	110	33	29	1955	Am-Jung	MWM TRHS/518 S	H Voith L33U
NDM5	B-B	365	50	22	1987	CLW	Cummins/KTA 1150L	H Voith L2r2zu2
ZDM2R	B-B	520	50	32	1964	Mak	Maybach/MD 435	HM Mak
ZDM3		520	50	35	1971	CLW	CLW/Mak/6M282A(k)	HM Kirloska
ZDM4A		520	50	38.5	1984	CLW	CLW/Mak/6M282A(k)	H Voith L4r 22
ZDM5		365	50	22	1990	CLW		

123Table 6.8 (Electric locomotives)							Builders		
Class	**Wheel arrangement**	**Output kW continuous/one hour**	**Speed km/h**	**Weight tones**	**No in service**	**First built**	**Mechanical**	**Electrical**	
Broad-gauge 1.5 kV DC									
WCM6	Co-Co	3,430	105	120	2	1996	CLW	CLW	
~~WCG2~~	Co-Co	3,130/1,220	90	132	0	1971	CLW	CLW	
Broad-gauge 25 kV DC									
~~WAM4~~	Co-Co	2,715/2,870	110	112.8	471	1971	CLW	CLW	
WAP1	Co-Co	2,800/2,910	130/140	107	56	1980	CLW	CLW	
WAP4	Co-Co	3,730/3,990	140	107	767	1995	CLW	CLW	
WAP5	Bo-Bo	2,985/4,000	160	78	239	1996	ABB	ABB (3 phase loco)	
WAP7	Co-Co	4,565	140	123	1474/834	2001		Bombardier/CLW (3 phase loco)	
WAG5	Co-Co	2,870/3,250	80			1978	CLW	CLW/BHEL	
WAG7	Co-Co	3,730/3,990	100	118.8	1955	1992	CLW	CLW	
WAG6A	Bo-Bo-Bo	4,475/4,560	100	123	4	1988	ASEA	ASEA	

WAG6B	Bo-Bo-Bo	4,475/4,560	100	123	6	1988	Hitachi	Hitachi
WAG6C	Co-Co	4,475/4,560	100	123	6	1988	Hitachi	Hitachi
WAG9/ WAG9H	Co-Co	4,565	100	123	61	1996	Adtranz	Adtranz/CLW
3 phase loco								
Broad-gauge dual voltage 25 kV AC/1.5 kV DC								
WCAM1	Co-Co	2,715/2,870 2,185	120/80	113	52	1975	CLW	CLW
WCAM2	Co-Co	3,505 2,160	120/80	113	20	1995	BHEL	BHEL
WCAM3	Co-Co	3,730 3,432	105	121	53	1996	BHEL	BHEL
WCAG1	Co-Co	3,730 3,432	100	128	12	1998	BHEL	BHEL
Metre-gauge 25 kV AC								
YAM1	Co-Co	1,215/1,300	80	52	18	1965	Mitsubishi	Mitsubishi
First figures apply to AC operation, subsequent figures to DC								

WAP-5, 7, WAG-9 & 12 are the next generation locomotives in the fleet of locomotives of Indian Railways. Their control electronics are based on the Solid-State devices- IGBT & is highly driver friendly. These locomotives are equipped with state of art Control Electronics, which keeps a continuous vigil on the functioning of various components en-route and advanced Fault Diagnostic system, which is capable of isolating the defective component and take further remedial action suo-moto to continue the train operation with display of suitable message on the driver desk. Apart from Regenerative breaking, which feeds back the regenerated energy to the 25 KV Overhead equipment, this is also equipped with Constant Speed module which smartly regulates the tractive effort to achieve constant speed within the band of +-2 Kmph even at up & down gradients. To ensure passenger's safety, this locomotive is equipped with advanced vigilance module at Driver desk, which acknowledges the action of the crew during last 180 seconds and if no action is found taken by crew, it activates an alarm, which activates emergency brakes, if not acknowledged by crew within 8 seconds. Its Memotel device (Speed recording device) is capable of storing huge data and reproducing continuous speed chart, which may further restrict on the chances of over-speeding. The Central Electronics also keeps the logging of the actions taken by crew on real time basis which are extremely important & conclusive for technical analysis. Due to these features, Railway Board has decided to manufacture these next generation electric locomotives only in future.

Wheel wear and General

The wheels of the rolling stock are subject to continuous wear and tear due to presence between wheel & Rail as well as wheels and brake blocks, during the application of brakes. Thus, it is a challenging task for the respective departments to maximize the wheel & rail life without affecting the safety of the train services.

Important items of the Instruction Bulletin on 'Wheel Wear and Application Management' No. MP.IB.BD.02.16.01 (Rev.01) dt. 31.12.2009 are as follows:

1. Brake cylinder pressure is to be maintained as stipulated to avoid excessive thermal loading of wheels due to repeated application.

2. Dynamic brake is provided on all locomotives on IR (except for WAP4). They should be sparingly used, especially while operating in a ghat section, Use of loco brake should be limited to the minimum.

3. Matching spring based on free height parameter is not adequate. They should be matched as per height under working load. Springs should be colour coded as per instructions of the specified Instruction Bulletins.

4. Pins and bushes of the Equalizer beam in Trimount/ High Adhesion bogie should be of recommended design and these should be renewed as specified in the Maintenance Instruction. Otherwise, inter-axle load transfer gets affected.

5. Locomotives having wheel guidance through pedestal are provided with liners at pedestal as well as on axle box. Lateral and longitudinal clearances to be maintained and the corresponding reference documents are specified in the Instruction. A proper record of these clearances is to be kept for all specified schedules.

6. Wear adapted profile as per RDSO Drg. No. SK. DL-2561 (Alt.8) shall be applicable to all BG Diesel& Electric locomotives irrespective of speed or IRS Thick flange profile as per CSL-3040 (Alt.2) would be applicable beyond 110 kmph(**Fig.** 18.3 and 18.4).

7. Correct cause of biased wear on a wheel should be identified considering Brake block shifting, Excessive lateral or less Longitudinal clearance between axle box and pedestal, Misalignment of bogie frame and excessive wheel diameter variation.

8. Variation in diagonal dimensions of bogie should not be more than 3 mm in order to prevent misalignment.

9. General limit of variation in wheel diameter is specified as below (Note- Any other specific instruction, if issued, may be followed)

Location	At **wheel turning**/change (mm)	**Service limit**(mm)
On same axle	0.5	2.5
On same bogie	2.0	8.0
On same loco	15.0	25.0

The Instruction includes limits of wheel diameter for various locomotives.

10. Limits of root, flange and tread wear are given for various locomotives.

11. Permissible variation in Wheel gauge is as below
New assembly: 1596 (± 0.5) mm
Service limit: 1596 (+3, -0.5) mm

12. Recommended time for application and release of Full service and Emergency brake application, brake pressure and suitable brake application practice are specified for reducing wheel skidding.

Limits of Wheel diameter, Variation in wheel diameter, Wear limits of Root, Flange and Tread and Lateral and Longitudinal clearances at the axle box for different locomotives, as specified in the Maintenance Instruction, are reproduced as **Annexure- I** to this chapter.

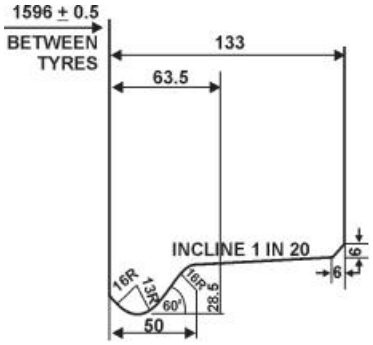
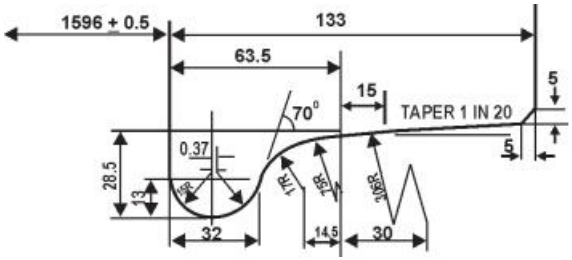


Fig. 18.3 Thick IRS Tyre Profiles for BG Loco (Check)



This was old version. Latest version (SK.DL-2561 Alt.8) is as below:

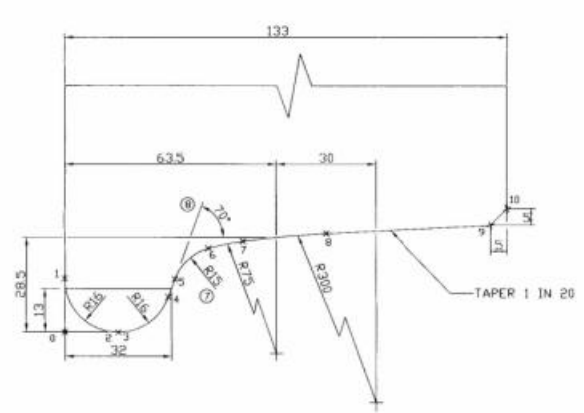


Fig. 18.4. Wheel Tread Profile (Wear adopted) for BG loco

The Science and Art of Railway Accidents Preventions, Investigation and Management, Volume I (Accident Prevention) By Hari Shankar Verma, IRTS, Director General, Indian Railways Institute of Transport Management (IRITM), Lucknow

ANNEXURE 1(All Dimensions are in mm)

Loco	New wheel diameter	Root wear limit	Flange wear	Total tread wear	Lateral & Longitudinal clearances			Difference in wheel diameter		
					Measurement	New condition	Service limit	Location	Diff. in Dia.	Permissible limit
WDM (Co-Co trimount bogies without conical thrust pad)	1092 (+5/-0)	6.0	3.0	6.5	As per MP.MI 71/78			As per MP.IB.BD.01.01.05		
					Lateral clearances End Axle (C1+C2) per axle	6.0	12.0	On same axle	0.5	-
					Lateral clearances middle Axle (B1+B2) per axle	25.0	31.0	On same bogie	2.0	8.0
					Longitudinal clearances for middle & End axles (A1+A2) per axle box	0.363-1.9	5.0	On same loco	15.0	25.0
WDM3A & WDM3C (Co-Co Trimount Bogies with conical thrust pad)	1092 (+5/-0)	6.0	3.0	6.5	As per MP/IB.VL-03.04.06 (Rev 01) dt.28.11.08			As per MP.IB.BD.01.01.05		
					Lateral clearances middle axle (C1+C2+C3+C4) per axle	22.4-24.8	30.0	On same axle	0.5	-
					Lateral clearances middle axle (B1+B2+B3+B4) per axle	4.0-6.6	12.0	On same bogie	2.0	8.0
					Longitudinal clearances for middle & End axles (A1+A2) per axle box	0.4-1.9	3.5	On same loco	15.0	25.0

Loco	New wheel diameter	Root wear limit	Flange wear	Total tread wear	Lateral & Longitudinal clearances			Difference in wheel diameter		
					Measurement	New condition	Service limit	Location	Diff. in Dia.	Permissible limit
					As per MP.IB.Vl.01.02.06(Rev.0.00)dt.27.01.2006			As per MI.VL.02/96		
WDG3A/ WDM3D	1092 (+5-0)	6.0	3.0	6.5	Lateral clearances End Axle (C1+C2) per axle	22.0–25.2	30.7	On same axle	0.5	2.5
					Lateral clearances middle Axle (B1+B2) per axle	2.4-6.0	11.5	On same bogie	2.0	8.0
					Longitudinal clearances for middle & End axles (A1+A2) per axle box	2.0 - 4.0	6.0 (SV.WDG2 dt.19.02.99)	On same loco	15.0	25.0
`WDP1	1092 (+5-0)	6.0	3.0	6.5	As per MP.IB.VL.05.06.06(rev.0.00)dt.03.08.2006			As per DLW MI-CHS=009		
					Lateral clearances middle axle (C1+C2+C3+C4) per axle	22.0-25.0	31.0	On same axle	0.5	1.5
					Longitudinal clearances for middle & End axles (A1+A2) per axle box	0.6-2.2	5.0	On same bogie	2.0	5.0
								On same loco	15	`20
WDP3A					As per Mi.VL-04/98					
					Lateral clearances middle Axle (C1+C2) per axle	1.2-3.0	6.0	On same axle	0.5	2.5
					Longitudinal clearances (Middle axles) (A1+A2) per axle box	2.0-4.0	6.0	On same bogie	2.0	8.0
								On same loco	15	25

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Loco	New wheel diameter	Root wear limit	Flange wear	Total tread wear	Lateral & Longitudinal clearances					Difference in wheel diameter		
					Measure ment	New condition	Service limit			Location	Diff. in Dia.	Permissible limit
					IB No. MP.IB.VL-03.28.08 (Rev. 00) dt. 30.09.08					EMD maintenance instruction no.1517 (Rev. A)		
WDG4	1092 (+5/-0)	6.0	3.0	6.5	**For End axle Lateral** clearance between thrust pad & bearing adapter (A1+A2) per	**Nominal Inch/mm**	**Min. Inch/mm**	**Max. Inch/mm**	**Service limit Inch/mm**	On same axle	0.5	1.6
						0.38/9.6	0.3/7.6	0.5/12.7	0.62/15.7			
					For middle axle Lateral clearance between thrust pad & bearing adapter (B1+B2) per axle	0.62/15.7	0.54/13.7	0.74/18.8	1.0/25.4	On same axle	3.2	6.4
										On same axle	14.2	31.8

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Loco	New wheel diameter	Root wear limit	Flange wear	Total tread wear	Lateral & Longitudinal clearances					Difference in wheel diameter		
					Measurement	New condition	Service limit			Location	Diff. in Dia.	Permissible limit
					IB No. MP.IB.VL-03.28.08 (Rev. 00) dt. 30.09.08					EMD maintenance instruction no.1517 (Rev. A)		
WDG4	1092 (+5/-0)	6.0	3.0	6.5	**For End axle Lateral** clearance between thrust pad & bearing adapter (A1+A2) per	**Nominal Inch/mm**	**Min. Inch/mm**	**Max. Inch/mm**	**Service limit Inch/mm**	On same axle	0.5	1.6
						0.24/6.1	0.16/4.1	0.36/9.1	0.5/12.7			
					For middle axle Lateral clearance between thrust pad & bearing adapter (B1+B2) per axle	0.62/15.7	0.54/13.7	0.74/18.8	1.0/25.4	On same axle	3.2	6.4
										On same axle	14.2	31.8

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CLEARANCES FOR ELECTRIC LOCOMOTIVES (All dimensions are in mm)

Loco	New wheel diameter	Wear limits			Axle Box Clearances				Difference in wheel diameter		
		Root	Flange	Tread	Measurement	New condition		Service limit	Location	Diff. in Dia.	Permissible limit
						Min	Max				
					As per MP.IB.VL-03.04.06 (Rev.0.0) dt.28.11.08				As per MP.MI/71/78 Jul.92		
WAM 4	1092 (+5/-0)	6	3	6.5	Lateral clearance End Axle per axle (C1+C2+C3+C4)	22.4	24.8	30.0	Same axle	0.5	2.5
					Lateral clearance Middle Axle (B1+B2+B3+B4)	4.0	6.6	12.0	Same bogie	2.0	8.0
					Longitudinal clearances Middle & End Axle per axle box.	0.4	1.9	3.5	Same loco	15.0	25.0
WAP 1/ WAP 4	1092 (+5/-0)	4 6 (WAP 4)	2.5 3 (WAP 4)	6.5	As per MP.IB.Vl.04.05.06(Rev.00) dt0.03.08.06				No.SD.WA1 dated. 10.10.2003		
					Lateral clearance End Axle per axle (C1+C2+C3+C4)	15.4	18.2	24.0	Same axle	0.5	1.5
					Lateral clearance Middle Axle (B1+B2+B3+B4)	3.6	7.2	12.0	Same bogie	2.0	5.0
					Longitudinal clearances Middle & End Axle per axle box.	0.4	2.0	4.0	Same loco	15.0	20.0

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Loco	New wheel diameter	Wear limits			Axle Box Clearances				Difference in wheel diameter		
		Root	Flange	Tread	Measurement	New condition		Service limit	Location	Diff. in Dia.	Permissible limit
						Min.	Max.				
					Technical Circular No. ELRS/TC/0082 (Rev00) dt.29.06.05				No. SD.WA1 dt.24.06.05		
WA G 9	1092 (+5/-0)	6	3.0	6.5	Vertical Clearance between Axle Box & Bogie Frame	30	35	27 to 35	Same axle	0.5	2.5
					Lateral Clearance between Axle Box & Bogie Frame	15	19	15 to 22	Same bogie	2.0	4.0
					Vertical Clearance between Bogie Frame & Under Frame	35	40	32 to 40	Same loco	15.0	20.0
					Lateral Clearance between Bogie Frame & Under Frame	45	50	45 to 55			

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MOVEMENT AND STABLING OF DEAD LOCO INCLUDING AXLE LOCKED LOCOMOTIVES

19

19.1 Procedure for stabling a loco in dead condition:

Locomotive is required to be made dead and stabled due to any of the following reasons.

i. Loco trouble/failure.
ii. Loco waiting for its next train/load.
iii. Crew for the loco is not available.

19.2 Procedure to be followed by the person/crew making the loco dead:

Following should be followed step by step-

1. Loco is to be stabled in a loop line or siding; it must be ensured that fouling mark is clear where loco is to be stabled.
2. Increase air pressure by MCP up-to 7.5 kg/cm²
3. Apply loco brakes and also the hand brakes of loco.
4. Use skids or wooden wedges for securing loco.
5. Put reverser in neutral position and remove MPJ.
6. Lower PT and remove ZPT.

7. Switch off all BL switches on drivers' desk and remove the BL key.
8. Put HBA on '0' position and see that battery voltage is '0'.
9. Keep ZPT, MPJ and BL key at a secure place in locomotive locker.
10. Lock the door from outside.
11. Hand over keys to Engine turner/ASM on duty informing the location of stabling the loco.

19.3 Precaution to be taken While Changing the Cab

Proper procedure while changing the cab of the locomotive should be followed to avoid any unusual / accident. In this chapter, the main precautions in this regard have been explained. It has been seen that some mistakes are made in changing the cab of a locomotive which results in problems like brake failure, pressure not building up etc. Therefore, important items which are to be given attention during changing the cab of locomotive with single loco or multiple locos is given as under:

19.3.1 Cab changing in single loco:

The following should be done step by step.

i. Application of loco brake with SA9 or loco brake.
ii. Switching off the DJ and lowering the pantograph.
iii. Removing the ZPT key, BL key and MPJ from the cab.
iv. Closing the isolating cock of loco and train brake in the cab and putting the handle of loco brake and train brake in released position.
v. Going to the next cab and putting the BL key, ZPT key and MPJ key in position.
   ZPT key should be put at appropriate position to raise the pantograph.
vi. The DJ should be closed and MPJ handle should be moved to forward position.
vii. The isolating cock of SA9 and A9 i.e. loco brake and train brake should be opened, and the brake should be released

by moving the handle of the loco brake in released position.

19.3.2 Cab changing in multiple loco:

The following additional points are to be checked/done in case of multiple loco when the cab is changed from one loco to another loco. (The items i to vii as explained above are followed in case of cab changing in multiple loco also).

The position of the MU2B valve in the loco which will work as trailing should be kept in trail position. Similarly, lead and trail cock should be open in leading loco and closed in trailing loco. The position of the MU2B valve in leading loco should be kept in lead position.

In trailing loco, loco brakes handle, and train brakes handle bolt should be kept in isolated condition. The loco brake and train brake of rear cab of leading loco should also be in isolated condition. The loco brakes and train brakes isolating cock should be open in working cab (leading cab) of the locomotive.

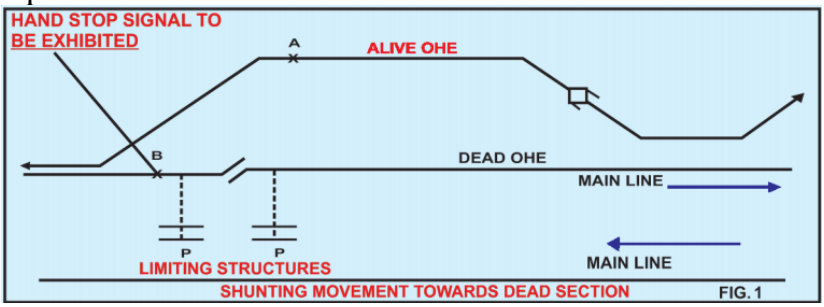
19.4 Shunting Movement Towards Dead Section

(Para No. 20626 of AC TRACTION MANUAL-VOLUME 11 PART 1).

1. In cases where no signal exists for controlling the entry of an electric Train into the dead section, the Station Master should arrange a hand stop signal to be exhibited at the point up to which alone the electric locomotive is allowed to proceed.

   If it is necessary for an electric locomotive to carry on shunting movement towards the dead section, the red warning collar placed on a lever may be removed to permit the movement, provided that a hand stop signal as above is exhibited and the Driver is specifically instructed not to move the loco beyond the point.
2. As per para 20625 the lever controlling the signals should have "red warning collars" placed on them to give protection to the dead section. However, If it is essential to carry out a shunting operation with an electric locomotive situated at point 'A' on the

loop line to move into the main through the turn-out, this may be permitted provided that the shunting movement is carried out only up-to limiting mast 'P', short of the overlap span, where a hand signal is to be exhibited to prevent all movements beyond the point 'P'.



3. Train or shunting movements by other than electric locomotives, i.e., by steam or diesel locos, may be permitted to enter the dead section, provided that the Station Master ensures by personal inspection that the Train formation does not include an electric locomotive or OHE Inspection Car or EMU with pantograph raised. The "red warning collars" may be permitted to be removed to allow such movement.

Movement of Axle Lock Locomotives

Technical Circular No. ELRS/TC/0090 (Rev.'0')

Sub: Procedure for movement of WAG9 / WAP7 and WAP5 locomotives for clearing blocked section by floating / lifting the locked axle in the event of axle getting locked on-line.

There are instances when locomotive axle gets locked in the mid-section thus blocking the Railway traffic movement on the affected section. Under such eventuality, it becomes the top priority to move the locomotive to the nearest station and restore the traffic.

These technical circular states the procedure for movement of WAG9 / WAP7 and WAP5 locomotives in the event of axle getting locked for clearing the blocked section while observing the extant norms / instructions in vogue from Railway Board vide letter no. 2001/M(L)/466/2305 dated 22.08.2003 and various concerned departments to maintain safe movement of the locomotive.

For lifting the end axles of WAG9 / WAP7 and any axle of WAP5, Wheel Set Trolley as per RDSO Drawing Nos. SK.VL-215 to 218 will be required. Earlier, RDSO drg. Nos. SKVL 129 - 132 were issued for use on WAP5 only. Whereas RDSO Drawing Nos. SK.VL-215 to 218 are suitable for WAG9 / WAP7 as well as WAP5.

Annexure "A" describes the procedure for WAG9/WAP7 locomotive. Annexure "B" describes the procedure for WAP5 locomotive.

Encl: Annexure "A" with 05 sketches

Annexure "B" with 02 sketches

Reference: Letter no. EL/3.1.35/2 dated 13.02.2006 is issued and signed by N.K. Sinha, Director General (Elect.) and given to all Chief Electrical Engineers and copy to Secretary/Elect. Engg. (RS), Railway Board, Rail Bhawan, New Delhi-110 001

Annexure – "A"

19.5 Procedure for Movement of WAG9/WAP7 Locomotives by Lifting/Floating the Locked Axle in the Event of Axle Getting Locked on line.

The schematic Arrangement of bogie of WAG9/WAP7 locomotive is shown in Sketch 1. An axle of the locomotive may get locked under the following circumstances:

a) Traction Motor Roller Bearing seizure.
b) Traction Motor Suspension Bearing seizure.
c) Axle Box Roller Bearing seizure.

While it may be possible to free the Traction Motor from the axle in case of Traction motor bearing seizure, the other cases require floating/lifting of the affected wheel for movement of the locomotive. Floating/lifting of the affected wheel may become necessary in case of wheel flats & heavy skidding of wheels also

19.5.1 Procedure when Traction Motor Roller Bearing gets Seized

In case of traction motor roller bearing seizure, the pinion of the affected motor should be removed, and all the traction motors of the affected bogie should be electrically isolated. The locomotive should be worked as light engine on its own power to the nearest Electric Locomotive Shed for attention

However, where removal of the pinion is not possible due to any reason, the locked axle should be floated following the procedure given at Para 19.5.2 below for clearing the section

19.5.2 Procedure for Floating / Lifting the Locked Axle:

In case when Axle gets locked due to Axle Roller Bearing Seizure, Traction Motor Suspension Bearing Seizure, Wheel Flat or Heavy Skidding of Wheels, the affected axle should be floated/lifted (depending on the axle number) after electrically isolating all the motors of affected bogie. The locomotive should be worked as a light engine on its own power with a maximum restricted speed of

25 km/h under escort by maintenance staff. In such cases, a close watch is necessary while passing over curves and turnouts.

19.5.3 Items required for Lifting of Axle

The following items are required for lifting the locked axle:

1. Two hydraulic jacks having minimum capacity of 15 tonnes each.
2. The distance pieces i.e. "wooden blocks" to raise the hydraulic jacks, if required, to compensate the gap between the jack & axle box/bogie frame
3. Two numbers of steel plates of size 300mm x 300mm x 30mm, which may be re- quired for making the foundation firm and leveled for jacks
4. Wooden wedges (at least 6 nos.) for application at the wheels for preventing rolling of locomotive while applying jacks
5. Resilient Block of thermoplastic polyurethane elastomer material (04 Nos.) as per the material, dimension and design conforming to Sketch 2.
6. Wheel Set Trolley to RDSO Drawing Nos. SK VL-215 to 218 (When end axle le Axle No. 1, 3, 4 or 6 is locked)
7. Short link as per the material, dimension and design conforming to Sketch 3 (02 Nos. each) (When Middle Axle i.e. Axle No. 2 or 5 is locked).
8. Toolbox with appropriate tools, Nuts, Bolts, Washers and Wrenches/Spanners.

19.5.4 Precautions to be taken

Before attempting the lifting of locked axle of the locomotive, the steps given below should strictly be followed to avoid damage to equipment or any mishap

1. Apply wooden wedges at wheels to prevent rolling of locomotive.
2. Release all TBUs (brakes) of the affected bogie, which requires lifting
3. Before applying jacks for lifting, ensure that the ground below the lifting jacks is firm and leveled. Due care must be taken to avoid slipping of the jacks.
4. Isolate all the traction motors of the affected bogie

5. Remove all primary vertical dampers of the affected bogie to avoid their damage.
6. Remove links between axle box and bogie frame from middle axle of the affected bogie

19.5.5 When One of the End Axles (i.e. Axle Nos. 1, 3, 4 or 6) gets Locked

1. Dismantle the slack adjuster of the locked end axle wheels.
2. Clamp the vertical brake hanger levers of locked axle at appropriate place with the bogie frame to prevent fouling of these levers with the wheel set trolley during movement.
3. Dismantle the sand box pipes. Remove footsteps, if required.
4. Remove the vertical dampers between the bogie frame and axle boxes of locked end axle of the affected bogie.
5. Lift frame of the affected bogie from the end at the other side of the locked axle (e.g. from the end near Axle No. 3 if Axle No. 1 is locked) to obtain a clearance of 75 to 80 mm between axle box top and bottom of the bogie frame at both sides by simultaneously applying two jacks of minimum 15t capacity each below the axle guide bracket/bogie end beam.
6. Place the Resilient Block between axle box top and bottom of the bogie frame at both the sides and release the jacks.
7. Now lift the locked end axle of the affected bogie simultaneously from both sides by applying two jacks of minimum 15t capacity each under the bogie end beam/axle guide bracket. The bogie frame should be lifted to obtain sufficient clearance between the axle box top and bottom of the bogie frame at middle axle.
8. Place the Resilient Block between axle box top and bottom of the bogie frame at both the sides at middle axle location and release the jacks.
9. While releasing the jacks, it must be ensured that the springs are property seated x. Now, lift the locked end axle from 55 to 60 mm by simultaneously applying two jacks of minimum 15t capacity each below the axle box housings at both sides.
10. Assemble the wheel set trolley below the locked end axle over the track in such a way that the wheels of locked axle rest over the

supporting rollers. Refer Procedure given below for Assembly of Wheel Set Trolley.

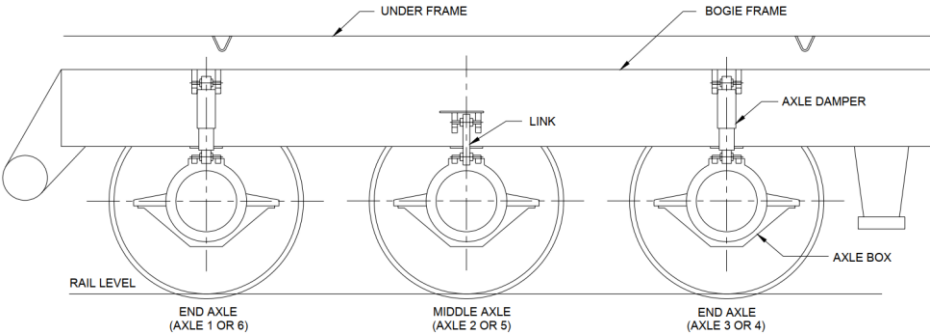
11. Sketch 4 shows the locations of the application of jacks for lifting and arrangement of wheel set trolley under the affected end axle.
12. Release the jacks from both sides of the locked end axle ensuring that the locomotive wheels of the locked axle rest properly on the rollers of the wheel set trolley.
13. Remove the wooden wedges placed at wheels of the locomotive
14. A locomotive with effected wheel set placed on the wheel set trolley can now be moved dead at a restricted speed not exceeding 25 km/h to clear the blocked section.

19.5.6 Procedure for Assembly of Wheel Set Trolley

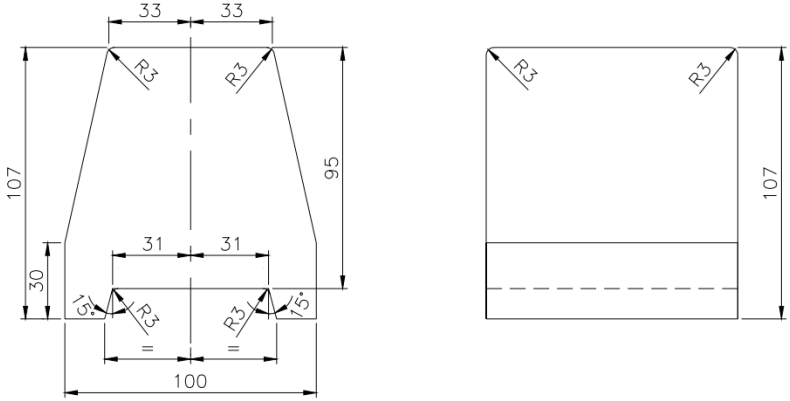
1. The locked wheel set has to be lifted up approximately from 55 mm to 60 mm.
2. Push both the Inner Longitudinal Frames (Item No. 1 of Drg. No. SK VL-215) of trolley under the locomotive.
3. Place both the Steel Tubes (Item no. 32 of Drg. No. SK VL-218) in position.
4. Lift up the frame along with the steel tubes, push in and fasten the running Wheel Arrangements (Item no.3 of Drg. No. SK VL-215), Supporting Roller Arrangements (Item No. 4 of Drg. No. SK VL-215) with keys and bolts
5. Push the outer Longitudinal Frames (Item No. 2 of Drg. No. SK.VL-215) of the trolley under the locomotive, lift the frame, push in Outer Steel Tubes / Sleeves (Item no. 33 of Drg. No. SK VL-218) and fasten the frames with keys and nuts.
6. To facilitate easy assembly of wheel set trolley, suitable markings as shown in the drawing must be provided to identify the matching parts.
7. Lower the locked wheel set of the locomotive gradually on the supporting rollers.
8. After lowering the wheels on trolley, it is essential to ensure that the wheel flanges of the lifted wheel set are sufficiently clear from the rails, to avoid hitting/infringement during movement of the locomotive.

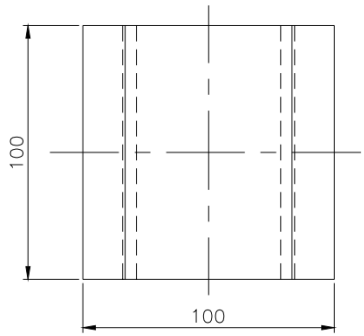
19.5.7 When Middle Axle (i.e. Axle No. 2 or 5) gets Locked

1. Lift the bogie frame of the affected bogie from one end by applying two jacks of minimum 151 capacity each simultaneously at both sides (RHS & LHS) below the axle guide bracket / bogie end beam to obtain a clearance of 105 to 110 mm be- tween axle box top and bottom of the bogie frame.
2. Place the Resilient Block at the top of axle box in center position at both the sides (RHS & LHS) of this end axle and release the jacks gradually till the bogie frame rests on the resilient blocks. While releasing the jacks it must be ensured that the springs are properly seated.
3. Now lift the bogie frame of the affected bogie from the other end axle from both the sides (RHS & LHS) simultaneously by applying two jacks of minimum 15t capacity each under the bogie end beam / axle guide bracket to obtain a clearance of 105 to 110 mm between axle box top and bottom of the bogie frame at this end.
4. Place the Resilient Block at the top of axle box in center position at both the sides (RHS & LHS) of this end axle and release the jacks gradually till the bogie frame rests on the resilient blocks. While releasing the jacks it must be ensured that the springs are properly seated.
5. Now, lift the locked middle axle simultaneously by applying two jacks of minimum 15t capacity each below the axle box housings at both sides (RHS & LHS)
6. Mount short links between axle box cover and bogie frame at both sides (RHS & LHS) as shown in Sketch 5 using existing pins of middle axle links.
7. It can be seen that the wheel flanges of the affected axle are lifted approximately 40 to 45 mm from rail level.
8. The locomotive with effected wheel set lifted can now be moved on its own power at a restricted speed not exceeding 25 km/h to clear the blocked section after isolating all the motors of the affected bogie.



Sketch 1: Schematic Bogie Arrangement



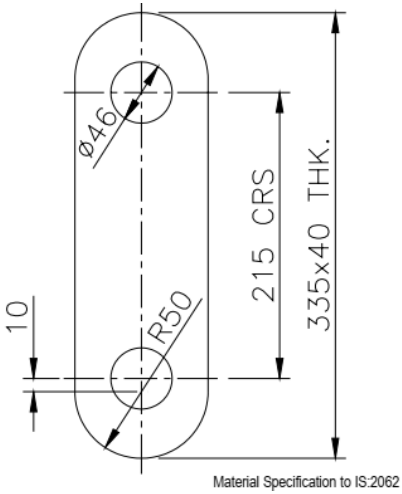


MATERIAL SPECIFICATION OF RESILIENT BLOCK

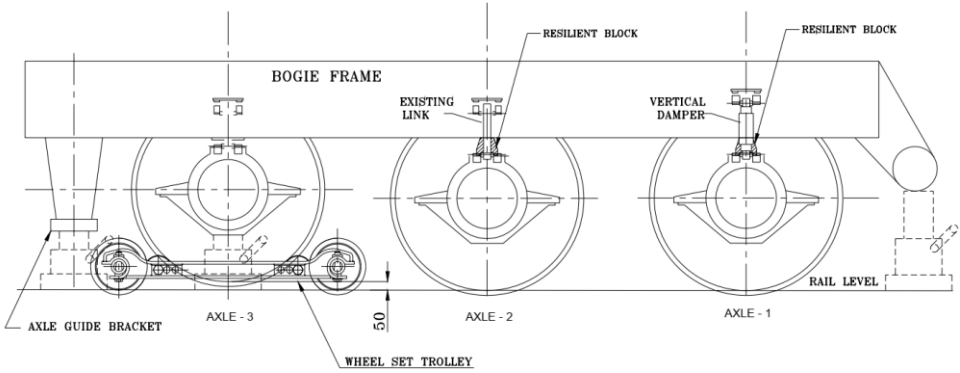
Material : Thermo Plastic Polyurethane Elastomer

Sl.	Property	Specified Value	Test Method
1.	Specific Gravity	1.15 to 1.25	ASTM D – 792
2.	Hardness	70 to 75 Shore 'D'	ASTM D – 2240
3.	Tensile Strength	300 kg/cm^2 (min.)	ASTM D – 412
4.	Elongation at Break	400% (min.)	ASTM D – 412

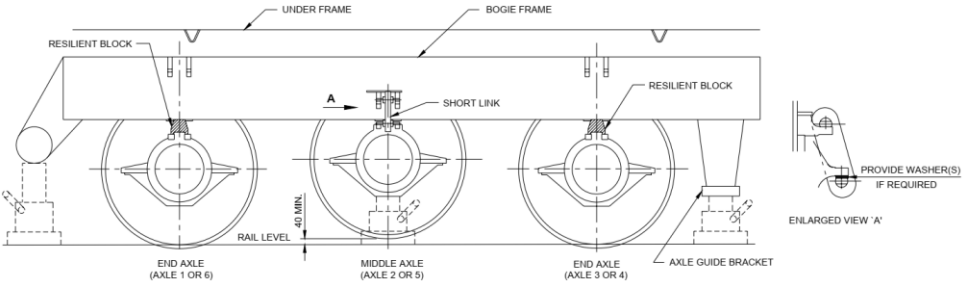
Sketch 2: Resilient Block



Sketch 3: Short Link



Sketch 4: Locations for Application of Lifting Jacks and Arrangement of Wheel Set Trolley for Lifting of End Acle in WAG9/WAP7 Locomotives



Sketch 5: Locations for Application of Lifting Jacks and Arrangement for Lifting of Middle Axle using short links in WAG9/WAP7 Locomotives

*****

Annexure – "B"

19.6 Procedure for Movement of WAP5 Locomotives by Lifting the Locked Axle in the Event of Axle Getting Locked on-line

The Schematic Arrangement of WAP5 locomotive bogie is shown in Sketch 1. An axle of the locomotive may get locked under the following circumstances:

1. Traction Motor Roller Bearing seizure.
2. Axle Box Roller Bearing seizure.

While it may be possible to free the Traction Motor from the axle in case of Traction motor bearing seizure, the other case requires lifting of the affected wheel for movement of the locomotive. Lifting of the affected wheel may become necessary in case of wheel flats & heavy skidding of wheels also.

19.6.1 Procedure when Traction Motor Roller Bearing gets Seized

In case of traction motor roller bearing seizure, the Hurth coupling connection of the affected traction motor should be removed / uncoupled, and both the traction motors of the affected bogie should be electrically isolated. The locomotive should be worked as a light engine on its own power to the nearest Electric Locomotive Shed for attention.

However, where removal of Hurth coupling connection is not possible due to any reason, the locked axle should be floated following the procedure given at Para 1.2 below for clearing the section.

19.6.2 Procedure for Lifting the Locked Axle

In case when Axle gets locked due to Axle Roller Bearing Seizure or there is Wheel Flat or Heavy Skidding of Wheels, the affected axle should be lifted after electrically isolating both the motors of affected bogie. The locomotive should be worked as a light engine on its own power with a maximum restricted speed of 25 km/h under escort by maintenance staff. In such cases, a close watch is necessary while passing over curves and turnouts.

19.6.3 Items required for Lifting of Axle

The following items are required for lifting the locked axle

1. Two hydraulic jacks having a minimum capacity of 15 tonnes each.
2. The distance pieces i.e. 'wooden blocks" to raise the hydraulic jacks, if required, to compensate the gap between the jack & axle box.
3. Two numbers of steel plates of size 300mm x 300mm x 30mm, which may be required for making the foundation firm and leveled for jacks.
4. Wooden wedges (at least 4 nos.) for application at the wheels for preventing rolling of locomotive while applying jacks.
5. Wheel Set Trolley to RDSO Drawing Nos. SK.VL-215 to 218.
6. Toolbox with appropriate tools, Nuts, Bolts, Washers and Wrenches / Spanners.

19.6.4 Precautions to be taken

Before attempting the lifting of locked axle of the locomotive, the steps given below should strictly be followed to avoid damage to equipment or any mishap:

1. Apply wooden wedges at wheels to prevent rolling of locomotive.
2. Release all brakes of the affected bogie, which requires lifting.
3. Before applying jacks for lifting, ensure that the ground below the lifting jacks is firm and level. Due care must be taken to avoid

slipping of the jacks.
4. Isolate both the traction motors of the affected bogie.
5. Remove all primary vertical dampers of the affected bogie to avoid their damage.

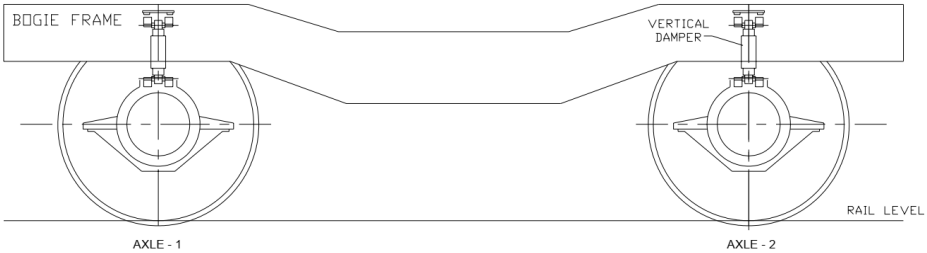
19.6.5 Procedure for lifting of Axle when it gets locked

1. Dismantle the sand box pipes. Remove footsteps, if required.
2. Remove the vertical dampers between the bogie frame and axle boxes of locked axle of the affected bogie.
3. Now, lift the locked axle from 55 to 60 mm by simultaneously applying two jacks of minimum 15t capacity each below the axle box housings at both sides.
4. Assemble the wheel set trolley below the locked axle over the track in such a way that the wheels of locked axle rest over the supporting rollers. Refer Proce- dure given below for Assembly of Wheel Set Trolley.
5. Sketch-2 shows the locations for application of jacks for lifting and arrangement of wheel set trolley under the affected axle.
6. Release the jacks from both sides of the locked axle ensuring that the locomotive wheels of the locked axle rest properly on the rollers of the wheel set trolley.
7. Remove the wooden wedges placed at wheels of the locomotive.
8. A locomotive with effected wheel set placed on the wheel set trolley can now be moved dead at a restricted speed not exceeding 25 km/h to clear the blocked section.

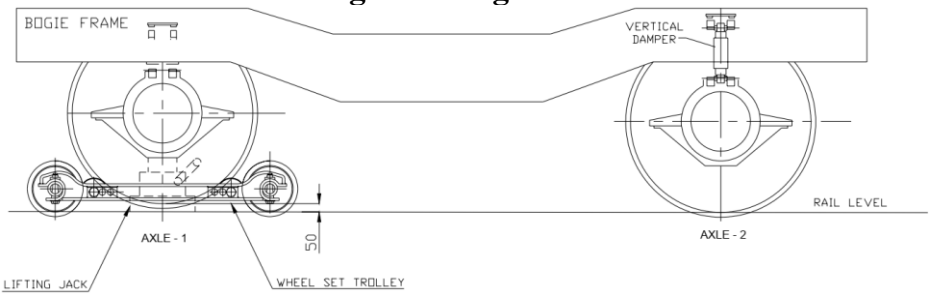
19.6.6 Procedure for Assembly of Wheel Set Trolley

1. The locked wheel set has to be lifted up approximately by 55 mm to 60 mm.
2. Push both the Inner Longitudinal Frames (Item No. 1 of Drg. No. SK.VL-215) of trolley under the locomotive.
3. Place both the Steel Tubes (Item no. 32 of Drg. No. SK.VL-218) in position.
4. Lift up the frame along with the steel tubes, push in and fasten the running Wheel Arrangements (Item no.3 of Drg. No. SK VL-215), Supporting Roller Arrangements (Item No. 4 of Drg No. SK.VL-215) with keys and bolts.

5. Push the outer Longitudinal Frames (Item No. 2 of Drg. No. SK.VL-215) of the trolley under the locomotive, lift the frame, push in Outer Steel Tubes / Sleeves (Item no. 33 of Drg. No. SK VL-218) and fasten the frames with keys and nuts.
6. To facilitate easy assembly of wheel set trolley, suitable markings as shown in the drawing must be provided to identify the matching parts. Lower the locked wheel set of the locomotive gradually on the supporting rollers. xv
7. After lowering the wheels on trolley, it is essential to ensure that the wheel flanges of the lifted wheel set are sufficiently clear from the rails, to avoid hitting/ infringement during movement of the locomotive.



Sketch 1: Schematic Bogie Arrangement of WAP5 Locomotive



Sketch 2: Locations for Application of Lifting Jacks and Arrangement of Wheel Set Trolley for Lifting of Locked Axle in WAP5 Locomotives

SAFETY IN SIGNALLING SYSTEM
AND THE PRINCIPLES OF INTERLOCKING

20

Safety in signalling system is very important and vital to railway operation. It is the responsibility of every operating official to understand the basics of signals, signal maintenance and their effects in day-to-day railway operation. It has been noticed that due to signal problems several accidents happened. Whenever any accident occurs with failure in signalling system, interlocking, and tempering of signal gear, the severity of accident is quite high. It is the prime duty of station masters and traffic inspectors to understand the importance of maintenance of signal gears. A reliable system of signal and communication is the primary requisite for efficient functioning of any organization. Such a communication system is of utmost importance in railway operation. A gigantic activity is going on round the clock for running thousands of trains all over the country. Be it at a station, yard or Control office, communication must be established before moving a train. Under the system of working "line clear" is to be obtained through Block Instruments provided with Block telephones. When the Block Instrument become defective, "paper

line clear" must be obtained through Block telephone or Control telephone. In abnormal circumstances, "line clear" through wireless communication like VHF set is also permitted. The telecommunication facilities also greatly influence the productivity of different loco sheds, depots and workshops which constitute the base of railway operation.

The signalling system used on Indian Railways comprises various techniques and technologies which range from rudimentary Semaphore signals to sophisticated electrically lit signals, both manual and automatic. The latest signalling system used is Solid State Interlocking which has revolutionized the functioning of signals. The signalling and telecommunication facilities provided on Indian Railways are as follows:

20.1 Signals

Signals are provided to guide the crew and Guard for con- trolling the movement of trains with advance information about the condition of the track ahead. Signals may be visible or audible. While the former includes Fixed Signals (Semaphore or Colour Light), Hand Signals and Flare Signals, the detonating signals come under the latter category. Semaphore signals work in the lower or upper quadrant.

In addition, there are different types of Indicators to show the conditions of the points by Point and Trap Indicators, Various types of Boards, namely Warning Board, Shunting Board, Block Section Limit Board, Whistle Board, Stop Board and Spring Point Warning Board, have also been provided for the Driver to regulate his train while approaching or passing a station, yard, or level crossing. The different types of signals provided on Indian Railways are:

1. **Hand Signals:**
   Such signals are exhibited by flags and lights with green and red colour. While a flag is used during day, light is, shown during night generally for shunting operations or indicating speed restrictions, etc.

2. **Detonating Signals:**
   The detonating signals, also known as "fog signals", are made of explosive material and used on the rails as and when required. When an engine or a vehicle passes over them, they explode with a loud sound that attracts attention of the Driver and warns him that he is approaching a fixed signal or that there is an obstruction on the track ahead, particularly when visibility is poor.
3. **Flare Signals:**
   A flare signal emits a bright red flame when lighted and is used for warning the Driver of an approaching train or an obstruction.
4. **Semaphore Signals:**
   These are normally two-aspect lower quadrant and multiple aspect upper quadrant signals operated manually or electrically to permit movement of a train up to the next signal. Multiple aspect upper quadrant signals displaying more than two aspects are also provided in some sections to improve train operation by speedier movement.
5. **Colour Light Signals:**
   Under this signalling arrangement, multi-aspect, viz green, yellow, and red, indicates if the train is permitted to go in the section. These are more efficient to forewarn the Driver before he approaches the most restrictive aspect of the signal, i.e., "red". This helps him in smooth braking with the advance information available. The Driver can also maintain the maximum permissible speed when his train is running through a station.
6. **Subsidiary Signals:**
   These signals as distinct from main signals are provided both in the Semaphore and Colour Light signalling territories either below a stop signal or on a separate post to control shunting movements or to

draw a train on an occupied line. Such signals are also provided at convenient locations when the main signals cannot be seen by Drivers from a required distance. These are termed as Repeater Signals.

7. **Engineering Signals:**
   Various indicators, namely Caution Indicator, Speed Indicator, Stop Indicator and Termination Indicator as described below should be displayed by the staff of Engineering Department to protect the site of work or maintain speed restrictions as per rules.

20.1.1 Caution Indicator:

It consists of a horizontal board fish- tailed at one end, jointed at the other and painted yellow and black. This indicator should be provided both for permanent and temporary speed restriction. For temporary restriction, the indicator should display two horizontal yellow lights to advancing trains at night, and for permanent restriction no light needs to be displayed.

20.1.2 Speed Indicator:

It is a yellow equilateral triangular board displaying the speed at which a train is to run. This indicator should be provided both for permanent and temporary restriction and illuminated by night for temporary restriction only by fixing a hand signal lamp in front of the board for the guidance of Drivers.

20.1.3 Stop Indicator:

It consists of a horizontal board with red- and-white vertical stripes painted on it. This indicator shall display two red lights by night. It is used in case of restriction with "stop dead".

20.1.4 Termination Indicator:

This indicator is provided to tell Drivers when the normal speed may be resumed. Such an indicator is fixed ordinarily at a distance covering the length of the longest goods train running in the section. This indicator consists of a circular disc painted yellow with a letter "T" in black. For temporary restriction, it is required to be illuminated at night by fixing a hand lamp.

All the above indicators should be placed at the prescribed distance and height as mentioned in the General Rules.

20.1.5 Block Working:

While movement of trains at a station is controlled by signals, the working of trains between two Block Stations is controlled by a Block Instrument to ensure safe entry of a train to a block section.

20.2 Token Instruments

Some sections on single line have Token Instruments, and busy sections are provided with Tokenless Instruments. Token Instruments at two adjacent stations are electrically connected to each other. Under both the token and Tokenless systems, only one train can be admitted at a time in the Block Section.

20.2.1 Token System:

The Token extracted from a Token Instrument indicates that the Block Section controlled by the instrument is clear of any other train. The Token is used as an authority for the Driver to proceed with his train from one station to the other. Unless the Token is extracted the stop signal of the exit station cannot be taken off.

20.2.2 Token less Block Instruments:

These instruments control the last stop signal of a station permitting entry of a train into the Block Section. These instruments also control the Receiving Signals at the entrance end station. Tokenless Block Instruments are provided at stations on busy single line sections to avoid delay in the process of extracting the Token and delivering it to the Drivers specially in case of crossing.

20.2.3 Track Circuiting:

This system is provided to detect occupation of any running line and ensure that the signals cannot be "taken off" for reception or despatch of a train unless the conditions for the same are fulfilled.

20.2.4 Axle Counters:

This is a substitute for track circuits. Through a suitable track mounted device, this counts the number of axles entering and leaving a nominated track section. The equal counts of the number of axles entering a section and leaving it indicate that the section of track is clear.

20.3 Interlocking of Points and Signals

As per rules, signals can be taken off for reception and despatch of trains only when the relevant points are set, facing points locked, level crossing gate, if any, closed and locked against road traffic. If such points and signals are free so as to be operated independently, signals can be taken off without proper setting of the route. To guard against such mistakes of the train-passing staff, interlocking of points and signals has been provided at the stations and yards.

Interlocking is a device for integrated operation of points and signals so that the signal cannot be taken off unless the relevant points and route are correctly set and facing points locked in safe passage of a train. It must not be possible to "take off" two signals simultaneously which may be conflicting. The inter- locking system has been developed from the rudimentary to the route relay and Solid-State Interlocking of today.

Interlocking may be achieved through mechanical, electrical, or electronic devices or a combination of the three. The operation of points and signals can be done either from the cabin or at site. The standard of interlocking to be provided is based on the density of traffic in the section. The standard of interlocking determines the speed at which a train can run while negotiating the facing points. Complement of signals is provided accordingly.

Three types of interlocking have been provided on Indian Railways, namely Standard 1. Standard II, and Standard III. In case of stations interlocked with Standard I. a train can run at a maximum speed of 50 kmph on the main line, provided through signals are "taken off". At stations with standard II interlocking the maximum speed is 75

kmph. In case of Standard III interlocked stations, the trains can run at an unrestricted speed subject to the maximum permissible speed. With the increase in the sectional speed, the interlocking arrangement as well as the track condition should be improved so that the speed of trains do not slow down below the booked speed, not to speak of the maximum permissible speed. It is, therefore, imperative that whenever there is a need of running high-speed trains, the system of signalling, interlocking and the track condition are improved first.

20.4 Advanced Signalling Systems

1. **Automatic Signalling:**
   This system has been provided on very busy sections to admit more than one train in the section between two stations. The section between two stations is divided into a number of automatic signalling sections by providing multi-aspect colour light signals at intermediate points. The normal aspect of such a signal is "green", and with occupation of the line ahead it automatically becomes "red". The signal thereafter assumes "yellow" or "double yellow" aspect, automatically depending on the condition of the track ahead. The entire territory is track circuited and there is no need for manual operation of signals under this system.
2. **Panel Interlocking System:**
   In this system a panel is provided at a centrally located place like Station Master's room/Cabin. Points and signals are operated through switches and push buttons. The layout of the station is indicated on the panel through a diagram. A particular route can be set by operating the relevant button/switch for the movement of a train and the route set is indicated by white light on the panel. As soon as the train enters the signalling section it is indicated on the panel, and the signal goes back to "red" aspect.
   With the introduction of panel interlocking train-passing duties have been entrusted to more responsible staff like Station Masters with unitary control which is safer.
3. **Auxiliary Warning System (AWS):**

In this system a buzzing sound is produced to caution the Driver about the "red" aspect of a signal being approached. The Driver must acknowledge this signal by pressing the prescribed button. In case he fails to do so, for not being alert, a penal application of brakes automatically takes place to stop the train before the "red" signal is passed, recording such failure on the part of the Driver.

2. **Route Relay Interlocking (RRI):**
   This is an improved signalling system for convenient and speedy setting of points in the route and "taking off" the relevant signals by electrical means. Under this system, the operating staff are relieved of many steps in the operation of points and signals and are re- quired to set the route for the desired movement by pressing the "Entrance" and "Exit" buttons only on the control panel. This eliminates chances of human errors, apart from saving much time in the process of setting and locking the points before "taking off the signal. There is also one control-switch-operated system.
3. **Solid State Interlocking (SSI):**
   It is an imported and the latest technology for an improved and most reliable system of interlocking. While the existing route relay interlocking is based on a large number of relays with moving parts and requires more space, solid state interlocking is a computer-based inter- locking controlled by software. With the introduction of SSI. requirements of space, manpower as well as power consumption will be considerably reduced. The requirement of wiring for any modification of the existing layout is very less as compared with relay interlocking. The maintenance is also easy and involves simply replacement of cards, whereas for the relay interlocking, the maintenance process is cumbersome and time-consuming.
   At present, solid-state interlocking is not cost-effective. How- ever, with the indigenous development of the system, the cost is likely to be reduced in future.
4. **Centralized Traffic Control:**
   It is a system where all the trains in a long section, which is entirely track circuited, are operated, and regulated from one place by one controller without the help of any operating staff in the whole

section. All points and signals are operated from the panel board provided for the purpose.

5. **Cab Signalling:**
   In the various types of signalling so far used on the surface railways in India, one big snag continues to remain if the Driver disregards the signal wilfully or otherwise, there is no way to prevent an accident. While the Metro Railway is an underground system, special precautionary measures should be taken, and accidents must be avoided at any cost. Apart from other improvements in track geometry, prevention of fire and inundation, etc., the latest technique of signalling called "cab signalling" has been introduced. The conventional signals, whether Semaphore or Colour Light or Automatic, are placed by the side of the track. In "cab signalling" the signals are indicated within the cab.

The principle involved is to tell the Driver the speed at which the previous train is moving so that he can also run his train at that speed and keep a safe distance. However, if the Driver fails to obey the speed command, the train mechanism automatically takes care of the braking arrangement, and the speed is either reduced or the train is brought to a stop.

The speed of the previous train is picked up by relays placed on the track and ultimately passed on to the cab of the train following. This system, therefore, not only performs the roles of the Driver but something more-it ensures against any failure of the Driver.

This system has been imported by the Metro Railway from GEC Alasthom, France, and consists of the following three independent sub-systems:

1. **Automatic Train Protection (ATP):**
   Safety subsystem.
2. **Automatic Train Operation (ATO):**
   Train driving sub-system.
3. **Automatic Train Supervision (ATS):**
   Supervision sub- system.

1. Automatic Train Protection

1. Prevent rear-end collision.
2. Prevent train from rolling back.
3. Train detection.
4. Speed measurement.
5. Transmission of speed command from track to train.
6. Decoding of speed command in the cab and displaying the same in the cab, i.e., cab signalling.
7. Overspeed protection.
8. Brake assurance.
9. Zero speed detection.

2. Automatic Train Operation

1. Traction control.
2. Service braking.
3. Automatic train stop.
4. Coasting
5. Door opening.
6. Traction prohibition in Neutral Sections.

3. Automatic Train Supervision

1. Maintain service according to prescribed schedule.
2. Revise schedule to meet passenger flow change.
3. Achieve optimum system capacity.
4. Provide management of passenger information.
5. Provide energy economy by coasting.
6. Monitor position and progress of trains and display this information on mini panel.
7. Automatically set routes ahead of the train.
8. Compile records of deviations from the planned train performance.
9. Log and maintain records of distance run by individual units of rolling stock as an aid to maintenance staff,
10. Train description.

With the introduction of cab signalling, while the function of ASM and Section Controller will be taken over by ATS, the function of the Driver will be assumed by ATO except for opening and closing

of doors. This will relieve the Driver of his routine work and he will get more time to concentrate on watch- out duties.

The maintenance of signal gear must be done with the issue of proper disconnection memo. Therefore, it is necessary to understand when disconnection memo is necessary for maintenance or otherwise. The following paragraph will illustrate all aspects of disconnection memos.

20.5 Maintenance of Signals

Signals are the most important aid to the train-passing staff and the running staff who are to control the movement of trains for reasons of safety. Failures of signals not only affect punctuality but also safety of trains. Although failure of signals is supposed to be on the safe side, an abnormal condition is created thereby and any mistake or lapse on the part of the train-passing staff or the crew may cause a disaster as has happened in many cases. It is, therefore, of utmost importance that the signals are maintained properly and kept in good fettle for safe running of trains. Signal Controllers are posted round the clock in the Divisional Control Offices to monitor the working of signals. In case of any failure or breakdown, arrangement is made quickly by the Signal Controller to send the maintenance staff to the spot to rectify the signals as early as possible. Transportation facilities must be provided for the maintenance staff to rush to the spot when the train service is not available.

Negligence of signal and maintenance staff

Negligence of signal and maintenance staff and improper maintenance are also responsible for signal failures. Maintenance of signals requires technically qualified personnel with requisite knowledge and skill. Shortage of maintenance staff and their inadequate knowledge affect proper maintenance of signals. Al- though there is a provision for direct recruitment of Signal In- Spector's and maintainers,

the posts of such essential staff are very often filled up by local arrangements or they remain vacant. The vacancies must be filled in time for proper maintenance of signal gears. Direct recruitment of maintenance staff has been stopped on some Zonal Railways and vacancies are being filled up by the promotion of Group D non-technical staff. Even in departmental promotion, only the technically qualified personnel should be selected.

Signal failures due to short-cut methods and unsafe practices.

Signal failures are also caused by short-cut methods or unsafe practices adopted in maintenance of signals. Often, there is an understanding between the signal maintenance staff and train-passing staff for short-circuiting the procedures. Inspections should be conducted by the supervisors and Signal Engineers with an element of surprise to ensure strict observance of procedure for disconnecting signal and telecommunication gears, etc. The lapses in this regard should be viewed seriously. Signal failures are also caused by the use of sub-standard materials like fuses, signal bulbs, relay, and battery. The requisite material is also not always available on time. Signal failure also occurs owing to movement of non-insulated trolley on track circuiting area, and maintenance of points by the Permanent Way staff without associating the S&T staff.

Signal failures due to improper handling and manipulation of the signalling equipments.

Signal failure often occurs owing to improper handling or manipulation of the signalling equipment. For example, if the levers of points and signals are not pulled properly, Block Instruments not handled correctly and "Train Entering Section" (TES) report not given in time, the signal may not function or fail

for the subsequent operation which is known as "one operation failure". The train-passing staff, particularly ASM, Switch- man and Cabinman should, therefore, be educated about proper handling of the equipment to avoid their malfunctioning.

Signal Failures due to interference by miscreants. Apart from failure on the part of the maintenance staff, signals also become defective owing to interference by miscreants, which is very rampant in certain areas. Stern action is called for against such activities prejudicial to public safety. The vulnerable sections should be patrolled, particularly during the night by the RPF and GRP personnel to apprehend the criminals.

Semaphore signals operated through wires are more prone to failure than electrically lit colour light signals and, therefore, require more attention. Moreover, Semaphore signals are also susceptible to interference by criminals as the wires can be easily cut or entangled. Indian Railways is progressively replacing Semaphore signals by Colour Light signals on non-electrified sections too. As reliability of such signals is better and as they require less maintenance, this will go a long way towards improving safety in train operation.

Lever frames and signal gears provided in the Cabin are re- quired to be overhauled at the prescribed interval to ensure safety of interlocking. But, in apprehension of transportation problems, such overhauling is often delayed. This is a potential source of failures of points and signals due to the malfunctioning of lever and signalling gears. It is, therefore, of utmost importance that Cabins are overhauled in time to keep the signalling equipment in full working order. Replacement of signalling gears should be planned on the age-cum-condition basis to improve their reliability. Signalling cables should be periodically tested to ensure proper insulation. Defective or low insulation cables should be replaced in

time. Constraints of fund should not stand in the way of replacement or renewal of such safety devices. Telecommunication The Railways has an extensive telephone network as detailed below:

Point-to-Point Block Circuits:

These are dedicated circuits between two fixed points used for enquiry as to whether trains can be despatched from one point to another. Such communication has been provided through telephones connected with the Block Instruments between adjacent stations either through cable or through 18 GHz microwave system wherever provided.

Control Circuits:

The Control office at the Divisional head- quarters and the Area Control office have been provided with omnibus control telecommunication circuits connecting all the stations and cabins under their jurisdiction to control, monitor and direct the movement of trains on each section. The Control network is under functional control of the Section Controller. Similarly, the Chief Controller. Deputy Controller, Traction Power Controller have also been provided with the facility of direct telecommunication with major stations to give instructions in connection with train operations. Engineering Control and Signal Control have also been provided to coordinate maintenance activities of permanent way and signalling system. Block working between stations and Control communication with various points are being progressively worked by 18 GHz microwave system, replacing the existing underground cables.

Emergency Control Communication:

It is provided to ensure prompt exchange of messages in case of an accident or emergency. This enables the Guard and the crew member of a train to talk to the Control office through a portable telephone provided to them. The portable telephone is to be connected with the emergency sockets provided at a suitable distance of one kilometre along the track in electrified sections. In non-electrified sections, where overhead lines are used for control communication, portable telephones are required to be hooked on to the control circuit to contact the Section Controller. The location of the emergency socket and the telephone mast is indicated by an arrow mark. On certain sections like Grand Chord of Eastern Railway, the conventional RE cable has been done away with and the station-to-station microwave system of communication has been provided. Emergency sockets no longer exist in such sections. Emergency communication has been provided through portable VHF set for communication with the emergency control situated in the Divisional Control office. Such mobile sets have been provided in the Brakevan of all passenger-carrying trains, OHE maintenance cars, Drivers, Permanent Way staff and others working on line to facilitate safe working.

Exchange Communication:

Telephone Exchange and Inter-com connections are provided as an independent means of communication from yard to yard, yard to cabin and on pockets in a yard for their routine jobs. In marshalling yards Paging and Talkback facility through microphone and loudspeakers is provided for communication between the yard staff and the train passing staff.

Administrative Communication:

A network called Administrative Trunk Circuits connecting the administrative units like the Zonal or

Divisional headquarters and other operational centers is also available. This provides point-to-point communication for conducting conferences by the headquarters with the Divisions and Area Control offices for close coordination. Railway-owned links and, in a few cases, MW channels are rented from the Department of Telecommunications.

Further, all the Divisional headquarters have been connected to the Zonal headquarters through Fax on railway communication network. Teleprinter or Auto-max network has also been provided for transmitting messages. These facilities may be used for sending accident messages, etc.

Thus, communication provided either by signals or through telephones is an indispensable aid for smooth and safe train operation and forms a vital link in the functioning of the entire railway system.

20.6 Disconnection memos for maintenance of signals gears

We must know and ensure the provision of General Rule 3.51(3), which states as under:

> "No Railway servant shall interfere with any points, signals or their fitting, Signal wires or any interlocking or block gear for the purpose of effecting repairs or for any other purpose except with the previous permission of the Station Master".

Further Signal Engineering Manual Part II Para 11.4 states that the maintenance of signal gears must be done as per issuance of disconnection notice. It states that-

1. Each Maintainer shall have in his possession a book of Disconnection Notices-Form S7T/DN.
2. A Maintainer who is in possession of a Competency Certificate cum training History book only shall independently undertake works necessitating issues of Disconnection Notices.

3. Disconnection Notices need not be issued in situations as provided in the signal manual and suitable precautions are taken in this regard.
4. In other situations, when it is necessary to disconnect any equipment in his charge for repairs, replacement or adjustment, the Maintainer shall advise the Station Master on duty in writing on Form S&T/DN and obtain the latter's signature before work is started and after it has been completed.
5. 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.

The Maintainer must seal the equipment opened by him under his competence. It is clear from the above that a disconnection notice must be issued by the Signalling staff and acknowledged by the SM before undertaking any work that interferes with the normal working of the signalling gears as also after completion of the works. However, there are some items of normal day-to-day maintenance, inspection of signalling work which do not involve any disconnection/Interference/repair of signalling gear and hence issue of disconnection notice is not required.

1. The situations where the issue of disconnection notice is essential is being/can be judged by the maintainers/JE (signal)/SE or SSE(Signal) keeping in view the nature of work involved.
2. A few illustrative examples of items of work which can be carried out by the signalling staff without issuing a disconnection for not disturbing the proper functioning of the gear, are indicated in the annexure for guidance.
3. This circular does not supersede or alter any of the existing rules and/or circulars on the subject but is only being issued to reiterate the extant practice.

20.7 When disconnection notice is necessary

(Ref: Annexure to Joint Safety and Signalling Circular No.SG.215/14 DATED 12.10.1988.)

List of some of the items where it is essential to issue a disconnection notice.

1. Disconnection of rod from the corresponding lever of the lever frame for any purpose from the unit worked by rodding, viz., the points, lock bar, etc., to which the rodding is connected.
2. Removal of either the points slides or the signal slides of mechanical point detectors.
3. Disconnection of a lock bar of a facing point lock plunger.
4. Carrying out changes in the internal wiring (interfering with the working circuit of relay rooms).
5. Removal of a key lock from the lever to which it is fixed.
6. Opening of a key transmitter for local releases of its key.
7. Disconnection of an arm circuit controller from the semaphore arm.
8. Opening up of the back cover or the front cover of a Block/Token/Tablet/Token less instruments for making any adjustments or change of wiring or disconnection of the instrument.
9. Disconnection of a circuit controller or a lever lock-cum-circuit controller from the lever to which it is connected.
10. Testing of Cables.
11. Conducting broken wire test.
12. Conducting safety checks by simulating conditions in route relay/panel interlocked installations.
13. Changing of signal arms in semaphore signalling territories.
14. Alterations to axle counters.
15. Removal/Replacement of any relay of a working signalling circuit.
16. Changing signalling cables, wiring etc. of a working circuit.
17. Carrying out alterations in locking.
18. Replacement of signal/point motors and reversers.
19. Any soldering work of a plug-in relay.
20. Changing of booms and wire ropes of a lifting barrier (except where alternative means of interlocking the gate by swing gates or interlocked chain working are available as a standby)

While carrying out some of the work, it is reiterated that normal precautions for not disturbing the proper functioning of the signalling equipment must be taken.

1. Removal of weeds in between rodding.
2. Putting earth for strengthening trestles.
3. Tightening screws, bolts, and nuts.
4. Graphiting.
5. Oiling the pins.
6. Replacing split pins.
7. Scraping the paint and repainting of rod runs.
8. Oiling and cleaning of signal spindle.
9. Checking and adjustment of dash spring and its housing.
10. Removal/refitting of glasses, roundels, lamps and lamp brackets during day light hours.
11. Focusing of signals.
12. Painting of signal posts, lever frames and accessories.
13. Lubrication of pulleys.
14. Removal and re fixing of pulleys.
15. Replacing number plates.
16. Testing locking of lever frame or S.M.'s slide instruments.
17. Cleaning of dust and mud affects the functioning of signalling gears.
18. Cleaning of colour light signals without removing lenses.
19. Testing of signals.
20. Replacement of fused bulbs (ensuring that no phantom indication is caused).
21. Replacement of other types of bulbs when fused.
22. Replacement of fuses the at a time.
23. Inspection of inside equipment's by opening the covers of point machines, signal motors and apparatus cases.
24. Cleaning of power supply equipment.
25. Voltage measurements of track circuits.
26. Carrying out functional test of signals/points by pulling relevant levers/operating push buttons/switches.
27. Restoration of signal failure that has occurred due to minor defects.
28. External/Internal cleaning of block instruments (When no train is in block section or line clear not granted).
29. Cleaning of equipment in the relay room without causing any physical or electrical disconnection.

20.8 Situations in which disconnection notice need not be issued provided suitable precautions are taken: (Ref: SEM Part II Annexure 3)

Cleaning and/or lubricating/Graphiting without affecting any physical/electrical disconnection.

1. Lever frame basement.
2. Relay Room and Battery Room.
3. Apparatus case/Battery boxes/Goomty.
4. Lifting barrier mechanism including winch.
5. Lever lock and Circuit controller without opening cover.
6. Inspection and cleaning of inside equipment by opening the covers of point machines, signal motors, reversers, apparatus cases and detectors.
7. Point, facing point lock and lock bar.
8. Cranks, compensators, pullies, wheels, roller stands, counterweights and levers.
9. Power supply equipment.
10. Insulation joints.
11. Lens/roundels of signal, point indicator, trap indicator and shunt permitting indicator provided phantom indication to driver of an incoming train is prevented by covering lenses.
12. Testing of track locking, approach locking, back locking, indication locking, route release.
13. Checking various parameters of axle counter without disconnecting the equipment.
14. Power supply equipment.
15. Lever frame, SM's control frame, signal operation, point operation, level crossing gate and slot circuits.
16. Point by obstruction test for lock only.
17. Checking and testing of track circuit parameters when the track is unoccupied.
18. Focusing of colour light signal provided phantom indication to driver of an incoming train is prevented by covering lenses.
19. Adjustment of wire transmission except double wire operated point transmission.
20. Tightening of terminals using insulated tools without causing any shorts on adjacent terminals.

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

20.9 Do's and Don'ts for Signal Maintainer

Do's

1. Ensure good visibility of signals by proper cleaning & focusing.
2. Be prompt in attending failures.
3. Ensure that proper remarks are given against each failure in the signal failure register.
4. Ensure double locking of relay room & cabin basement.
5. Prepare a joint reading record of lever position /indications / panel position immediately after any accident.
6. Inform ASM / P-Way staff immediately when you come across any broken rail / broken switch rail.
7. Check and ensure that there is no infringement to standard dimension.
8. Be present physically while disconnection of any gear is going on at site or also while class IVth / Blacksmith is working on any gear.
9. Ensure fire-fighting equipment is not overdue for recharging. Get acquainted with how to use it.
10. Ensure that no window pan is broken in any relay hut or relay room.
11. Ensure that relay room / relay hut / battery rooms are properly lit.
12. Ensure that exhaust fan is in working condition in battery room.
13. Arrange to clear rail flanges clear of ballast by 25 mm to avoid track circuit failure.
14. Arrange to replace timely 'likely to fail nylon / glued joints' through P -Way staff.

15. Ensure proper packing of points insulation joints through P -Way staff.
16. Ensure that 'under moving wheel flashing point 'immediately attended by P- Way & S&T staff.
17. Ensure that brake dust / iron chips are cleaned at insulation joints at regular intervals.
18. Ensure that all jumpers & bond wires are intact.
19. Ensure that no glass / outer casing of any relay is not broken.
20. Ensure that all CB's, Emergency Keys, Block Inst, Resetting Keys, Counters etc. are properly scaled.
21. Maintenance is done as per schedule & updates all records.
22. Earth connections are proper.
23. Earth is watered regularly.
24. In the Railway Electrification (RE) area lever frame generators etc. are properly earthed.
25. In the Railway Electrification (RE) area wire insulators / rod insulation are provided& intact.

Don'ts

1. Never take any intoxicant while on duty.
2. Don't open the relay room, cabin basement without proper entry.
3. Never adopt a friendly way of working on trust by violating rules.
4. Never tamper with any scale.
5. Never adopt the short cut method.
6. Never release any route unless a proper memo is received.
7. Never disconnect a signal gear unless disconnection is granted.
8. Don't give indication of disconnected gear to allow signaled move.
9. Don't provide bond wire over broken rail unless P-Way staff has made fit the track.
10. Don't allow unskilled staff to repair any gear independently.
11. Don't start repairing a damaged point until permitted by authorized officers.

20.10 Derailment Investigations

"Accident Investigations - a tool to prevent recurrence" In most case on Indian Railways, cause of the accident is not clearly established This results in repetitive failures. Pinpointing the scientific causes of accidents, therefore, becomes a preventive strategy

Site Investigation:

1) The position of block instruments, signals, points Indicators.
2) At stations with panel interlocking position of switches & indicators to be recorded preferably by two officers or two Sr. Subordinates of different branches and relay room to be sealed.
3) Position of important relays
4) Seize & freeze all records as laid down in accident manual.
5) The statement of the concerned staff available at site should be recorded for finding the cause of accident.
6) To give the prima-facie cause of the accident with expected time of restoration.
7) Marshalling of the train, with regard to anti-telescopic coaches.
8) Arrange to take photographs from different angles to assist in reconstructing the scene of the accident,
9) The dates given in the accident reporting form must be recorded for locomotive to produce before the Accident Enquiry Committee. The track and coach/wagon are to be examined jointly and the data and information collected are to be recorded jointly signed by the Sr. Subordinates available at the site.

20.11 Derailments at Points and Crossings:

Points and crossings are meant for changing the road of a train and it has some discontinuities thereby making it a weak link in track structure. In one point there are two tongue rails connected together by stretcher bars and this assembly is called switch. A pull rod from some distance operates this switch. Today, most of the points are operated by motors and they have some interlocking arrangement.

The interlocking for motor operated points is done with a lock bar and it has a detection device also to detect proper housing of points. Tongue rails forming the switch are hinged onto the heel blocks in the rear. The bolts, provided for hinging the tongue rails, are kept loose for easy operation of switch. After the switch arrangement, another important part is the nose of crossing. Here all the wheels traverse the path shown by the switch.

Most of the derailments at points and crossings either initiate at the toe of the tongue rail or near the nose of the crossing. Whenever a derailment takes place on a point the following checks must be done: -

Gauge of point must be checked at four locations:

1. 305 mm in advance of nose of tongue rail
2. 152 mm inside the tongue rail for straight road and turn out.
3. At heel for tongue rail for straight road and turn out.
4. At middle of tongue rail for straight road and turn out.

The Gauge must be correct at all places except at the toe where it may be 6 mm slack for housing the tongue rail.

It can be appreciated that conditions created by slack gauge are not permitted near the switch. IRPWM- 1985, Para 237 t (8) (a) and (b) is reproduced below: -

"(8) Gauge and Super-elevation in turnouts-

(a) It is a good practice to maintain uniform gauge over turnouts.

(b) If the gauge of track adjoining the points and crossings is maintained wider/tighter than the gauge on the points and crossings. The gauge on the adjoining track must CIRE be brought to the same gauge as in points and crossings and run out at the rate of 1 mm in 3 meters to the requisite extent. It should, however, be ensured that the same gauge as applicable to the points and crossings is maintained

for at least one rail length on either side of point and crossings."

In case of derailment suspected to have started near the switch of the turnout the following points need to be carefully examined:

1. The condition of tongue rail-whether broken, chipped or bent.
2. Whether the damage is old or new.
3. Height of the tip of the switch from top of stock rail.
4. Thickness of the tongue rail
5. Any gap between the tongue rail and stock rail
6. Any damage to stretcher bar
7. In case of interlocked points, the slackness between the locking bar slot and slide should be recorded.
8. The condition of brackets holding the stock rail
9. Whether the switch jumps up when a wheel passes on its heel.

   If the derailment is suspected to have started near the crossing the following points must be carefully checked: -
10. Condition of nose-wear, breakage, chipped, bent.
11. Reduction in the level of host as compared with wing rails.
12. Clearance between wing rail and stock rail (near the nose) on both sides.
13. Clearance between guard rail and stock rail
14. Alignment of turnout to be measured for checking smoothness (with 6-meter chord at 1.5-meter intervals)

IRPWM has specified a checklist for complete examination of points and crossings.

There is one potentially dangerous structure called diamond crossing, which is generally not provided on the main line. A simple diamond crossing has four noses (two acute angles and two obtuse angles), which require a critical watch. Even a slight damage to these noses or disturbance to the clearance between stock rails and guardrails make this diamond crossing unsafe. The problem is further compounded if a diamond crossing has one or two slips also. The curvature of the slip is generally so high that these structures are not fit for speeds above 8 to 10 kmph. It is advisable to avoid the use of these structures.

20.12 Following Details should be recorded and considered Accident Involving S&T

1. If the station is interlocked, standard and system of interlocking and classification of station?
2. Are the signals concerned visible from the place of operation? If not, are repeaters provided both in cabin and in the Station Masters office and what was the condition of repeaters at the time of accident?
3. Is the outer visible from the required distance? What is the approach like?
4. Is the Home Signal visible while approaching the outer? If so, at what distance before the outer?
5. Lighting of signal lamps or indicators and the condition of lamps.
6. Were the signals, points, repeaters, slots tested by the were their committee concerned observations?
7. Recent History of signal concerned.
8. Are other points worked from a cabin or a ground frame? Whether rod operated or power operated?
9. Method of locking the points. Are points provided with point indicator or governed by starting signals whether FPL, Lock Bar or Track Circuit provided for route holding?
10. Method of controlling the reception and departure signal.

11. Were the rules and instructions complied with?
12. Did the Lever man feel an obstruction while operating points or signal lever?
13. When did the maintenance staff last attend the maintenance of the apparatus?
14. In the case of double wire signaling, was the "Auxiliary Lever sealed and was it in the safe custody of the station Master?
15. When was the "Auxiliary Lever" last used and for what purpose?
16. Were the points found correctly housed and set and what is the condition of the switches? Are they worn out or chipped?
17. Were the lever collars provided & used as per instructions in force?
18. Were the points found correctly set and locked and what is the condition of the switches? Are they worn out or chipped?
19. Was the Relay Room properly locked and Operating Key is in possession of SM/ ASM?
20. Were the Relays properly sealed?
21. When was the crank handle last used and for what purpose?
22. Was the Crank Handle sealed?
23. Was the Block Instrument properly sealed and locked?
24. Were Motor points in intact position and no tampering has been done?
25. Was Panel sealed and all the counters reading were properly recorded for last operation?
26. Whatever indications are shown on the panel (viz. Routes, Sub-routes, Signal aspects indications etc. should be recorded as shown on the panel).

20.13 DO's & DON'Ts for S&T staff

a. Do's

1. Take pride in providing safe & Reliable Signalling System.
2. Remember that you are vital and every action of yours has safety implications directly / indirectly.
3. Follow Maintenance schedules as given in Signal Engineering manual / Zonal Railways
4. Follow G&SR rules in dealing with failures and replacements.
5. Check station SWR and ensure its correctness.
6. Ensure that completion drawings are available, and all the alterations incorporated.
7. Ensure testing of panel or lever frame is done properly.
8. Check train shunt resistance of all track circuits and see that they shunt properly with light vehicle/motor trolley.
9. Ensure double lock and sealing arrangements in all signalling systems like Block Instruments, Relay room, locking Trough.
10. Ensure overhauling schedules for Block instruments, Relays are adhered to.
11. Ensure Data logger Time is synchronized to operating time and also ensure the inputs and outputs are validated.
12. Ensure the micro switch used for checking Relay room opening and closing is properly working.
13. Ensure that proper tools are available, and Maintainers have proper knowledge of the gear, he has to attend.
14. Data logger reports to be used for analysis of failures -both for predictive and preventive measures.
15. Ensure proper disconnection and Reconnection of gears at all time including failures.
16. Ask for failure memo and put-up disconnection before attending a failure.

17. Ensure force drop of mechanical locks through entire travel of lever.
18. Ensure all installations adhere to a schedule of dimensions.
19. Ensure joint inspections of points and crossings done religiously with all correctness in readings and defects are promptly attended.
20. Ensure all replacement schedules are properly carried out.
21. If a gear is not working safely, it may be suspended and replaced at earliest.
22. While disconnecting a point ensure that feed and detections also disconnected.
23. Check regularly for Earth faults in any circuits. Install Earth Leakage Detector.
24. Be vigilant at all times, particularly while working with field gear.
25. Maintenance staff and construction staff should work in co-operation.
26. Reduce non-interlocked period during commissioning of signaling systems.
27. Make elaborate planning while carrying out any signaling work.
28. Train the staff in improving working methods.
29. Make sure periodical remarks of the S&T equipment e.g. batteries, ground connection of points, Block joints etc.
30. Develop a safety culture. Be calm & composed during failures.
31. Be Professional in your work.
32. Ensure proper working Block Instruments e.g. commutator lock CKTS. For their integrity.

b. Dont's

1. Don't work in haste; don’t panic at the time of failure.
2. Don't adopt any shortcut methods.

3. Don't attend to any failure or carryout any work involving safety without proper disconnection.
4. Don't infringe any gear or installation with schedule of dimensions.
5. Don't attend any gear without adequate knowledge of circuitry.
6. Don't compromise with safe working rules.
7. Don't bypass any contact in any circuit.
8. Don't neglect any problem. Try to go to the root cause and prevent recurrence.
9. Don't hide failures.
10. Don't open the coding holes in base of relays, to make it possible to plug in a different configuration relay.

SHORTCUTS BY OPERATING STAFF
CAUSING ACCIDENT AND ITS PREVENTION

21

21.1 Shortcut done by Operating Staff breaching safety

Some of the shortcuts done by operating staff are logged as under:

1. The passing of the train without ensuring that points are clamped padlocked, and signals were given.
2. Exchanging all right signals without observing the passing train from both sides.
3. Issue of caution order in advance anticipation that caution. The order is intended for the same train.
4. Non-Cotter Bolting of points during shunting and deployment of less shunting staff during shunting.
5. The poor-quality Walkie-Talkie or no walkie-talkie to have communication with cabin or ASM. At most of the locations, walkie-talkie is in short supply and even non-granted to guards and shunting staff. So far railway could not formulize the rightful procedure for procurement of walkie-talkie, maintenance, and their disbursal to train operation staff.
6. Guards of Mail Express and Freight Trains are not exchanging the alright signals with passing trains in a more vigilant manner.
7. The rakes, which had been tippled left with residual material causing imbalance in running and leading to accidents.

8. During shunting operation, especially in pushing back and forward movement at roadside station, guards are generally not supervising and left the work to poor point to poor point's man, which are also insufficient in number at that station.
9. Due to slackness by the station master, points and crossing signals are not reverted rather allowing the movement in anticipation that what is the need of again and again following the same ritual.
10. Often, points are not reversed after departure of the train to un-occupied line.
11. Shortcut in GDR/not checking the load properly before start.
12. Shunting on hand operated points without padlocking with cotter bolt is the common phenomena and Traffic Inspectors (Tls) and Station Masters are not taking it seriously as they believe that it will impact the efficiency in shunting operation.
13. During shunting, guards occupy themselves in Loco cab rather on line to supervise the shunting movement.
14. Hand operated points set to the movement but not clamped & padlocked, when shunting done on fast phase in these locations there is always chance of derailment of coach or wagon.
15. Exchange of Private Number by gateman and SM in advance i.e., prior to physical closure of gate at non interlocked Level Crossings.
16. Shunting is allowed without issuing proper shunting order.
17. None securing of vehicles, which are parked at railway stations and sometimes they slipped into working station yard causing derailment to themselves or a reason for collision to the running train.
18. Over the years, it has been the habit of field officers and inspectors not to do detailed inspections at the railway station while spending time with staff but resort to taking away safety inspection register to their home and fill and return. Most of the officers do not record the deficiencies, shortcuts, breach of the block rules in proper register and don't question the station master. Most of the inspections of officers are superficial in nature and the station master responds to those inspections as noted and so on.
19. Now a day, senior supervisors are in the habit of issuing compliance reports without visiting the site and verification.

20. There is a habit among officers, supervisors, and sometimes senior officers also to hide the accidents and USF to show the improvement, but they don't know that they are doing a great mistake to the down the line of the cadre for complacency and in orderliness. We must realize that safety is truth and truth is the God. Mindfulness and truth can avert any accidents either in the working sphere or performing the domestic chorus including social living.
21. It is a common habit of the station staff that they use stones for securing the vehicle at the railway station instead of designed skids.
22. Most of the time, loading supervisors do not ensure that the cargo is evenly spread to avoid dislocation of the wagon during run.
23. Some of the station masters issue the authority to pass a Stop Signal/ Shunt Signal in advance while shunting operation is on.
24. Improper or no locking of points during shunting.

Few more shortcuts that come to my notice are logged as under:

1. In absence of shunt signals in station yard, SMs resort to reverse setting of route to avoid manual clamping.
2. Points setting not against blocked line.
3. Not clamping points during non-signaled movement.
4. Not properly securing of stabled vehicles.
5. When receiving a train on obstruction road through calling on, Points man is not deputed to exhibit stop hand signal to LP.
6. Vehicles/wagons are secured with skids, but not secured with safety chains/but not applied hand brake of the wagon/wagons.
7. Vehicles/wagons are secured with skids, but safety chains are put with brake application rod or cattle guard instead of wheel.
8. During failure of point/signal, not ensuring the correct setting of points physically before issuing an authority to LP of train.
9. During my stint as Safety Officer, I come to know the several shortcut methods adopted by the Traction & Rolling Stock Departments over IR during the working:
10. Shunting on walkie-talkie without proper observation and written authority.
11. Shunting done from rear cab.
12. Use of Walkie-Talkie for operational works and not following the procedure like All right signal, shunting etc.
13. Shunting without Brake pipe pressure.

14. Crew not exchanging signals loudly.
15. Non-compliance of speed limits during shunting.
16. Shunting without presence of Shunter/ Pointsman in the last vehicle in pushing.
17. Shutter not changing to lead cab in the Loco during shunt movements in yards.
18. The motorman did not give a single bell while stopped at red signal.
19. Shunting of coaching rakes without full brake pressure.
20. Improper or no exchange of signals by loco pilots with guards or station staff and following instructions on walkie-talkie.
21. Loco pilots acknowledge circulars in CMS without reading it in detail.
22. Not draining the moisture from air vessels before continuity test.
23. Late joining for duty and late reaching to the Loco. This results in insufficient time for properly checking the Loco.
24. Before reaching the destination, i.e., one station before packing their personal things on run.
25. Using personal mobile phone while driving the train.
26. While working on tower wagon not providing discharge rod on both sides.
27. Taking Power block on mobile phone rather than on TPC Phone.
28. Non-Provision of wooden Wedges by the Mechanical Dept for stabled the rakes in yards.
29. Shunting without Brake pipe pressure.
30. Crew not exchanging signals loudly.
31. Skipping the Rolling in /Rolling out examination.
32. Allowing Shunting without creating Air pressure in rolling stock.
33. Signing of duty without taking proper rest at Headquarter/Running room by running staff.
34. Allowing moving goods train with invalid BPC, without proper GDR checks and with open wagon doors after unloading.
35. Empties are drawn out from siding with pressure given to 5/10 wagons only.
36. On similar line, I have found Shortcut methods adopted by the engineering department over IR during the working.
37. Filling of joint proforma without critical examination. (e.g., Points & crossings register)
38. Overdue packing in yards.

39. Overlook maintenance of points-crossing as per Para 429 of IRPWM. Only about one third of items having interface with S&T get Aare generally covered under joint inspection register for Points & Crossings.
40. Faults exist in rail/weld, but it is not detected during USFD.
41. Casual inspections /observations and compliance of Points & Crossings deficiencies.
42. Non securing of Vehicles/rakes after attachment/detachment in yard and stations
43. P. Way work without Eng. block.
44. Engineering staff working without proper block.
45. Joint inspection of points & crossing is not done properly, and compliance of deficiencies noticed was not attended timely and properly.
46. Using single banner flag at curves
47. Issuing PN without closing gate.
48. Avoiding skid placement during maintenance at sick lines.
49. Works of short duration are done under banner flag at improper distance.
50. After granting line block to Track machines no protection is done in rear of the machine working.
51. Giving LC gate closed indication without physically closing LC gate boom.
52. Removing a greater number of ERC, than stipulated to save block time/to have more progress during CTRTFRT/distressing works.
53. The Signal and Telecommunication department, which is the watchdog of safety in railway operation also do resort several shortcuts, which are logged as under:
54. Nonissue of memo by ASM to S&T for failure.
55. At busy stations ESM and ASM sometimes avoid disconnection Memos to manage time and failures.
56. Signalling maintenance work without disconnection.
57. Attending the Block instrument failure/ maintenance without issuing disconnection memo.

It is not humanly possible to log down all probable causes of the accidents but if we stress on philosophy of the accidents, resolve to ourselves that no accident would take place during my charge, spend time with subordinate staff, educating about safe practices in

railway operation and appreciating the staff may lead to safe working in SWR and also on Indian Railways. There is no easy and available recipe for safety, but persistent efforts everyday may lead to a safe environment. Unsafe working is the symptom of rot in the system and in those systems, nothing is in order if we carefully examined. After all, in spite of several technological advancements, human beings are the only safety equipment, which can be improved by education, training and counseling.

21.2 The important rules of G&SR, Accident Manuals, and other instructions for Station Masters and other operating staff.

It has been observed during inspections and safety audits of stations / cabins it was noticed that the Operating Staff knowledge is inadequate during failures / unusual circumstances. In order to prevent such failures, the following guidelines from G&SR, Accident Manual, JPOs, etc., from time to time will be helpful in prevention of accident due to station staff.

21.3 Altering the points immediately on arrival of train (GR 3.38(2))

1. Immediately on arrival of a stopping train within the fouling mark, the SMs of all stations shall alter the points in rear on double line, and points in rear and front on single line sections.
2. SMs working on double line sections shall alter both the points (points in rear and front) whenever a stopping train is received on common loop.

21.4 Block instrument / BPAC failure (Para 8.3 of BWM Part 'A', 'B' & 'C')

Whenever block instrument / BPAC fail, ensure that failure entries are made in the Signal Failure Register of both the stations connecting the block section.

21.5 Home Signal Failure (G & SR 3.68, 3.69)

1. Check, the panel for correctness of operation like, whether the SM's key is proper in 'in' position, line is clear of obstruction not only up to the berthing track portion but also overlap portion, etc.,

2. If the Home signal still does not respond, try for alternate line (ensuring that line is free and permitted for passenger carrying train).
3. If the signal still fails to obey, take 'off' the Calling-on signal.
4. If Calling-on signal also fail to obey, personally ensure that the points (facing and trailing) are correctly set by using the crank handle, clamp and padlock the points, arrange to hand over T.369 (3b) to the loco crew through a competency railway servant who shall do so and exhibit 'proceed hand signal' from the foot of the defective home signal.
5. Do ensure that the signal failure is registered in the Signal Failure Register irrespective of the train received on alternate line or through Calling-on signal.
6. Also ensure that the entry is made in the Calling-on route cancellation registers when the train is received on Calling-on signal.

21.6 Receiving a train on obstructed line (GR 5.09)

1. Depute one competent railway servant to exhibit 'stop' hand signal 45m ahead of obstruction.
2. Ensure the train is in the Calling-on zone and relevant facing points are correctly set, take 'off' the Calling-on signal, and then wait for 60 seconds for the signal to respond.
3. Depute another competent railway servant to stop the train near the facing point leading to the obstructed line.
4. After the arrival of the train, initiate Calling-on cancellation which should take 240 seconds to clear the route.
5. Do not forget to make an entry in the Calling-on route cancellation register with complete details.
6. If the Calling-on signal is not working, ensure the facing point/s are correctly set, clamped, and padlocked before authorizing the LP to proceed on T.509 authority.

21.7 Stabling & securing of load (G&SR 5.23)

1. Ensure the formation is within the fouling.
2. Ensure securing of the formation with two safety chains (one at either end), at least 4 skids (two at either end), application of hand brakes of at least 6 wagons on either end of the formation (in case

of coaching stock, hand brake in Guard compartment of SLR/s). All these shall be supervised by Guard or SM.

3. Ensure the formation is not split. If split for any reason, each such split should be treated as a separate load for the purpose of securing.
4. Set the points against the obstructed line (if layout permits movements of other lines), clamp and padlock.
5. Place 'line blocked' caps on the signal / point buttons.
6. Make a red ink entry in the TSR and Station Diary.
7. Exchange PN with the SCOR.
8. Make entries in the 'stabled load' register with complete details while stabling and while clearing the load.
9. If the loco is not detached and required to be unmanned, serve a memo to the loco crew who are further responsible to secure the loco.
10. Obtain the signature of LP & Guard in the 'stabled load' register (if the loco is not stabled, obtain only the signature of Guard).

Note:

- The above instructions need to be followed, even if the load is stabled on non-running lines.
- Entries and precautions need to be taken even if full/part of coaching rake is stabled with or without passengers irrespective of time that they are stabled.

21.8 When Lurch has been reported by Loco pilot (SR 6.07)

1. Immediately inform the SM of adjacent station, JE/SEP. Way, ADEN/DEN, Chief Controller and DOM.
2. Arrange to dispatch self-propelled vehicle or light engine or full train with Engineering Official with a caution order to stop dead sufficiently short of the KM as reported by the LP.
3. In the absence of the Engineering Official, allow the train to proceed with a caution order of stop dead ahead of the suspected KM and proceed at 10 KMPH, if it is safe to proceed further or else to return back to the station.
4. Subsequent trains shall be allowed with a caution order of 10 KMPH and this procedure will continue till the Engineering Official inspects and certifies the track for safe running.

5. If the condition as reported earlier is confirmed by the LP, no train movement shall be allowed till certified to be safe by the Engineering Official.

21.9 Dispatching relief loco (SR 6.02.6) in Absolute Block System

1. Prepare T/A 602 and permit a relief loco to enter into the obstructed block section.
2. Caution order restricting the speed to 15/10 KMPH shall be given.
3. The location of the loco and BV/SLR of the train should be mentioned.
4. Red ink entries should be made in the TSR.

21.10 LC Gate working (Appendix II of G&SR)

1. Ensure that the Gatemen of non-interlocked LC Gate is informed under exchange of PN before granting/ obtaining line clear for a train.
2. In case of interlocked LC Gates, inform the train details to the Gateman.
3. Write the correct details in the prescribed LC Gate Register direction-wise.
4. In case of any change in the planning / cancellation of movement of trains, inform the Gatemen under exchange of PN.
5. When interlocked LC Gate fails (may be Traffic or Engineering LC Gate), do not forget to exchange PN with the Gateman treating that LC Gate as non-interlocked LC Gate.
6. While dispatching a train from wrong line on double line section, do exchange PN with the Gateman of interlocked / non-interlocked LC Gates.

21.11 Shunting operations (G&SR 5.13, 5.14, 5.20, 8.05, 8.06, 8.09, 8.14 & Appendix XII)

1. Prepare Shunting Order T. 806 in triplicate unless the same is exempted for issue by the Sr. DOM of the Division.
2. Do not resort to shortcut methods while performing shunting.

3. Ensure the correct setting and locking of points for unsignalled movements.
4. Encourage the staff to use hand signals.
5. Give clear instructions to the shunting staff and make them understand the same.
6. Any change in the planning, inform the same to all those persons who were earlier informed.
7. Do follow the instructions of Para 8 of SWR.
8. On single line sections, do not perform shunting even within station section after granting line clear for a train unless the same is permitted in the SWR.
9. If shunting movements involve entry into block section, follow the instructions of BWM which stipulate.

On single line

- T.806 + Shunt key when the movement is beyond LSS but up to opposite FSS.
- Beyond FSS, treat the movement as train movement and make suitable red ink entries in TSR.

On double line

- Beyond LSS – block forward and prepare T.806 with PN.
- Following a train travelling away from the station – T.806 without PN.
- Behind BSLB / outermost facing points – block back and prepare T.806 with PN.

PART C:
PREVENTION OF
ACCIDENT DURING WORKS

PREVENTION OF ACCIDENT AT WORKSITE

22

Many men and machinery are deployed by the contractors for track renewals, gauge conversions, doublings, bridge rebuilding etc. It is therefore essential that adequate safety measures are to be taken for safety of the trains as well as the work force.

Several incidents have occurred in past wherein contractor's machinery while working very close to the Railway line has infringed the moving dimensions resulting into train accidents. Some accidents also took place due to infringement left at worksite after closure of the work such as repair in tunnels, Complete Track Renewals etc.

It is extremely necessary for every person, who are in some, or the other way connected with the track to be safety minded and adopt no short cut methods during execution of various track works which may lead to compromise with the safety norms and may eventually lead to an accident.

22.1 Prevention of worksite accident

Casualties among employees due to mishaps in the workplace are another area of concern. It is proposed to achieve a substantial reduction in such mishaps by adopting various safety measures. It is the responsibility of

an employee not to willfully indulge in unsafe working. Staff must be taught and constantly encouraged to work safely. It should be ensured that all protective systems are working and are in place before staff undertakes any work.

Necessary protective systems will be adopted to prevent recurrence. Training in personal safety will also be given to new entrants during their initial training course and refresher course. Special training on personal safety will be given to staff deployed to ARTs and operating other breakdown equipment.

Worksites would be supervised at pre-defined appropriate levels. Personal protective equipment would be provided in sufficient quantity, and they would include luminous jackets, protective gloves, crash helmets, safety belts, boots, safety jackets etc. depending upon the job requirement of the staff.

22.2 Guidelines to work at worksite

a. On a double line section where the tracks are close by or for track works on a long bridge, particularly on girder bridges, special care should be taken for labourers staying away from running trains from both directions while passing over the work site. There should be watchmen deployed on both sides with red flags and hooters/whistle to keep a watch on the approaching trains and alert the workers well in time with the use of hooters/whistle.

b. Caution orders speed restriction may be imposed when considered necessary. During the hours of night and at work site where speed restriction has been imposed, the lamps of the permanent indicators, which are not reflective type, should be lit at sunset and kept burning till sunrise, where trains run at night. Reflective type temporary indicators need not be lit. (Para 808,(3) of IRPWM)

c. All permissible or sanctioned infringements should be consolidated for each Division, Section wise. The consolidated list should be in possession of DRM, ADRM, Sr. DSO or DSO, Construction officer in-charge of the Division and relevant extract with each Divisional and other officers. These should

be checked once a year at Assistant officer's level and it should be ensured that there is no aggravation of any permitted infringement.

d. All the works inside a tunnel, deep cutting, on bridges, constricted area etc. should be carried out under the protection of engineering signals and preferably under block protection. The Inspector concerned shall be responsible for the safety of trains and of the men and equipments.

22.3 Safety at Work Site Close to the Running Lines and fixed Structures

All works planned for execution close to the running lines and fixed structures, on bridges, inside tunnels, cutting, constricted area etc. should be carried out only after preparation of detailed plans for the same and getting clearance from Engineering Department of open line and approval of competent authority to ensure that the execution of the work will not in any way infringe the prescribed schedule of dimension or aggravate existing permissible infringement.

22.4 Measure to be ensured by Engineer In-charge prior to start of Work

Before starting any track work the engineering in charge**,** of the section shall ensure that he has complete knowledge of the following aspects-

1. Detailed planning of the work including protection of track and safety measures proposed to be adopted and precautions to be taken at site for working of trains including materials required for protection after joint survey of site by the supervisors of the contractor and Railway.
2. Railway supervisor at site will ensure safety precautions against any danger to safety of track and will accordingly educate the contractor's staff and take their acknowledgement before starting the work.
3. Before permitting the execution of certain works close vicinity of existing running line like earthwork, supply of ballast for new or

existing rail line, gauge conversion or laying of concrete sleepers and rails etc. where it is necessary to use road vehicle/ machinery, Open lines Engineer-in-charge (ADEN/DEN) of the section shall ensure that he receives the prior intimation of the following aspects from Assistant Engineer/ Assistant Officer in charge of the work of the executing agency i.e. construction, electrification, S& T etc.

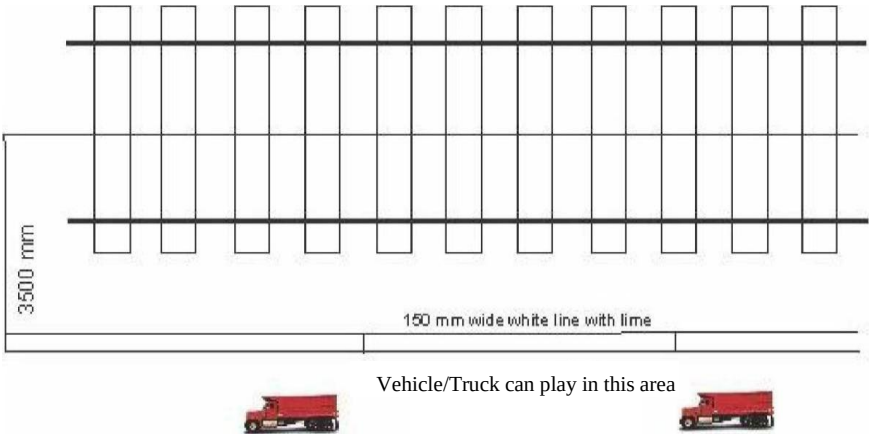
4. Name and address of the contractor assigned to execute the work.
5. List of individual vehicles with numbers, name and license particulars of the drivers, those are proposed to be used by contractor at work site.
6. Information regarding location, where the vehicles are planned to be plied.
7. The supervisor/workmen should be counselled about safety measures. The staff of the contractor should be fully trained for the work. List of contractor's supervisors who have been issued competency certificate with location and the nature of works they will supervise. A competency certificate as per proforma given below shall be issued by Assistant Engineer to the supervisor/ staff of the contractor and then only they will be allowed to start the work. Competency certificate will be valid only for the work for which it has been issued.

22.5 COMPETENCY CERTIFICATE

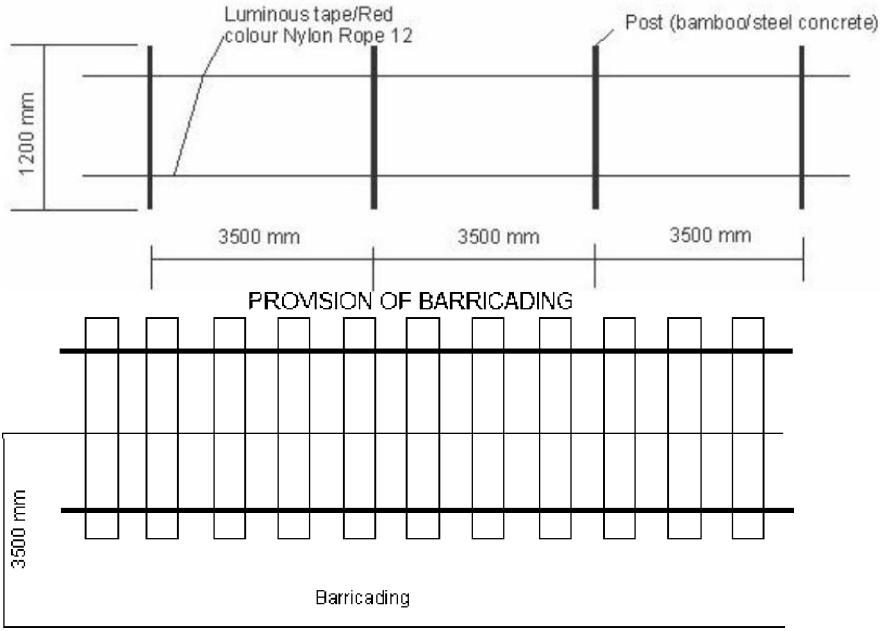
Certified that Shri ……..…. P. Way supervisor of M/s……has been examined regarding P. Way working on work. His knowledge has been found satisfactory and he is capable of supervising the work safely.

1. The other organizations working in the section should submit to ADEN the names of supervisors of construction organizations/other organizations who are going to be site in-charge / in-charge of work site.

2. Before the start of work, the land strip adjacent to running track where road vehicle machinery is to ply for the work shall be demarcated with lime in advance at the appropriate distance from the centre of existing track and acknowledged by contractor. Sketches showing the location of marking are as under.



3. Barricading as design given below shall be provided in full length of work area along the track at the specified distance.



4. The worksite shall be suitably demarcated to keep public and passengers away from work area. Necessary signage boards such as 'Work in progress' etc shall be provided at appropriate locations to warn the public/passengers.

5. Check list given in Annexure-I shall be used to ensure that all the

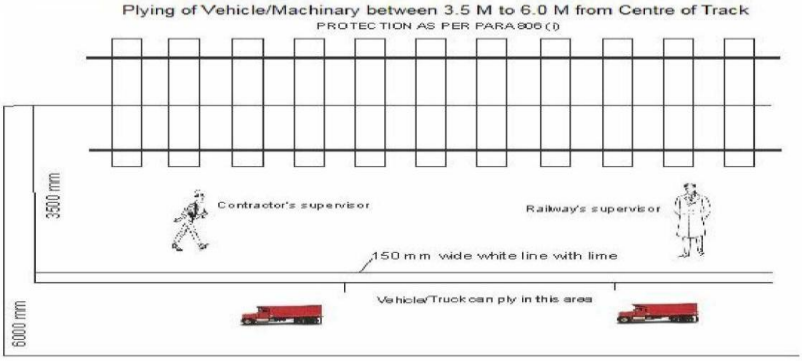
Requisites measures have been taken before start of the work.

22.6 Precaution to be taken while execution of the Work by Executing Agency and Engineer In-charge

The Engineer in-charge shall approve the methodology proposed to be adopted by the contractor, with a view to ensure safety of trains, passengers and workers and he shall also ensure that the methods and arrangements are actually available at site before start of the work and the contractor's supervisors, and the workers have clearly understood the safety aspects and requirements to be adopted/followed while executing the work.

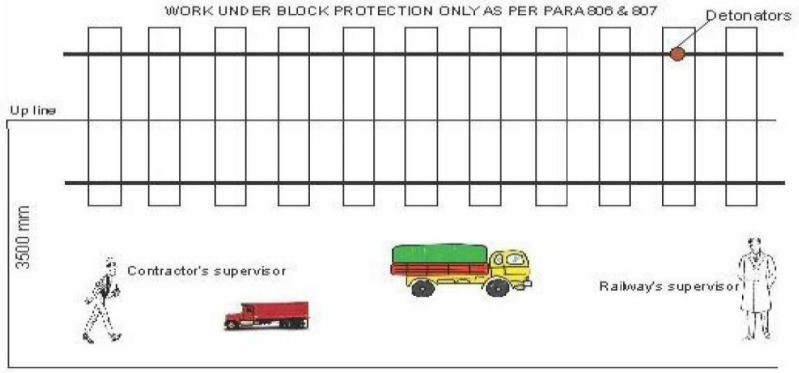
1. There shall be an assurance register kept at each site, which will have to be signed by both, i.e. Railway Supervisor or his representative as well as the contractor's supervisor as a token of their having understood the safety precautions to be observed at site.
2. The contractor shall not start any work without the presence of railway supervisor or his representative and contractor's supervisor at site.
3. Only trained supervisors have been deputed at work sites duly certified by ADEN/in charge of the work.
4. Drivers of road vehicles / machinery have been briefed about the safety and precautions to be taken while moving / working close to traffic / track.
5. The contractor shall not allow any road vehicle belonging to him or his suppliers etc. to ply within 6meters from centre of running line without presence of railway trained supervisor.
6. Contractor shall ply road vehicles only between sunrise and sunset. When vehicle is plied to work during night hours, sufficient lighting shall be ensured in the complete work area for the safety of public and passengers. Engineering indicator will be of luminous material. Also, the luminous tapes should be used for demarcation of prohibited area. Additional staff shall be posted as necessary for night working.
7. The area of work should be demarcated by providing barricades and Sign Boards, which will enable the workmen posted at site and also the lorry drives to have clear guidelines of the movement on vehicles.
8. Contractor shall ensure that road vehicle / machinery ply in a way so that these do not infringe the line of demarcation.
9. The look out and whistle caution orders shall be issued to the trains and speed restrictions imposed where considered necessary. Suitable flagmen/detonators shall be provided where necessary for protection of trains.

10. In unusual circumstances, where operator apprehends infringement to track while working truck/machinery near running track, following action shall be taken-
    a) The track should be protected as per the provision of IRPWM laid in para 806(i) by the Railway staff.
    b) Any emergency, if occurs, will be protected and attended by the Railway staff, contractor's staff may assist the Railway staff.
11. All temporary arrangements required to be made during execution of work shall be made in such a manner that moving dimensions are not infringing. Necessary checks shall be exercised by site in-charge from time to time.
12. In case, work has been planned to be done within 6m but beyond 3.5 m of centre of track, it shall be ensured that, necessary precautions for protection of track have been taken as per Para 806 (i) of IRPWM and look out man has been posted where necessary.
13. In case work is planned within 3.5 m of center line of adjacent track, it shall be ensured that the work is done under block protection only and necessary safety precautions for protection to track as per Para no. 806 and 807 of IRPWM are taken.



14. Proper communication system shall be available in form of Mobile phones or Walkie-Talkie sets, where necessary at works sites.
15. In one block section, Lorries should be permitted to work at not more than two locations at a time.
16. Where turnings of Lorries are found necessary in course of work, locations for reversing for the purpose of turning should be nominated and should be selected in such a way that there is no danger to the running train. At such locations, a Railway official not below the rank of Works / P-Way supervisor should be available with Hand Signal Flag to ensure that the Lorries do not infringe the Standard Dimension for the running lines.

Sufficiently strong stoppers or rail barricades should be installed at such locations wherever required to ensure that even by carelessness or oversight the Lorries do not infringe the fixed dimensions. Wherever Lorries have to take turn, the reversing should be done in such a way the driver invariably faces the running lines at all times.



17. The new embankment for doubling should be made extra wide at every 500m or so interval for permitting turning/crossing of vehicles/construction machinery. The extra earthwork involved in such widening of embankment, may be included in the schedule of quantities as a paid item.
18. Engineering Supervisors and Contractor's representative should ensure the clearance of total infringements before they leave the work site.
19. Supplementary site-specific instructions, wherever considered necessary, shall be issued by the Engineer in Charge.
20. While inspecting the worksite check list given in Annexure -II shall be used to ensure that all the Requisites measures have been taken during the execution of the work.

22.7 Measures while Undertaking Excavation &Trenching Adjacent to Track

1. Before taking up any digging activity on a particular work by any agency Sr. DSTE/DSTE or Sr. DEE/DEE of the section shall be approached in writing by the concerned Eng. or S&T or Electrical officer for permitting to undertake the work.
2. After getting the permission from S&T or Electrical Deptt. as case may be the, relevant portion of the cable route plan shall be attached to the letter through which permission is issued to the contractor by concerned Eng. official for commencement of work and ensuring that the contractors has

fully understood the cable rout plan and precautions to be taken to prevent damage to the underground cables. The contractor shall be asked to study the cable plan and follow it meticulously to ensure that the safety the cable is not endangered. Such a provision including any penalty for default should form part of agreement also. However, basic responsibility will be of the Department executing the work and the Contractor.

3. While digging in station area, if any cable is found, digging should be stopped and concerned signalling /electrical staff should be informed immediately.
4. No new OFC or Quad cable shall be laid close to the existing track. It shall be laid close to the Railway boundary to the extent possible to avoid any interference with the future work (doubling etc.). It shall be ensured in the new work of the cable laying that the cable route is properly identified with electronic or concrete markers.
5. Trenches and foundation pits should be adequately and securely fenced, provided with proper caution signs and marked with red lights at suitable intervals during night to avoid accidents. Adequate protective measures should be taken to see that the excavation operations do not affect or damage adjoining existing buildings.
6. Position of all underground installations such as sewer, gas pipes, water pipes, electrical cables and other civic facilities that may cause danger during the work should be checked and proper precautions should be taken not to damage them.
7. Land should be cleared of trees, loose boulders and other obstructions before excavation commences so as to avoid accidents.
8. Where hard rock is found with and blasting operations are considered necessary, the contractor should obtain the permission of the Engineer-in-Charge in writing for resorting to blasting operation.
9. Proper precautions should be taken for safety of persons and adjacent track before undertaking any blasting operation. Red flags should be prominently displayed around the area to be blasted. All the people on the work except those who actually light the fuses should be withdrawn to a safe distance of not less than 300 metres from the blasting site.

22.8 Unloading and stacking of materials along the Railway Track

1. The sites for material stacking shall be selected in advance ensuring that no part of the stacked material would infringe the standard moving dimensions or inconvenience to any worker or the public.

Necessary fencing and lights are to be provided. Later on, the material may be stacked to a place from where it may be conveniently disposed off. A plan of proposed stacking locations be made and signed jointly by a competent Railway representative and authorized Contractor's representative, if stacking is done within 6 meters of track centre.

2. The selected locations within 6 meters shall be marked by lime in advance.
3. All unloading operations near the track should be undertaken under the supervision of a competent P. Way Supervisor.
4. The unloaded ballast/rails/sleepers/other P.Way materials after unloading along track should be kept clear off moving dimensions and stacked as per the specified heights and distance from the running track, which will not cause infringement to SOD in case of accidental roll off.
5. After completion of work, the released sleepers and fittings shall be properly stacked away from the track clear of moving dimensions.
6. While inspecting the worksite, check list given In Annexure-II shall be used to ensure that all the requisite measures have been taken during the execution of work.

22.9 Precaution Required to be taken during execution of work requiring Traffic Block

1. Any work, which infringes moving dimension, shall be started only after the traffic blocks have been imposed and track protected.
2. At location where night working is unavoidable, proper lighting arrangement should be made.
3. Before closing the work, the track shall be left with the proper track geometry so that the trains run safely. After completion of work, the released sleepers and fittings should properly be stacked away from the track to be kept clear of moving dimensions.
4. Block shall be removed only when all the temporary arrangements, machineries, tools, plants, etc. have been kept clear of moving dimensions.

22.10 Safety aspects to be Observed While Working in OHE Area

1. The risk of direct contact with live OHE is ever present while working in electrified sections such as for painting of steel work of through spans of bridges and platform cover.
2. The return current in the rails may cause dangerous voltages. 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 fishplates or rails, temporary metallic jumpers of approved design shall be provided.
3. No electrical work close to running track shall be carried out without permission of Railway's representative.
4. No work shall be done within a distance of two meters from the live parts of the OHE without a 'permit-to-work'.
5. While unloading rails from BFRs in an electrified section, it should be ensured that no metallic rod/ stick held by the workmen come in touch with the OHE. A minimum distance of 2 m has to be maintained between live OHE wire and body part of worker or tools or metallic supports etc.
6. It is important to note that dangerous voltages may be induced in metallic masses such as fencing posts, continuous metallic mass (unloaded rails) of length greater than 300 metres in the vicinity of traction conductors. To avoid possibility of shock due to such voltages, the metallic structures are bonded together and earthed.
7. No electric connection etc. can be tapped from OHE.
8. Authorized OHE staff should invariably be present when the relaying work or any major work is carried out.
9. In the electrified territories, the cutting and day to day trimming of the trees, wherever required shall be done in the presence of authorized engineering and TRD staff to ensure safety and to maintain the 4 m safety clearances from OHE.
10. Power block is correctly taken and 'Permit to work' is issued.
11. The structure bonds, track bonds, cross bonds, longitudinal rail bonds are not disturbed and if disconnected for the work, they are reconnected properly when the track work is completed.
12. The track level is not raised beyond the permissible limit during the work.
13. The relative alignment of the centre line of the track with respect to the alignment of the contact wire must be maintained within the specified tolerances.

14. No fallen wire or wires shall be touched unless the power has been switched off and the wire or wires have been suitably earthed.
15. In the electrified section, for carrying out repairs/ painting works etc. to bottom of FOB, top chords and bracing of trough type / semi through type girder bridges and other overhead structures over track, power block should be taken before commencing the work in consultation with SSE (Electrical). 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.
16. 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.
17. During excavation, if workmen come across 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 and or S&T department as the case may be.
18. No crane shall be worked except on the authorized '**permit-to-work'.**
19. For inspection of roofs and sides of a tunnel, the overhead equipment shall be rendered **'dead'**.

22.11 Working of Track Machines

Track machine working is likely to produce a dusty atmosphere and/or heavy noise pollution. Hence extra care is necessary at site to ensure safety of workers. For this, the following steps should be taken.

1. Hooters should be provided on the track machines. These hooters should preferably have removed control operation so that the Lookout man standing around 150 m away from the track machine can operate the hooter to warn the staff working on/around the track machine about approaching train on adjoining track.
2. Temporary `Whistle Board` should be fixed on the adjoining track, which can be moved along with track machine worksite.
3. It is necessary that all trains passing on the adjoining track should be issued a caution order "OBSERVE HAND SIGNAL, WHISTLE FREELY AND STOP, IF REQUIRED". Such caution order on the adjoining track is necessary due to high noise level caused by track machine and large concentration of staff working around it.

22.12 Precautions prior to Demolition of Structure Near Running Track

1. If the structure to be demolished is one which may have got hidden damages, caused by fire, flood or earthquake, measures necessary to prevent accidental collapse by way of bracing, shoring, etc., should be provided.
2. When demolition by explosives has to be resorted to, this should be done only after the approval of the Authority and after taking necessary precautions.
3. Prominent danger signs should be posted all-round the property and all openings giving access to the structures should be kept barricaded or manned except during the actual passage of workmen or equipment. However, provision should be made for at least two independent exits for escape of workmen during any emergency. During night, warning lights should be placed on or above all barricades.
4. All gas, water, electricity, steam, and other service lines should be shut off outside the property line after notifying the service companies and concerned authorities and obtaining their approval. Any temporary service connections required for the demolition work should be separately taken and arranged in such a manner as to afford safety to the workmen.
5. When work is not in progress, watchmen should be provided to prevent unauthorised entry of the public in the danger zone.
6. All necessary safety appliances should be issued to the workers prior to starting of work.
7. Safety distances to ensure safety of the public should be clearly marked and prominent sign boards posted. Every sidewalk or road adjacent to the work should be closed or protected.

22.13 Provisions Regarding safety at Work Site in Contracts

Following items, which are illustrative rather than exhaustive, be provided in the works contract, involving works near track.

1. The Contract Agreement should contain all the provisions of safe working as suitable barricading and signboards to forewarn the road vehicle driver,

its type, level of contractor's supervisors who will necessarily be present if work is being done in vicinity of track etc should be specifically provided as an item in tender schedule and paid for as the work progress, rather than mentioning the same in general way in the General conditions or Special conditions. The luminous tape, strung on bamboo poles can be considered for such barricading and provided as separate item in schedule.

2. Provision for contractor's flagman and supervisors: The engineer- in-charge or his authorized representative will personally counsel, examine & certify the contractor's flagman & supervisor and will give written permission, giving names of such flagman & supervisor to be deployed on the work, location, period and time of the work Contractor shall not normally change such authorized persons. In exceptional circumstances only, contractor should approach Railway for counselling of fresh staff. Photo ID of trained staff and supervisor shall he provided. Staff trained at one site can be used for another site also.
3. For items such as walkie-talkie sets, and mobile phones suitable provision may be incorporated in the tender conditions as per site requirement.

22.14 Training

1. Special Training and Counselling should be imparted to all Field staff engaged in maintenance of railway assets regarding the Safety at work site and all of them should be in possession of a Compendium prepared in the same format as Engineering Standing order No.16 (Annexure-VI) issued by the Railway Board in August 1999.
2. Similar training should be organised for railway's Associates and Contractors working in close proximity of the running track as directed by the Railway Board in their letter No.99/CE-II/PRA/32 of 20.04.2000.

22.15 Do's and Don't to prevent accident at worksite

1. Boulders including CST-9 plate, rail pieces etc., should not be left unguarded in the mid-section to facilitate miscreants for their unauthorized placing on the track particularly in areas prone for such miscreant activities.
2. Whenever construction of the double line is undertaken fencing alongside the Railway line in complete length of the block section where doubling is being done should be erected so as to prevent any infringements to the moving dimensions likely to be caused by moving or stationary vehicles used for execution of the works. The fencing should conform to the design approved by CE/Construction.
3. Suitable gates/barriers should be installed across the new embankment,

preferably adjoining the manned/unmanned level crossings. The entry for the vehicles should be regulated by an authorized representative of the Engineer-in-charge during the working hours.

4. The design & drawings of FOB other than standard designs/drawings, if adopted, should be adopted "in toto" without any alterations. If any alternation, modification required fresh design should be done.
5. Any unusual noticed at site during fabrication & erection shall be viewed seriously and shall not be neglected. The design section should be consulted immediately. In case it is not possible to attend the same well in time do not keep it in a state affecting the running line till it is attended.
6. Open line Supervisors & Officers should be vigilant about the work being carried out by Construction Organization on & near running lines and promptly bring into the notice of any deficiencies/ defects/ unusual noticed and prompt remedial action should be taken.
7. During construction it should be ensured that any structure or part of the structure should not be subjected to loads for which it is not designed. Especially in FOBs. Precast slabs to be placed should not be stacked at one place.

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भारत सरकार (GOVERNMENT OF INDIA)
रेल मंत्रालय (MINISTRY OF RAILWAYS)
रेलवे बोर्ड (RAILWAY BOARD)

No.2015/CE-II/TK/14 New Delhi dated 11.10.2019.

Principal Chief Engineers
All Zonal Railways

Sub: Safety at Worksite

Ref: Board's letter of even no. dated 06.11.2018 & 30.12.2015

Instructions on ensuring safety at worksites have been issued and reiterated from time to time by the Board. However, accidents including derailments are still occurring at work sites, which is a serious cause of concern.

In order to avoid any further incidence on above account, following actions are required to be taken & implemented by Zonal Railways: -

1. The presence of Competent Railway's and the contractor's supervisors must be ensured at site.
2. Protection of work sites be rechecked for correct locations of caution boards, flagmen, etc.

3. Recording of "Assurance" at the time of closure of work for track fitness at given speed by Railway and contractor's supervisor. For this an Assurance Register shall be maintained at each worksite, each page of which should be pre numbered.
4. Restoration of normal speed over the worksite should be ensured within the stipulated number of days, with machine packing & adequate ballasting.
5. The attempt should be to open a smaller number of sites and progress work by pooling resources.
6. A review of all worksites should be conducted periodically by inspections at minimum sectional DEN level for ensuring safety measures. Compromises found at the work site to be taken up severely with working agencies & supervisory staff. Conduct such a review in the next 7 days to cover all sites.
7. Adequate manpower with proper tools & equipment should be ensured for each site for achieving desired progress per day/week/month.
8. Track renewal activities should be taken up using track machines only. Prior Board's approval should be taken for manual execution of track works if it is inescapable to resort to manual renewals.
9. At Deep Screening/TSR location, proper ramping is required to be provided. Proper packing of sleepers at this location with correct track parameters at close of work is the key to safety. Railway and Agency supervisors must be sensitized about it. The location of curves requires special attention w.r.t Versines & Cross levels.

Senior officers including SAG from HQ should make it a point to inspect the worksite during their inspection to cross check above.

Action taken by Railways in this regard should be appraised at the Board's office at the earliest.

(Pradeep Nagar)
Director Civil Engg. (P)
Railway Board

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NON-INTERLOCKING (NI) WORKING AT RAILWAY STATIONS

23

Non-Interlock Working means temporary disconnection of points, signals, track circuits, axle counters and other signalling gadgets for any designated works. This kind of working is normally resorted to works such as over hauling of lever frames, yard remodelling, introduction of panel/RRI working, cable etc.,. In another sense, at an interlocked station when points and signals become defective, station becomes non-interlocked for the purpose of working.

In both the cases the safeguards ingrained through normal functioning of various signalling equipment are missing and as such responsibility of the part of staff increases manifold. N.I. working puts staff under severe strain and hence prone for lapses. Unflagging attention from every quarter is the need of the hour so that safety is ensured.

Non-Interlocked working entails not only slowing down of train operations; it is also a less safe system as compared to interlocked working Since it is desirable to avoid NI altogether, both from safety as also customer Convenience point of view, attempt must be made at the project proposal stage itself to dispense with NI altogether and undertake the work by means of traffic blocks.

Instructions given below are in addition to existing rules for Non-Interlocked working such as issue of Green Notice etc. They must be read together with existing provisions in G&SR, Block Working Manual etc.

23.1 Requirement of Non - Interlocked Working:

The following guidelines are laid down for a correct assessment of whether NI working is required in the first place or whether it can be dispensed with altogether.

a. NI working should not be resorted to as far as possible, in case of installation of new S&T gears. NI is unavoidable only if modifications are to be made to existing S&T gears.
b. For new S&T gears, there is no need of NI, and the work can be managed through well- planned pre-change over works (insertions of point & crossing etc). The final change over to new gears can be carried out under partial or complete traffic block.
c. At the project proposal stage itself. S&T department should make it clear whether the project requires NI or not, and if it does the duration of such NI. This fact must be mentioned in the check list on the original tracing itself.
d. Sr. DOM & Sr. DCM must quantify the actual impact of such NI, and deduce it to monetary terms, by calculating anticipated losses both on account of passenger and freight traffic. These should include losses on account of cancellation, short termination, diversion, rescheduling, detention to trains and imposition of restriction on booking/movement of freight traffic.
e. Expenses likely to be incurred on account of TA/DA of temporary NI staff, and other administrative costs should also be added to arrive at the traffic cost of proposed NI working.
f. This traffic cost of NI should be communicated to S&T, who will evaluate if new gears can be installed without resorting to NI for less than the expected cost of proposed NI, if necessary, by constructing a new building etc. as the case may be.
g. If new gears can be installed in a new building and commissioned under traffic block at a cost that is comparatively less than the overall traffic cost of proposed NI, then the project should be recorded as one to be taken up without NI
h. This entire exercise must be carried out under the personal supervision of

DRM, who will ensure that all estimates are reasonable, and no figures are unrealistic both with regard to duration of NI and the anticipated traffic cost.

i. Thus, NI will be undertaken only if found to be unavoidable, and this fact will be recorded on the original tracing to be signed by branch officers concerned, and the DRM.

1. Guidelines given below should be followed for deciding whether NI working is required or not. NI working is not required, and the work can be managed by traffic block in following cases:
   (1) Replacement of Mechanical lever frame by another Mechanical lever frame.
   (2) Replacement of Mechanical lever frame by panel.
   (3) Replacement of Panel by RRI
   (4) Replacement of RRI by RRI
   (5) Commissioning of new SSI/RRI
   (6) Amalgamation of newly constructed double line portion into existing conventional double line
2. NI working is required only for following cases:
   (1) Overhauling of cabins.
   (2) Replacement of Panel by Panel at roadside stations
   (3) Meggering of cables.
   (4) Changes in yard layouts
3. NI working can be divided into 2 distinct categories, namely minor and major works.
   (1) Minor works-Overhauling of cabins at roadside stations.
   (2) Major works Changes in yard layouts, overhauling of cabins etc. at comparatively bigger terminals and junction stations.

23.2 Minor Works for Non-Interlock Working

23.2.1 Procedure to be followed for Non-Interlocked Working for Minor Works:

Roadside stations on double line having up to 2 lines in each direction, and on single line having up to one main line and 2 loop lines are covered under this heading of Minor Works.

23.2.1.1 (C1) Duration of NI working for Minor Works

1. A roadside station would normally have about 21 levers in each

end cabin (including spare levers)

2. S&T department must suitably augment the strength of their NI gang so that each cabin can be completed in one day.
3. NI working at the 1st cabin should start at 8/- hrs in the morning and by 18/- hrs. the same must be interlocked and handed back to traffic.
4. The same procedure should be repeated the next day for the 2nd cabin

23.2.1.2 (C2) General Instructions for Train Operation

1. Speed restriction of 15 kmph. shall be imposed over all facing points.
2. No train/wagon should be stabled on any running line of the NI station.
3. The common line should not be used for reception of trains coming from opposite directions.
4. Emergency and other crossovers including sidings taking off from the station should be set for normal position and clamped and padlocked. The keys of all padlocked points must be kept in the personal custody of the overall in-charge of NI working to prevent their being used even by mistake

23.2.1.3 (C3) Train Running on double line section during NI working

1. Twin single line should be suspended during the duration of NI working and section worked as conventional double line only.
2. No temporary single line working should be introduced during NI period, except in case of an accident or blockade of through communication.
3. At roadside stations on double line, route must be set for platform line in each direction and clamped and padlocked.
4. In case there is more than one platform in each direction, route must be set for one nominated platform.
5. At all such stations no precedence should be arranged.
6. During the NI period station should basically function as a halt station.

23.2.1.4 (C4) Train Running on single line section during NI working

1. Ideally, if possible, only one platform line should be nominated for train running.

2. The route must be set for this platform line in each direction and clamped and padlocked.
3. No precedence or crossing should be arranged at this station:
4. In case it is not possible to nominate only one line, then 2 specific lines should be nominated for Up and Down movement.
5. In that case, while crossings would have to take place, no precedence should be arranged at this station

23.2.1.5 (C5) Staff requirement:

1. Sectional TI and SI will be overall in-charge of NI working at the station Additional staff if required should be managed locally.

23.3 Major Work for Non-Interlock Working

23.3.1 Procedure to be followed for Non-Interlocked Working for Major Works:

Changes in yard layouts, overhauling of cabins etc. at comparatively bigger terminals and Junction stations are covered under this heading of Major Works.

23.3.1.1 (D1) Duration of Non-Interlocked Working

1. NI working must not be simultaneously introduced at more than one station in a Division.
2. NI must be planned during temperate weather, to avoid wrong actions on account of harsh and inclement weather.
3. Period of Non interlocked working must be kept to the bare minimum as it is a potential safety hazard.
4. Staff of all departments must work round the clock in three shifts so that the work can be completed at the earliest.
5. For NI working of up to 3 days, plans will be finalized in consultation with DRM, Branch Officers and concerned HOD of Construction/RE Organization.
6. For NI working of more than 3 days, plans will be finalized in consultation with CTPM, CPTM and HOD of RE/Construction Organization at Zonal level to assess the duration and arrangements of Ni working.
7. For more than 3 days NI, plans should be worked out for cancellation, diversion, rescheduling. or even extension of trains as the case may be.
8. For NI working of more than 7 days personal approval of the General Manager must be obtained.

9. No NI working should last for more than 14 days.

23.3.1.2 (D2) Sanctions, clearances and preparatory works:

1. Signal Plan must be finalised in Hdqrts. at least 45 days in advance.
2. All plans and clearances including CRS sanctions that are required for NI working must be available at least 1 month before commencement of NI working.
3. Under no circumstances should this period of 1 month be relaxed.
4. NI working must be postponed in order to provide for 1 clear month before start of NI either in case of :
   (i) Delay in receipt of above clearances/sanctions etc.
   (ii) Last minute modifications to Signal Plan.
5. All pre – NI work that can be carried out without non – interlocking must be completed before actual NI working begins. These include changes in yard layout, insertion /removal of points & crossings etc. Changing/installation of new point machines must be done in advance.
6. Preparatory work in connection with OHE work must also be done in advance, including shifting of neutral section, if required.
7. Lessons learnt during previous NIs must be gone through in detail so that shortcomings of earlier occasions are avoided.

23.3.1.3 (D3) Level of Supervision/Responsibility:

1. Responsibility to ensure availability of proper arrangement for NI working shall be of Construction/RE organization.
2. Though the responsibility to provide necessary arrangement will be of Construction/RE organization, concerned branch officers from open line shall be responsible to ensure its availability and functioning during train operation. For this he shall be the coordinating officer for the department concerned.
3. PERT chart should be made out detailing various activities to be completed on a day-to-day basis.
4. For round the clock working PERT chart should be made out detailing various activities to be completed on a shift-to-shift basis.

5. Dy. CSTE/Dy. CE/Dy. CEE as applicable shall make themselves available in non-interlocked area where the work is being undertaken.
6. The concerned Project in – charge (XEN, DSTE/Con. etc) shall camp near the non-interlocked area till completion of non-interlocked working.
7. Overall, in charge for NI working will be Sr. DOM/DOM as the case may be for both Safety and Operations.

23.3.1.4 (D4) Green Notice:

1. Construction officials responsible for carrying out the work should send a 'circular notice' to the Sr. DOM/Sr. DSO at least two months in advance.
2. They will advise as to when the work will be undertaken with a request to issue special instructions. A copy of the notice shall also to be sent to SS of the station concerned.
3. Sr. DOM/Sr. DSO on receiving such 'circular notice' get special instructions prepared for that station. These are then issued to all concerned.
4. Green notice is to be issued by Sr. DOM. It should incorporate the following :
   (i) Details of existing yard layout and its various provisions.
   (ii) List of all works to be completed by Civil Engg./S&T/Elec. before start of NI.
   (iii) List of all works to be undertaken by Civil Engg./S&T/Elec. during NI period.
   (iv) Additional facilities to be made available after commissioning of new works.
   (v) Existing facilities that are to be dismantled.
   (vi) Details of yard layout to be made available after completion of NI.
5. Signalling Plan must indicate permissible routings and simultaneous movement facilities to be made available. Details of yard layout to be made available after completion of NI.
6. Signalling Plan must invariably indicate whether any of existing facilities for train movement are to be (i) either curtailed, (ii) modified or (iii) restricted.

23.3.1.5 (D5) Time Tabling changes:

For assessing the impact of NI working at a bigger terminal or at a Junction station, a detailed exercise has to be undertaken as indicated below.

1. During the course of NI working changing of points manually after passage of a train and after completing all formalities takes about 10 minutes time.
2. The capacity of the junction station to handle maximum number of trains during a particular time period has to be worked out keeping in mind the above constraints.
3. Every possible train movement of reception and despatch must be clearly documented,
   (i) Along with time of movement.
   (ii) With exact sequence of points, whether in normal or reverse.
4. For time-tabled moves, trains demanding same point either at the same time or within 10 minutes must be identified since this is the time required before an existing setting of points can be changed. In case of conflicting moves, the less important moves have to be cancelled, rescheduled or diverted.
5. Crossing and precedence must be restricted to the bare minimum with few specific routes being selected for most movements.
6. As a thumb rule, only 80% of the reduced capacity as worked out should be utilized since unforeseen failures such as ACP, equipment failures etc. are likely to take up the remaining 20% of the available capacity.
7. In all such planning it is better to keep adequate cushion in train operations and initially cancel, reschedule or divert more number of trains than what may be required. In case NI working progresses smoothly without major detentions and it is felt that some of the cancelled trains can be restored, the same may be done after a week or so.
8. Clear corridor for freight must be charted out, with exact number of moves possible, and extra freight trains that

cannot be handled should be planned to be diverted to other routes. In case diversion is not possible then operating restrictions must be imposed.

9. More time must be spent in precise planning of each move during NI period, such that the station is not brought under pressure at any time.
10. Changes in PRS reservation system for cancellation, diversion, rescheduling etc. must be done in advance as per advance period of reservation.

23.3.1.6 (D6) Advance preparation for Train Running:

Stoppages on Platform:

1. Duration of stoppages of Mail/Express trains must be reduced to the extent feasible.
2. Loading/unloading of parcels should be reduced to the bare minimum. If possible, handling of parcels should be suspended giving due publicity in the Press and other media.
3. Running of trains with single SLR must be prohibited.
4. Shunting operations must be restricted to the bare minimum and preferably avoided altogether as far as possible.
5. Booking of through carriages, inspection carriages, etc. to the NI station must be restricted.
6. Quick watering of coaches must be ensured by deputing additional staff as required. Nominated stations for watering of coaches may also be changed if alternate stations are available.
7. Extra TXR staff on platforms for attending to defects in rolling stock and promptly attending to complaints.
8. Extra train lighting staff must also be deputed on platform duty for promptly attending to complaints.
9. Special squads of commercial and RPF staff must be deputed on platform duty for checking ACP etc.
10. All efforts must be made to minimize detentions.

Crew Changing :

1. Loco Supervisor must be kept on round the clock duty on

the platform for quick change over of crews.

2. If possible, crew changing for through passing trains may be planned at adjoining stations.
3. If necessary, LIs may be deputed to accompany the loco pilot from one station before NI station till one station after NI station.
4. Traffic Supervisor must be kept on round the clock duty on the platform for quick change over of guards.
5. At notice stations, computerized print out of caution orders must be used for saving time.
6. Similarly, extra porters should be deputed for delivering these caution orders to loco pilot and guard.

Locomotives:

1. Engine changing for through trains must be curtailed.
2. Locomotives must be freely extendable beyond territorial jurisdiction.
3. If it is unavoidable, then changing of locos may be done at either side of NI station.
4. For avoiding changing of locos from Diesel to Electric and vice versa, train routings may be changed during the duration of NI working.
5. For traction changing, half shunt of locos may be freely resorted to.
6. Attaching of locos in rear should be resorted to in case of stations where trains reverse.
7. Sending of light engines to sheds must be restricted. For this purpose, an out pit may be opened, if necessary.

Controlling of Trains:

1. In case of major terminal stations, a mini control office may be opened at the station. This mini control will liasion with divisional control office for purposes of train running. The jurisdiction of this mini control office would be the NI station itself, and 2 – 3 stations on either side in each direction.
2. Station undergoing NI must not be permitted to be brought under any pressure whatsoever at any time during NI

working.

3. All relevant notices must be issued in advance.

23.3.1.7 (D7) Goomty Arrangements:

Location and number of goomties is an extremely important aspect of advance planning for NI. Sr. DOM/Sr. DSO should personally approve final arrangements regarding goomties.

1. Cabins should not be used as goomties .
2. For a group of maximum of three sets of points operated from the ground, one goomty should be made.
3. Ideally, only 2 sets of points should be controlled from a single goomty.
4. Each goomty should be provided close to the group of points that it controls. This will ensure that physical movement of staff is reduced to the bare minimum.
5. A group of 3 – 4 goomties at one end of the yard should be put in one zone.
6. Under no circumstances should 2 ends of the same points/crossings be with different goomties . This must be specially ensured for diamonds with single slips and also with double slips. Each such diamond must be under the same zonal in-charge.
7. Location of each goomty as also number of points that are controlled from it should be tentatively marked out in yard diagram. This should then be physically cross checked at site by visiting the station yard.
8. At site it must be ensured that staff are not required to walk long distances for setting of points.
9. Both ends of each point must be clearly visible from the goomty itself.
10. A goomty must be provided near the first stop signal for prompt issue of OPT forms etc. as required. Another goomty must be provided at the last stop signal to ensure correct dispatch of trains.

23.3.1.8 (D8) Staff Arrangements :

Staff Requirement:

1. Each goomty should have one ASM and two Pointsman in

each shift. These extra ASMs posted in goomties shall be called goomty ASMs. ASM posted with indoor ASM will be termed as co-ordinating ASM.

2. For cabin operated points, extra commensurate staff as required (ASM/cabinman/ pointsman) should be provided. However, cabins should not be used as goomties as far as possible.
3. Goomty ASMs during their duty hours shall be fully in-charge of working of points/levers under their charge. They shall discharge all obligations of the cabinman/pointsman working at the station/cabin. They shall work under the direct supervision and instructions of the coordinating ASM on duty.
4. A group of four goomties or more at each end of the station should be put in one zone. Each zone should be under the charge of a TI in each shift. TI will periodically keep moving about amongst the goomties within his zone. He will check up and monitor the working of group of goomties under his charge.
5. For non-interlocking work at major terminal stations, necessary arrangement for additional staff should be made, if necessary, from adjoining divisions, before undertaking NI working.
6. Under no circumstances should NI working be started unless full complement of staff is available at the station as per above norm and adequate training has been imparted to them.
7. Preferably those staff should be drawn from outstation who have
   (i) Adequate knowledge of NI working.
   (ii) Previous experience of the same.
8. Boarding and lodging of outstation staff is an important aspect of NI preparation. Dormitory type arrangement would be ideal, if these can be arranged. At major junctions these can be taken care of by stabling a few coaches at sidings. However, facilities will have to be

arranged for electrical charging, watering, cleaning of bathrooms, sanitation etc.

9. On divisions where separate non – interlocking gangs are already in existence their strength may be adjusted accordingly. However, composition of such NI gangs should be periodically changed by inducting fresh faces and with drawing earlier ones.
10. Round the clock engineering gangs with crowbars and handles should be available to move points in emergency. One gangman should be available with each goomty in each shift for this purpose.
11. At each non-interlocked station one Asst. Scale officer of operating department will be nominated for overall supervision.

23.3.1.9 (D9) HOER

1. Under no circumstances HOER violation should be permitted during NI working. As far as possible duty hours of staff should be restricted to 8 hrs. duty per shift in continuous roster.
2. For catering to unexpected casualties such as leave sickness etc. during the NI period, RG and LR staff must invariably be provided for.
3. RG and LR must be made available shift wise. The standard of RG and LR should be the same as that of regular duty cadre staff for that shift as stipulated.

23.3.1.10 (D10) Duty Rosters shift wise:

Meticulous detailed planning must be carried out for drawing up roster of staff to be deputed for NI working. While drawing up roster of staff for various shift duties, following guidelines must be followed :

1. Duty rosters must be drawn up as per guidelines given below.
2. These should be drawn up for the entire duration of NI period.
3. Duty rosters drawn up should be openly displayed and given wide publicity.

4. No staff shall be permitted to mutually exchange his duty roster with any other staff, without prior permission of his departmental officer at site.
5. Level 'N + 1' shall be responsible for ensuring that level 'N' has followed all instructions, etc. as laid down above.

Last Night Shift Duty:

1. Regular staff permanently posted at the NI station must be rostered during the last night shift.
2. Second preference should be for staff who have previously worked at that station.
3. Best and most competent supervisors should be deployed for last night shift duty.

First Night Shift Duty:

1. Regular staff permanently posted at the NI station, if still available for deployment after covering last night shift, should be rostered for first night shift duty.
2. Second preference should be for staff who have previously worked at that station.
3. Amongst outstation staff preference should be as follows-
   (i) Senior staff having previous experience of NI working.
   (ii) Staff who are presently posted at major junctions.

Day Shift Duty:

1. Comparatively junior inexperienced staff from outstation should be deputed for day shift working.
2. Teams for different goomties should be so formed as to include at least one staff having previous experience of NI working.
3. For day shift working, more number of staff may be deputed per goomty, if required, to cater for comparatively inexperienced staff.

23.3.1.11 (D11) Temporary Working Instructions (TWI):

1. When NI is undertaken, inter – locking provisions stipulated in SWR are no longer available. So, the SWR in its existing form becomes invalid.
2. TWI is basically meant to replace some portion of

Station Working Rules of the station during the period of NI working. While they need not be as detailed as the original SWR of the station, nevertheless, they must cover all aspects of train operation that are included in the existing SWR.

3. Static information of SWR will continue to be valid. These include :
   (i) Inter – station distances.
   (ii) Description of yard layout.
   (iii) Level crossing gates.
4. TWI is to be read in conjunction with G&SR, Operating Manual, Block Working Manual. It must also be read along with existing SWR of the station.
5. Portions of SWR that will get replaced pertain to:
   (i) Ensuring clearance of running lines.
   (ii) Granting of line clear.
   (iii) Reception/despatch of trains.
   (iv) Working of level crossing gates.
   (v) All checks that are done by means of :
      (a) Slots.
      (b) Lock bars.
      (c) Point locks.
      (d) Signals.

   All these checks have to be taken care of manually.
6. TWI should list out:
   (i) Number of goomties.
   (ii) Portions of yard that each goomty would control.
   (iii) Which goomties are to be involved for reception/departure of a train on/from different lines.
7. TWI should list out different conditions required to be fulfilled for reception despatch of train:
   (i) How line clear is to be granted/obtained.
   (ii) How clearance of nominated line is to be ensured.
   (iii) Procedure for closure of level crossing gates, if any.
   (iv) How the route is to be set.
   (v) What are the series of points involved.
   (vi) Which one of them are to be in normal position and which ones in reverse.

(vii) How signals are to be lowered.
(viii) Which staff would do what.

23.3.1.12 (D12) Field level Advance Preparation:

1. Detailed working instructions clearly specifying the zone of responsibility of each and every staff and supervisor along with temporary working instructions must be issued well in advance of the NI working. In any case these should be ready at least 15 days in advance of NI working.
2. Station Superintendent/Traffic Inspector who is overall in-charge should be fully aware of their responsibilities/duties. Temporary working instructions should clearly stipulate these unambiguously.
3. Each Station Masters/Assist. Station Master, Cabin Man and point man deployed on shift duty should be supplied with copies of temporary working instructions. In addition, SM/ASM and Cabin Man shall be supplied with yard layout diagrams and pull charts for their guidance.
4. The temporary working instruction shall be supplied to SS/ASM/Cabinman and Pointsman in advance for study by them and for explaining to illiterate staff.
5. The instruction should be prepared in Hindi, English and Vernacular language and assurance to the fact that they have understood shall be obtained.
6. Ready-made pull charts indicating normal and reverse position of points for specific routes must be prepared goomty wise. All such pull charts should be prepared at least 15 days in advance.
7. TI should be entrusted with the job of personally checking each and every pull chart. Compliance report must be submitted by TI at least 10 days in advance.
8. These pull charts must be printed, laminated and displayed in goomties as also given to each staff concerned.
9. Draft instructions and pull sheets must be computerized

and prepared in advance. Thereafter these should be revised on a day-to-day basis. Actual revision should take into account the progress of work as per the original time schedule.

10. A checklist of items to be inspected jointly by Traffic, Signal and Permanent Way Inspector should be drawn and controlling officers should monitor that instructions in the checklist are complied with.
11. The exact location on the stock rail where clamps are to be fixed must be marked with white paint and clamps should actually be fitted to check that there are no obstructions. Clamps should be actually fitted to check that there are no obstructions.
12. It may not be possible to fix clamps on motor operated points provided with second leading stretcher bar. In all such cases provision must be made for cotter bolting of points.
13. In any case, cotter bolting of points must always be preferred as compared to clamping and padlocking since it is a much faster method.
14. Normal/reverse position of points should be painted on tongue rail to indicate position of the road.

23.3.1.13 (D13) Mock Drill and Staff Assurance:

1. Before the SM/ASM/Cabinman/Pointsman and other staff connected with train passing work are allowed independent duty, the Station Superintendent shall obtain their verbal assurance that they have understood the same.
2. With regard to semi – literate and illiterate staff :
   (i) SS/TI should explain detailed working.
   (ii) Test their knowledge.
   (iii) Satisfy himself that they can work independently.
3. Before starting actual non-interlocked working, a “mock drill” or “hands-on” demonstration/training should be given to all staff for at least 1 to 3 days in advance (depending on the size of the station) to familiarize them thoroughly with the type of work they have to handle.

4. This should be carried out in all the 3 shifts to ascertain difficulties, if any, which may be encountered during NI working.
5. Teams already formed for different shifts should be deputed as per roster.
6. "Mock drills" should be carried out without actually disconnecting signal gears, points etc.
7. Whatever deficiencies are noticed during this period should be rectified before introduction of actual NI. This experience should also be used to accurately estimate capacity to be available during N.I. and the number of trains planned to handled should be accordingly revised.
8. Written assurances are required to be obtained before staff connected with train passing duties are allowed to work independently.
9. This written assurance should be taken from the staff only after.
   (i) They have participated in the "mock drill".
   (ii) Worked independently as per their laid down roster.
   (iii) Successfully carried out all responsibilities entrusted to them during the "mock drill".
10. No staff should be deployed unless proper entries are made in the "Assurance Register" and relevant signatures obtained.

23.3.1.14 (D14) Dissemination of information:

1. All aspects of working during NI and changes post-NI should be clearly documented and explained at all Loco pilot/Guard lobbies, whose staff pass through that yard.
2. For this purpose, loco/traffic inspectors, senior subordinates will be nominated to visit these lobbies, with yard plans and camp at these lobbies.
3. Assurance of each and every running staff regarding these changes should be recorded in respective lobby assurance registers, and complete report submitted to Sr. DOM/Sr. DSO/Sr. DME/Sr. DEE on return.
4. Adjoining divisions/railways including notice stations and

inter-change points should also be intimated of the detailed program pertaining to NI working.

5. All control staff including CHC, Dy. CHC, Section controllers, Power controllers, TLCs, TXR control etc. should be appropriately briefed.
6. The section controllers working on control boards must be fully conversant with the proposed changes pre-NI, restricted movement during the course of NI working and post-NI facilities to be made available.
7. Adequate publicity must be given through newspaper advertisements, electronic media, announcements at stations etc. informing the public of the likely repercussions on train running.

23.3.1.15 (D15) Telecommunication, Lighting and Medical:

1. Absolutely foolproof arrangements must be made regarding communication between the station and two adjoining stations on either side so that under no circumstances should there be a situation of total failure of communication between these stations.
2. Satisfactory arrangements for telephonic communication between station (indoor), Cabins, Goomty and Level Crossings Gates should be made to ensure efficient functioning of telephones provided at various locations.
3. Additional fail-safe communication between control office and the NI station must be provided as a backup to existing section control channels.
4. Arrangements for public address system should also be made so that the same can be used for warning the public etc.
5. Loudspeakers must be provided on each goomty for making announcements regarding train movement.
6. Walkie – Talkie sets must be provided to all supervisors working at site.
7. Gangmen, Keymen and Patrolmen in 2 block sections on either side of the NI station must be provided with walkie – talkie sets, electronic hand signal lamps etc.
8. Arrangements of staff and recharging facilities should be available for charging of batteries of telecom equipment

including walkie – talkies.

9. General lighting in yard should be adequate.
10. Separate lighting should be provided in each point zone. Lighting should be adequate so as to ensure that each point controlled from a goomty is clearly visible to the ASM/Cabinman in charge of that goomty.
11. Adequate generator backup should be provided. Spare bulbs should also be provided at each location.
12. Round-the-clock medical post with doctor and para-medical staff must be provided. They should be equipped for handling first aid and crush injuries. Anti-snake venom (Covalent) should be available. Road ambulance should be permanently stationed for quick transportation if needed.

23.3.1.16 (D16) Safety Equipment:

1. Safety equipment required for each location such as goomty, cabin, level crossing gate etc. must be spelt out in detail and full complement arranged.
2. Adequate spares must be arranged for safety equipment such as of hand signal flags, detonators, fusees, clamps and pad locks etc.
3. LED based flashing Hand Signal Lamp must be provided to each such location for better visibility.
4. Cotter bolts, cotter pins and clamps & padlocks must be thoroughly tested to be in proper working condition.
5. Spare numbered crank handles must be provided in goomties where point machines are predominantly working.
6. Each goomty must be provided with the following safety equipment :
   (i) Clamps, padlocks, detonators, fusees.
   (ii) Flags, hand signal lamps etc.
   (iii) Relevant pull sheets, yard diagrams etc. duly laminated.
   (iv) Torches, emergency light, in addition to normal lighting.
   (v) Umbrellas, caps, raincoats as required.
   (vi) Cotton Gloves for staff handling points etc.
   (vii) Table, chairs in tent or covered area.

(viii) Containers and glasses for drinking water.
(ix) Thermos for tea/coffee and provision of snacks and meals for staff deployed from other station or /headquarters.
(x) Mosquito/insect repellant creams.
(xi) Magnetto, and VHF walkie talkies, Public Address Equipment.
(xii) Private number books, paper, pens.

23.3.1.17 (D17) Security arrangements:

1. Adequate RPF security staff round the clock must be arranged at following locations:
   (i) ASM's office.
   (ii) Central place at the station.
   (iii) Level crossing gates.
   (iv) Outer most goomties on either end.

23.3.1.18 (D18) Introduction of NI working:

1. Before permitting introduction of NI working DRM/ADRM will satisfy himself regarding arrangement of staff, safety equipment, lighting, telecommunication and ground position.
2. On the day of commencement of NI working, branch officers concerned from Operating/Safety, Engineering, Signal, Electrical and Mechanical along with DRM/ADRM will visit the place of work. They shall satisfy themselves of availability of necessary arrangement as per standard before permitting introduction of non-interlocking.
3. On the notified day, for introduction of NI working, Signal Inspector concerned shall give a general disconnection memo for gears proposed for NI working.

23.3.1.19 (D19) Train Operation during NI period:

Working of Signals:

1. Speed restriction of 15 kmph. must be in force over all points and crossings. Speed restriction Board of 15 kmph. must be exhibited at the foot of the first stop signal.
2. The following signals should be provided with caution aspect :
   (i) In case of colour light signals, a common NI home

signal without route indicator.
(ii) In case of MAUQ/TALQ, single arm NI home signal.
(iii) Warner signals, if any are to be put out of commission by putting 2 cross bars.

3. NI Home/Starter signal can be taken off only after ensuring that :
   (i) All points on the route are correctly set, both facing and trailing points clamped and padlocked.
   (ii) In addition to correct setting, clamping and padlocking of facing points, they must also be manned.
   (iii) Level crossing gates on the route have been closed against road traffic.
4. Last stop signal should not be disconnected throughout NI working except at the fag end.
5. Movement of trains to and from the block sections should be controlled by taking off the last stop signal.
6. Normally, no Paper Line Clear should be issued to the loco pilots as authority to proceed in the block section.
7. A traffic block of 2 – 3 hrs. should be taken for disconnecting the last stop signal and block instrument and reconnecting the new last stop signal and new block instrument.

Train Running

1. Each train movement must be announced well in advance on the loudspeaker:
   (i) Along with the number of the goomty involved.
   (ii) Sequence of points required to be set and locked in normal or reverse condition.
2. Trains must be allowed to enter cautiously at 15 kmph.
3. Loco pilot of an incoming train must not under any circumstances pass the outermost facing points even though signals have been taken off:
   (i) Unless he also sees that the points are manned.
   (ii) A proceed hand signal is exhibited towards him from the points.

23.3.1.20 (D20) Failures

1. All indicative accidents during the period of NI working

must be immediately reported to the site in charge in order to ensure prompt corrective action and avoidance in future.

2. Details regarding such cases must be promptly intimated to DRM and Sr. DSO.
3. A register must be opened at each goomty in which before handing over charge, staff will enter details of whatever difficulties they have faced during their shift. The person in charge of NI working at that station must scrutinize this register daily.
4. Cases of bursting of NI target should be appropriately dealt with and individual responsibility should be fixed up.

23.3.1.21 (D21) Revised Station Working Rules:

1. After completion of NI working, new works are to be commissioned.
2. Since the yard layout, facilities etc. have changed, the previous SWR is no longer valid.
3. A new SWR duly approved by CRS is to be brought into effect after completion of NI.
4. Staff assurances for the revised SWR must be taken afresh.

23.3.1.22 (D22) Completion of NI Working:

1. NI working must not be terminated unless and until each and every item originally scheduled for completion has been successfully complied with.
2. Designated operating officer must visit the NI station and verify the following:
   (i) Completion of work as per program.
   (ii) Correspondence of yard layout as per SWR.
   (iii) Correspondence of movements permitted as per SWR.
3. The installation shall jointly be tested by Traffic, S&T and Engg. officials and for their correct functioning.
   (i) The lever/knobs, signals, points and connections work freely and properly, and that the installation fulfils its objective.
   (ii) Signals are properly focussed, the indications on the panel correspond with the signal aspect and point position at site.

(iii) Engineering officials shall check the proper housing of points gauge level etc.

4. Before issue of Safety certificate and taking over of stations, the Transportation/Safety Officer shall instruct the station staff responsible or working the interlocking installation and test them in their knowledge of the signalling arrangement.
5. Engineering and S&T officers shall give a certificate stating that all works as per the approved plan are completed.
6. Staff concerned shall be notified through Station Order Book, Control Order Book and their acknowledgement obtained. All inspectors and other supervisors shall ensure strict compliance and report any deviation or violation with prompt to notify then and there.
7. On the day of completion of work, branch officers concerned shall visit the work site to ensure completion of work as per program.

23.3.1.23 (D23) Post NI analysis:

1. Within 7 days of completion of NI, a brainstorming session should be held with all the senior supervisors involved for taking stock of lessons learnt.
2. These lessons learnt should be compiled at one place for successive NIs, so that they are available for future reference.
3. A copy of the same may also be sent to other divisions for reference purposes.

ELECTRIFICATION: SAFETY PRECAUTIONS WHILE WORKING ON TSS AND SP/SSP

24

24.1 General Precaution while Working or Maintenance on OHE

1. No work shall be done within a distance of 2 metres from the live OHE without a "Permit to Work".
2. Inductive effects occur on large metallic structures such as fencings, structural steel of platforms running parallel to the track. They will have to be earthed suitably.
3. Discharge/Earthing pole assembly shall be inspected by SSE/JE once in a month
4. Each working gang shall be protected by at least two independent earths, one on each side of a working gang.
5. The continuity of the cable connection between the top clamp and the earthing clamp should be checked once a fortnight.
6. The cable of earth pole should be renewed if more than 20% strands are broken.
7. The cable of earth pole shall be flexible and should have adequate cross section of 40 mm^2 so as to withstand short circuit currents.

8. For providing earth on the OHE, fix the earthing clamp securely to a mast at least one span away after making sure that the mast to earth rail bond of this mast is intact.
9. Earthing clamps should always be fixed to the traction rail or mast first and then the top clamp must be tested on RT or BT and hooked to the contact wire.
10. For removing the earthing, first remove the hook of discharge rod on the OHE and then the clamp fixed to the rail or mast.
11. If the distance between the working gangs exceeds 100 meters, intermediate earth shall be provided in such a manner as to ensure that the distance between earths does not exceed 100meters,
12. No fallen wires shall be touched unless power is switched off and the wire suitably earthed.
13. Men shall be deputed on both sides of the site of work to warn the working party of any approaching train on the same track and adjacent track.
14. In electrified track, steel tape or metallic tape or tape with woven metal reinforcement should not be used. In electrified track, PVC fiber glass tape shall be used.
15. Even when earthing is provided by isolator switches with earthing heels, additional temporary earths shall also be provided both side of the isolator at two points.
16. Neutral sections should be treated as live equipment and earthed separately at two points on either side of the working gang before commencing work.
17. Ropes made of cotton or jute with ladders should be used. Use of metallic ropes is prohibited.
18. All the staff should wear helmets to protect their heads against any tool or equipment which may drop down accidentally.
19. Ends of conductors which may have snapped should be separately earthed at two points after switching off supply to both parts of the OHE. This precaution should also be observed when working or in the vicinity of a sectioning point and cut in insulators.
20. Staff should protect themselves against an inadvertent fall by wearing a safety belt and helmet for supporting themselves by a rope sling.

21. When work is to be carried out on an isolator, both sides of the isolator should be earthed at two points.
22. The useful cross section of a conductor shall not be reduced while making joints.
23. Ropes, pulleys, pull lifts, come along clamps, 'D' shackles and tirfors etc. should be tested once in six months at least, in the presence of SSE/JE-(TRD), and record of such tests maintained in each depot.
24. A ladder should be held by one person on the ground to prevent slipping, while the top end should be tied to the supporting structure or conductor to keep it in position and prevent it sliding away.
25. Ladders should never be allowed to fall on or rest against the contact wire.
26. It is important that staff who asks for power block should know the correct method of identifying and describing any section of OHE where shutdown is required.
27. Do not stand on contact wire while working resulting kink form under swivel clip.
28. Ladder should be always allowed to fall on catenary wire towards the mast side.
29. Always provide 20/16 dia. GI bolt in step of ladder which is used for pulling lift and extension step.
30. More than one person shall not normally be allowed on a ladder as far as possible.
31. Climbing on a ladder with wet or slippery foot wear is forbidden.
32. Whenever there is a doubt in the description, the person asking for power block shall state clearly the line (Up or Dn) and OHE structure numbers between which works is to be done.
33. Do not wear loose cloths such as kurta pazama, Lungi, safi, chappal etc. Always wear rubber sole shoes while working.
34. A rope should be used to pass tools or any equipment to the man working on a ladder.
35. Do not tie the rope on rail without taking traffic block.
36. Ensure that working personnel should not stand directly below a work spot under a ladder.
37. It is necessary to take traffic block while working on tunnel or bridge.

38. Any contact with conductors which are not specifically earthed is forbidden.
39. All messages relating to shut down and restoration of power supply, permits to work, etc. issued over the telephone shall invariably be supported by exchange of private numbers and repeated twice.
40. Staff should not sit under the ATD (balance weight).

24.2Safety Precautions while working on TSS & SP/SSP.

24.2.1 A. General Safety Precaution

1. Do not leave unwanted material in switching yard.
2. Ensure no vegetation in switching yard.
3. Do not work without proper shoes in switching yard.
4. Ensure fire buckets are filled with sand. Fire extinguishers should not be of expiry date.
5. Ensure operator and maintenance personnel must know the operation of fire extinguishers.
6. Ensure equipment and poles etc. are kept in proper stacking and covered.
7. Operator should use rubber hand gloves while working in switch yard.
8. Always use industrial helmet while working.
9. Do not use shoes with leather sole in switching yard. The sole must be of rubber and should not be fixed with nails.
10. Staff should protect themselves against an inadvertent fall by wearing a safety belt and helmet for supporting themselves by a rope sling.
11. Do not wear loose clothes such as kurta pazama, Lungi, safi, chappal etc.
12. Do not go in switching yard wearing wet clothes and also ensure that lower part of the pants/trousers is not wet.
13. In TSS & SP/SSP, PVC fiber glass measuring tape shall be used.
14. Do not allow un-authorized person and animals in TSS & SP/SSP.
15. Do not fire in dry vegetation in switch yard.

16. Ensure that no gap between bottom side of fencing and ground for entry of animals in TSS & SP/SSP.
17. Do not grow fruit tree in the premise in TSS & SP/SSP otherwise stone pelting might be observed.
18. Ensure field telephone, TPC, P&T and Railway phone of TSS shall be in working condition.
19. Ensure a surface layer of crushed rock is provided to a thickness of about 100 mm at traction substation and switching station.
20. Ensure first aid box is equipped with necessary medicines.
21. Ensure that trench covers are properly seated on trenches.
22. Tree branches shall not come in the vicinity of feeder wire.

24.2.2 B. Safety precaution while working.

1. No work shall be done within a distance of 02 meters from the live wire without a "Permit to Work".
2. Discharge/earthing pole assembly shall be inspected by SSE/JE once a month.
3. The continuity of the cable connection between the top clamp and the earthing clamp should be checked once a fortnight.
4. The cable of earth pole should be renewed if more than 20% strands are broken. The cable of earth pole shall be flexible and should have adequate cross-section 40 mm^2 so as to withstand short circuit currents.
5. Before commencing the work, staff should be conversant about the work to be done.
6. After obtaining Permit to Work (PTW) from TPC, ensure that power supply of concerned equipment/ circuit is switched off and earthed.
7. Equipment should be on local mode at control panel/mechanism box. Caution tag shall be provided on local/remote switch at control panel of concerned equipment on which work to be carried out.

8. Do not work on equipment during Live / ON condition. Ensure that equipment is in 'OFF' condition before commencing the work.
9. Ensure that switches of DC and AC supply are 'OFF' before commencing the work.
10. Equipment must be earthed before commencing the work.
11. Red banner flag / Danger board shall be provided on other live equipment or mast in the vicinity of the equipment to be maintained.
12. Do not gossip at the time of work/ power block.
13. Be vigilant while working.
14. Always carry the ladder / lengthy object in down position in switching yard.
15. Do not leave equipment covers in open condition after completion of work.
16. Do not leave any tool/ material on / in the equipment after completion of work.
17. Use correct size ladder/ stool while working on equipment.
18. Do not support the ladder on insulator/equipment while working.
19. A ladder should be held by one person on the ground to prevent slipping of ladder.
20. Use of old extension ladder having less strength should be avoided.
21. More than one person shall not normally be allowed on a ladder as far as possible.
22. Climbing on a ladder with wet or slippery footwear is forbidden.

FIRE INCIDENCES IN INDIAN RAILWAY

25

The fire incidences in trains are among the most serious disasters impacting human lives as well as property of Indian Railways and other stake holders. Thus, prevention of train fire has been a serious concern for the Indian Railways. A train fire is different from a fire in other places as in the way it breaks out, grows, and spreads, and in the method of fighting it, as well as the damages it causes. Fire in a running train is more dangerous than a static one, because the fanning effect may spread the fire very quickly to other coaches.

Fire especially in uncontrolled state, is a source of very rapid destruction and this gets compounded when loss of human life is involved. Hence all possible steps should be taken to prevent fire from breaking out in coaches, and if it breaks out, to prevent it from spreading and causing further damage.

The following points summarize the characteristics of a train fire, which need special consideration when deciding upon counter measures: -

1. A train consists of long narrow vehicles coupled with each other with limited exits.

2. High traveling speeds prevent quick escape and assist rapid spread of fire.
3. Wide range of track conditions, including confined sections such as bridges, tunnels, Ghats, etc., may make it difficult for passengers to get off the vehicle easily in times of emergency.
4. Restriction in movement of passengers and fast spread of fire aggravates the situation.
5. Many passengers traveling on trains has to be attended to by a small team of on-board staff.
6. Even a delay of few initial seconds due to inadequacy of direct communication with the crew can be devastating.
7. Smoke emission in a confined place may also lead to panic.

25.1 Characteristics of Fire

The fire requires three elements to ignite: heat, fuel, and an oxidizing agent (usually oxygen). By eliminating any one of the elements, fire can be extinguished.

$$\text{FUEL + AIR (OXYGEN)} \xrightarrow{\text{HEAT}} \text{FIRE}$$

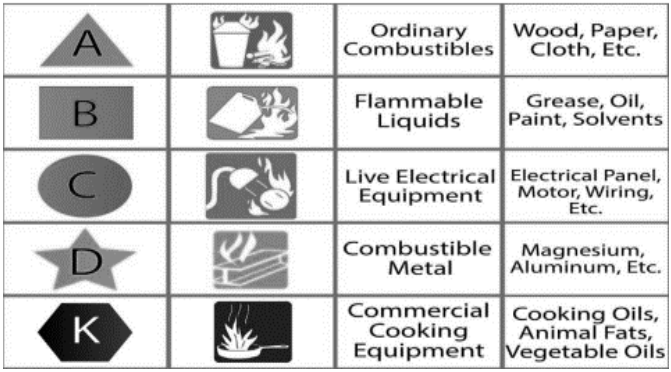
25.2 Classification of Fire

Fires are classified according to the type of fuel that is burning. If wrong type of fire extinguisher is used for extinguishing the fire, it might make matters worse. The four different fire (fuel) classifications are as under:

1. **Class A:**
   Class A fire involve Wood, paper, cloth, trash, and plastics - solids that are not metals.
2. **Class B:**
   Class B fire involve Flammable liquids - gasoline, oil, grease, acetone etc. Includes flammable gases.
3. **Class C:**
   Class C fire involve Electrical - energized electrical equipment (as long as it's "plugged in" or supply ON),

electrical panel, wiring etc.

4. **Class D:**
   Class D fire involve Combustible Metals - potassium, sodium, aluminium, magnesium. Requires Metal foam, and other special extinguishing agents.
5. **Class K:**
   Class K fires involve vegetable oils, animal oils, or fats in cooking appliances. Extinguishers with a K rating is designed to extinguish fires involving vegetable oils, animal oils, or fats utilized in commercial cooking appliances.



25.3 Probable Causes of Fire in Railway Coaches

1. Carrying inflammable goods like stove, gas cylinder, kerosene oil, petrol, fireworks, poll posters etc. in passenger coaches.
2. Making/using fire near paper, wood, petrol, or such other inflammable articles.
3. Throwing waste material outside dust bin, near door, non-removal of garbage from pantry cars/coaches.
4. Bad habits like carelessly throwing lighted match sticks, cigarette butts and Bidi butts etc.
5. Leakages/Blasts of pantry gas cylinders.
6. Gas regulator, flame arrester and pressure gauge in pantry car are not in proper working order.
7. Improper storage of inflammable materials like newspapers, edible oil etc. in pantry cars.

8. Insertion of cigarette butts, Bidi buts, Gutkha wrapper etc. in fan base, fuse distribution board, roof openings and ventilators etc.
9. Sabotage.
10. Mishandling/Careless use of pantry equipment by pantry car staff.
11. Poor maintenance of electrical equipment and short circuits.
12. Loose or temporary connection, hanging wires/exposed joints etc.
13. Defects in locomotive/traction unit causing fire.
14. Use of open fire near trains carrying petrol/gas/other flammable material.

25.4 The type of Fire Extinguishers & it uses.

Portable fire extinguishers are classified by the type of fires they are designed to extinguish. There are five basic classifications of fire extinguishers. Extinguishers are labelled with either letter-shaped or pictorial symbols that indicate what types of fires they are intended for.

It is vital to know about type of extinguishers. Using the wrong type of extinguisher for extinguishing of fire can be life-threatening. Locos, EMU's, and AC coaches are being provided with DCP types of fire extinguishers, considering it is the most suitable for electrical fires.

a) **Wet Chemical extinguisher -** The wet chemical extinguisher is a specialized type primarily focused on class K fires, those involving cooking media such as animal and vegetable fats or oils. These extinguishers contain a solution composed of potassium that effectively launches a two-pronged assault on fires. First, the liquid mist it sprays acts to cool the fire. Second, due to the chemical reaction of the solution with the cooking medium, a thick soap-like substance forms, sealing the surface of the liquid to prevent re-ignition.

b) **DCP (Dry Chemical Powder) extinguishers** come in a variety of types and are suitable for a combination of Class A, B, C& D fires. These are filled with foam or powder and pressurized with nitrogen. DCP (Dry Chemical Powder) extinguishers have an advantage over CO_2

extinguishers since that leave a non-flammable substance on the extinguished material, reducing the likelihood of re-ignition.

c) **Water extinguisher or APW extinguishers** (air pressurized water) are suitable for Class A fires only. Never use water extinguishers on grease fires, electrical fires, or Class D fires – the flames will spread and make the fire bigger. Water extinguishers are filled with water and are typically pressurized with air. Again, water extinguishers can be very dangerous in the wrong type of situation. Only fight the fire if you're certain as it contains ordinary combustible materials only.

d) **Foam extinguisher -** Foam fire extinguishers are suitable for class A and the flammable liquids of class B, though not effective for gaseous fires. They spray a type of foam that expands when it hits the air and blankets the fire. This blanket prevents the vapours from rising off the liquid to feed the fire, thus starving it of fuel. Also, because the foam is mixed with water, it has a cooling effect as well. Foam extinguishers are some of the bests for liquid fires, such as gasoline fires, but can also be used on Class A fires involving solid combustibles like wood.

e) **Carbon Dioxide (CO2) extinguishers** are used for Class A, B and C fires. (CO2) extinguishers contain dioxide, a non-flammable gas, and are highly pressurized. The pressure is so great that it is not uncommon for bits of dry ice to shoot out the nozzle. They don't work very well on class A fires because they may not be able to displace enough oxygen to put the fire out, causing it to re-ignite. CO2 extinguishers have an advantage over DCP (Dry Chemical Powder) since they don't leave a harmful residue – a good choice for an electrical fire on a computer or other favourite electronic device such as a stereo or TV.



25.5 Fire Hazards in Coaches

Excessive current in the cables is the only probable cause of electrical fires on coaches. The excessive current in the cables can result either due to inadequate size of cables used in the circuit or any short circuit in electrical circuit. Sizes of the cables on different circuits on the coaches have already been standardized and included in specification EL/TL/48 (Rev. 1)-2005 and if proper care is taken during wiring of coaches, this cause can be eliminated.

This leaves short circuit on coach wiring as the only cause of excessive current and therefore, complete care is to be taken to ensure that -

1. Cause of electrical short circuits on the coaches are avoided.
2. In case electrical short circuits take place, the protective device in the circuit should isolate the fault instantaneously without causing damage to the cables.
3. In case the electrical fire does break out, it should be ensured that the fire does not spread, for which equipment and material used in wiring should be of good quality particularly where fire retardant properties of the item have been specified. This includes items like cables and PVC conduits, boards, paints on wooden members in the vicinity of the wiring etc.

25.6 Action to be Taken to Prevent Fire Hazard in Coaches: -

The following documents are to be followed to prevent fire hazards in coaches: -

SN	Document No.	Description
1	EL/TL/48 (Rev. 1)-2005	System specification and code of practice for wiring for 110 V DC Self Generation Train Lighting System.
2	RDSO/PE/O/0008-2005 (Rev. O)	Code of practice for prevention of fire in AC Coaches.
3	ELE-M1-79	Code of practice for prevention of fire in Power cars.
4	ELPS/SPEC/EOG/01	Specification and code of practice for wiring in 750-volt End-On-

		Generation System Coaching Stock.

1. Cable Sizes: -

a. The Air-conditioned coaches are provided with Elastomeric Copper cables to RDSO Specification No. E-14/01/Pt-I/Rev. II and copper conductor PVC insulated unsheathed cables to RDSO Specification No. RDSO/SPEC/TL/0027-2002 (Rev. O) with amendment no. 1.

b. However as per latest guidelines from Railway Board, E-beam irradiated thin-walled elastomeric cable as per RDSO Specification No. RDSO/SPEC/ELC/0019 (Rev. O)-2002 are being used for presently manufactured Air-conditioned coaches.

c. The layout and cable harness scheme for electrical wiring in coach should be such as to minimize the number of joints and junction boxes.

2. Earth Checking:

a. The train lighting wiring is on two-wire unearthed system and therefore at least two earths one on positive polarity and the other on negative polarity are necessary to cause short circuit through the coach body (counting the possibility of direct short between the cables of opposite polarities because of segregation of positive and negative wiring on super structure).

b. Thus, earthing of wiring on the coach at first stage cause short circuit and should therefore be checked promptly.

c. The earth will be checked both on positive and negative wire separately by Earth Indicating Double Test Lamp Method.

d. Light point, fan point, and the switches are particularly prone to earthing in metal bodied coaches and therefore to minimize its possibility, proper attention is required to be paid at the time of fitment of the lamp holder, brush holder of the fan and toggle switches and while carrying out their maintenance in service. The insulating bush in the mounting lug of the fan SHALL NOT BE PROVIDED.

e. The dia of the mounting hole provided in the mounting lug shall be of 9 mm. It shall be ensured that fan base of all the fans have a live contact with the coach body.

f. All electrical fittings both on super structure and on under frame shall be mounted directly on the coach body and not electrically insulated.
g. The trouble shooting instruction for earth on coach wiring may be followed as per enclosed Annexure-A (Sheet No. I and II).

3. Air Clearances:

Air clearance of 10 mm has been specified between any live part and the coach body and 4 mm between parts of opposite polarities. (EL/TL/48 clause 3.9.4). This is primarily to ensure adequate separation to facilitate ease of fitment and maintenance in service. In case of clearance being inadequate, there can be a possibility of short circuit caused by the working tools or other inadvertent causes on the coach. It is therefore important that adequate clearance as specified is maintained in all fittings etc. between live parts and earth or between parts of opposite polarity.

4. Damaged Insulation:

a. Cable insulation on coaches get damaged in various ways resulting in earth on wiring which in turn may cause short circuit. Therefore, insulation damage should be prevented and attended promptly.
b. It is noted that for testing the maintenance staff many times adopt dangerous practice of chipping the cable insulation. This leaves a permanent scar on the cable insulation and even its subsequent taping with tape will not be quite satisfactory. Staff should be educated and asked not to chip cable insulation in middle and to test, feed etc. in course of maintenance but at terminals only.
c. The cables passing through the holes in the metallic members on the coach are liable to get their insulation punctured because of pressing and chafing against the sharp edges. This may result in earthing on the coach. This should be protected against by providing proper PVC grommets to BS:1767 or grade 6 of IS:5831 with non-inflammable properties.
d. At cable terminals, cable lugs should always be taped to insulate the bare portion of the conductor, if any, and also portions where

the clearances are critical. Crimped connections are to be made properly.

e. The poor joint will cause heating, damaging the insulation of the cables at the end. A poor joint can always be detected easily by feeling the temperature of the socket with full load current passing through it. A hot terminal indicates either an improper connection or a bad crimped joint. While cause of damage to cable should be checked, a record of insulation of the coach wiring should also be maintained to monitor the health of insulation of wiring.

6. Coach Insulation Test:

Insulation resistance of coach should be measured with 500 V megger. Procedure to be adopted for insulation measurement shall be as under: -

i) Superstructure wiring and under frame wiring will be tested separately for which the main negative fuse in the junction box will be opened and controlling switch L1, L2, F+, SPM1, SPM2 will be kept off. Insulation resistance will be measured with all fittings and equipment connected both on under frame & super structure. The under-frame wiring will be tested with battery fuse open. Insulation resistance under fair weather conditions will be minimum 2 Meg Ohm. However, under adverse (highly humid/ wet) weather conditions, the minimum insulation up to 1 Meg Ohm, will be acceptable.

ii) In case insulation resistance is found less than mentioned in para above, individual sub-Circuits at junction box, i.e. L1, L2, F+, SPM1 and SPM2 for super structure wiring will be meggered separately and the coach will be treated to have passed the test if insulation resistance value of these feeders individually is within the limits prescribed in para above.

7. Rewiring of Coaches: -

In terms of Board's letter no. 2002/AC-II/1/10 dated 24.05.2006, the coach wiring is to be taken up after 12 years of coach life. The coach wiring is to be taken up during Mid Life Rehabilitation.

8. Battery Box:

The mono block of battery shall be arranged in single row perpendicular to track, inside a sturdy steel box and secured to under frame by bolts and nuts, lock nuts or split pins as per ICF drawing no. ICF/ SK-7-1-306 for BG and MG coaches. FRP trays shall be provided at the bottom of the battery box to avoid corrosion of battery box from spillage of acid. The battery box shall be suitable for accommodating 18 mono blocks of battery conforming to RDSO's spec. no. EL/TL-38 (Rev. B) with amendment no. 1.

The box shall be provided with ventilating grills to permit flow of outside air over the cells. A drainpipe shall be provided at the bottom of the box to allow split acid or water to drain out. The location and a design of the ventilation and drain arrangements s be such as to avoid ingress of dust into the battery box. Provision shall be made on the front cover for part opening for inspection and maintenance of the cells. The cells shall be tightly packed by wooden packings inside the battery box in all sides except at top. The battery box and wooden packings shall be protected against corrosion by battery acid by two coats of acid resistance paint. In addition, wooden packings shall also be protected against attack by vermin. The battery box shall have minimum 150 mm clearance at the top of battery for maintenance of cells,

The battery fuses shall be located in a battery charging socket and fuse box to RDSO's Drg.no.SKEL-3930. This box shall be provided adjacent to the positive end of the battery box and shall be accessible without the necessity of entering between the track rails. Rewirable 32A for single battery and 24A for double battery tinned copper fuses conforming to specn.no.IS:9925-1961 shall be provided according to coach loads.

Mild steel rods threaded at both ends shall be fixed to the battery boxes after loading the cells as an anti-theft arrangement in accordance with para 6.12 of IRS Specn.no.E-45/1977.

9. Protective Devices:

Notwithstanding the above precautions, the possibility of short circuit on coach cannot be discounted altogether and, therefore, protective devices are necessary to afford protection in the event of any short circuit or excessive current on the coaches. As mentioned

earlier, short circuits are the only probable cause of electrical fires and, therefore, if provision of proper protective devices is ensured, it will go a long way in avoiding incidence of fires of electrical origin on coaches. On coaches' rewirable fuses and HRC fuses have been standardized. The sizes and the rated currebelow, these protective devices for different circuits are given below and it should be ensured that only correct size of these devices are put on the coach.

The quality of protective devices is also important and should conform to their relevant specification indicated below, while rewirable fuses and HRC fuses as at Table 1 shall be procured by Railways from renowned sources approved by RDSO/Railways.

Table-1

Sr.	Circuit	Fuse location	Fuse rating	Non fusing non tripping current	Minimum size of cable protected for Short Circuit		
					60Sec. Fusing/ Tripping Current	Size	Short Time (60Sec) Rating of cable
1	Positive/ Negative branch fuse	DFB	6A (0.20 8Amm) (35SWG)	8A	13A (4mm2)	7/0.85	37A
2	LI, LII & F+	Jun Box		-	-	7/1.7 ($16mm^2$)	148A
3	SPM-I & SPM-II	-do-	-do-	-	-	7/1.7 ($16mm^2$)	148A
4	Main - ve	-do-	35A HRC	-	-	7/2.52 ($35mm^2$)	325A
5	Battery Fuse						
	a. Single Battery	Battery Box	32A (20 SWG)	45.0A	70A	7/2.52 ($35mm^2$)	325A
	b. Double Battery	-do-	24A (22 SWG)	34A	53A	$35mm^2$	325A
6	Alternator						
	i. Phase	Rectifier Cum Regulator	32A HRC	-	-	-	-
	ii. Field		6/10A HRC	-	-	-	-

10. Segregation of Positive & Negative Cables:

The wiring on the under frame and end walls of the coach shall be run in rigid steel conduits and on the superstructure in Rigid

PVC conduits and the positive and negative cables shall be segregated by running them in two separate conduits.

Note: The phase & field cables from the alternator to terminal box shall run in one flexible PVC conduit and-from terminal box to Rectifier- cum-Regulator and from Rectifier-cum-Regulator to under frame terminal board in one rigid steel conduit.

11. Coach Wiring Accessories:

11.1 Connectors

Wiring for fan point, berth light, step light, taillight and side light fittings on the coach shall be terminated in a connector. This will ensure that when these fittings are removed from the coach, the coach wiring is not disturbed and remains in position with its opposite polarities' terminals adequately apart.

The connectors are covered under IS:6896 and shall be of tough non-ignitable moulding material or rigid PVC.

11.2 Cleats:

The cleats used in coach wiring shall be of rigid PVC with non-inflammable properties. However, wooden cleats pressure impregnated with ASCU fire retardant can be used but they shall be further provided with two coats of fire retarding paint of approved make.

11.3 Grommets and bushes:

Grommets used in coach wiring on coaches to protect cable insulation shall be of hard PVC as per BS:1767-1951 or to grade 6 of IS:5831. The bushes used on coaches at various locations shall be of the same class of PVC with non-inflammable properties.

11.4 Conduits:

Flexible PVC conduits shall be used for toilet wiring under the water tank. The flexible PVC conduits shall conform to IS:6946. Rigid PVC conduits used in wiring at other locations on the coach shall be as per IS:9537.

The PVC conduits both flexible and rigid shall be for fire retardant class and shall pass flame retarding test as specified in specification IS:9537.

11.5 Insulation tapes:

Fire Retardant Low Tension (FRLT) pressure sensitive insulating tapes are being used in different colours as per ICF Specification No. ICF/Elect/921, CS No. 2, Rev. O.

11.6 Distribution fuse board and terminal boards:

Various terminal board and panel boards used in each wiring shall be of FRP with fire retardant properties to ICF specification no, ICF/ELEC/ 866.

11.7 Wood and Fire-Retardant Paint:

Insulating blocks are provided for the lamp holders and switches to insulate the fitting from the coach body. Blocks shall be of seasoned hard teak wood. All the wooden boards, blocks and cleats used in the wiring or in the vicinity of the wiring shall be painted with two coats of fire-retardant paint as approved by RDSO. The following fire-retardant paints are approved by RDSO, and they only shall be used for painting cleats and wooden blocks and other wooden boards in vicinity of wiring in coach.

(i) Acrylic superlac plastic emulsion paint of M/s Shalimar.

(ii) Fire resistant paint, light grey of M/s Jenson & Nicholson.

(iii) Mica base fire retardant paint of M/s Central Glass and Ceramic Research Institute

12. Round Trip Maintenance Schedule:

a. The loose and exposed / hanging wiring shall be secured and properly covered. In case of wiring needs replacement, the coach shall be taken for repairs.

b. Look for any overheating of terminal and cable insulation etc. This is to be checked by switching 'ON' the coach load and then feeling the temperature of various terminals by hand. An overheated terminal can be either due to looseness or because of defective jointing (crimping). The terminal should, therefore, be tightened and if joint is heated the crimping be redone.

c. Check for proper sizes of fuses: An overheated fuse can blow prematurely and therefore should be replaced. Check for proper securing and tightness of connections. HRC fuses should be

checked for correct size, connections and if it is healthy. Replace if blown and tighten connections, if found loose.

d. Provide tape at terminals and overheated portion of cable insulation at terminals.
e. Check earth on coach wiring and attend if an earth is noted as per procedure given in Annexure -A. However, in emergencies, a coach with negative earth fault which could not be attended can be given in service but then the coach will be taken up for repairs during next trip. Before allowing such coach in service, a particular check will be made that all protection devices are properly provided. The coach shall also be marked with defect and noted for attention during next trip.

13. Safety Items to be Checked During Primary Maintenance:

Underframe Equipments: -

1. Suspension bush, pin, split pin and locking plate of alternator to be checked.
2. Tensioning device and its sleeve to be checked.
3. Proper tightness of axle pulley with torque wrench to be ensured.
4. Tightness of battery box frame to be checked and corroded battery boxes are to be repaired.
5. Corroded inverters if any may be replaced/repaired immediately.
6. Suspension arrangement of under-slung conventional air conditioning equipments like pre-cooling transformer, RR Box, Compressor and Compressor motor unit, condenser motor and condenser unit, water raising apparatus etc to be checked.
7. Suspension arrangement of RMPU air conditioning equipments like pre-cooling transformer, RR Box, water raising apparatus etc to be checked.
8. Suspension arrangement of LHB air conditioning equipments like 60/50 KVA transformer, water raising apparatus and proper working and fixing of IV Couplers are to be checked.

Fire Safety Equipments: -

1. Functioning of vane relay.
2. Functioning of Overheat protection system.
3. Working of heater in auto mode.

4. Use of fire-retardant canvas cloth.
5. Proper rating of all fuses/MCBs should be ensured.
6. Regular cleaning of accumulated garbage/muck in the vicinity of FDBs.
7. Proper covers of FDB's/rotary junction boxes should be ensured.
8. Proper working of OVPs should be ensured.
9. Proper working of lights and fans.
10. Proper working of emergency feed terminal.
11. Earthing faults to be detected and rectified.
12. Working of emergency lights.
13. Periodical checking of engine room of power car to be carried out for any oil spillage.
14. Instruction for locking of electric supply to pantry equipment during night to be ensured.

25.7 Fire in LHB Coaches

Detection and Suppression System

Fire Detection System



The system is fitted with 2 nos. Fire Cum Smoke a Detectors inside the Engine/ Generator Cabin. The Detectors are connected to the control Unit as Shown above.

The following are the constituent of the control panel.

1. Sounder cum flasher beacon
2. Controller

In case of Fire inside the Genset Cabin, the heat/smoke sensors will activate the Alarm system which will give a Audio Visual Alarm.

On Hearing/ seeing the Alarm, the trained attendant, should activate the High-Pressure water mist suppression system as described in

next section and IMMEDATELY LEAVE THE COACH AFTER THAT.

High pressure water mist fire suppression system

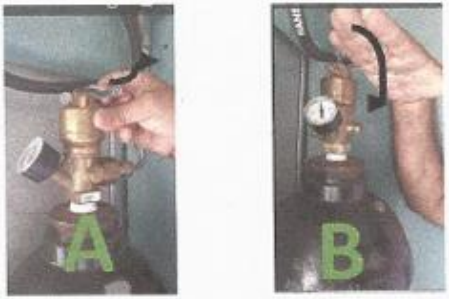
The following are the constituent of the wate mist fire suppression system.



1. Nitrogen Cylinder 50L At 200 kg/cm^2.
2. Water Cylinder 2 x 80 L each.

Operating Instruction

1. On Hearing/Seeing the Fire Alarm make sure that everybody should leave the generator compartment.
2. Close the door of generator compartment.
3. Switch off the Gensets, exhaust and ventilation equipment.
4. Pull the pin of the operating handle as shown. (Fig A)
5. Push the operating handle as shown. (Fig B)
6. Once the High-pressure water mist activate inside the press the reset button on the alarm system.



Control Panel Box



Step-1: In event of fire / smoke inside the generator room, audio-visual alarm will start indicating red light with siren sound on control panel.

Step-2: Check & confirm inside the generator room for actual fire event.

Step-3: In case of actual fire event, stop both the generators system & cut-off its fuel supply.

Step-4: Lift the flap on the "Manual Actuation Switch" and press it (as shown above) provided on control panel.

Step-5: Control system will activate the high-pressure water mist suppression system & discharge will start through nozzles installed inside the generator room to suppress the fire.

Step-6: After discharge of suppression system & fire suppression, the cylinders would be empty & required to be refilled with Nitrogen & demineralized water.

Step-7: In the event of only smoke and no fire, the audio/visual alarm would be actuated. The same have to be resettled by opening the control box and pressing the reset button on evaluation unit for more than 5 seconds.

Step-8: "Orange light" in any LED of evaluation unit, indicates fault in the system which needs correction.

25.8 Fire Fighting System in Coaches

Fire Fighting Arrangement in Coaches/Trains

Guard-cum-Brake Van, AC coaches and Pantry Cars in all trains are provided with portable fire extinguishers to cater for emergencies due to fire accidents. Presently, in sleeper coaches, fire extinguishers are not provided. It may be provided in those coaches with TTE seats. Efforts may be made to provide portable fire extinguishers in other Non-AC coaches also. Ball-type fire extinguishers may be proliferated in trains for ease of use.

All AC coaches are being provided with smoke and fire detection systems which give alarm in case of fire or smoke. The pantry and power cars are being provided with smoke and fire detection as well as suppression systems. The suppression systems provided may be manual or automatic.

Fire Extinguishers

The fire extinguishers provided in railway coaches are of Dry Chemical powder (DCP) type. Dry chemical fire extinguishers come in a variety of types and are suitable for a combination of Class A, B, C & D fires. These are filled with foam or powder and pressurized with nitrogen. It puts out fire by coating the fuel with a thin layer of dust. This separates the fuel from the oxygen in the air.

1. **Using a DCP type Fire Extinguisher**
   i) Remove the safety clip of fire extinguisher.
   ii) Tilt the extinguisher at 60 degrees to avoid injury to user.
   iii) Break the cartridge by hitting the plunger duly holding the pipe.
   iv) Direct the jet towards the near edge of the fire with a rapid sweeping motion.
2. **Operation of Automatic/Manual Fire Suppression Systems**
   i) The Operating Instruction is pasted by the side of the Suppression System and members of Instant Action Team should be well aware of.
   ii) In case of Manual Suppression System, whenever there is a fire / smoke inside the coach, sensor will activate smoke alarm which will give audio / visual signal at this stage, if required. Fire Suppression System can be activated by pressing manual activation switch.

iii) In case of Automatic Suppression System, whenever there is a fire / smoke inside the coach, sensor will activate heat alarm which will give audio / visual signal and the Suppression System will automatically operate within 30 seconds.

iv) If in case the system is not functioning, the suppression system can still be activated manually by pressing the lever in the nitrogen cylinder as detailed in the operating instruction pasted near the suppression system. Staff travelling should be trained to operate the system.

The Dry Chemical Powder (DCP) Type Fire Extinguishers should be provided at the following locations on trains–

S. N	Locations	No. of Fire Ext.*
1	Each Electric / Diesel Loco	**4**
2	Each Brake Van (SLR) (Front & Rear)	**2**
3	Each AC Coach	**2**
4	Each Pantry Car	**4**
5	Each Generator Van	**4**
6	Each Motorman Cabin of EMU coaches	**2**

* No. of Fire extinguishers

Prevention of Fire Accidents

Though the average number of fire accidents as well as the annual average fatalities are 8 per year for both, a stray major fire in train accident may lead to disaster. In general, nearly 40 % of fire accidents are caused by unidentified elements, on which the Railways have little control. With the rising social awareness, stringent scrutiny on trains, induction of fire-proof coaches & more and more technological inputs, it is assessed that the fire accidents and consequent fatalities would be reduced by 80% as compared to their present level. Fire accidents and consequent fatalities will be reduced by 80% by adoption of fireproof coaches and fire-retardant material in the existing coaches. Fire accidents cannot be totally eliminated as some of them occur

because of unidentified elements on which Railways have little control.

1. **Use of fire-retardant materials**
   The Indian Railways have adopted fire retardant interior furnishing including, wall panelling, flooring, roof panelling etc. to minimize the risk of fire accidents. Fire retardant curtains and upholstery have been adopted all over the system. The prototype of a `nearly fireproof coach' is expected to be manufactured soon by RCF.

2. **Provision of emergency exit**
   AC and non-AC coaches are being provided with emergency escape windows. Provision of emergency escape windows in all new coaches and all coaches coming out from POH will be ensured.

3. Rear-view mirror outside loco cab, multi-resetting vigilance control device, audio-visual alarm system in SLRs, will be tried out to contain fire accidents.

The responsibility of staff in prevention of fire incidence

Fire causes destruction, damage to property and disruption to rail traffic apart from causing deaths and injuries to passengers. Hence, prevent fire hazards by observing following precautions.

Loco pilot:

1. Ensure that four fire extinguishers of Dry Chemical Powder (DCP) type are available in the loco and they are within the expiry date.
2. Check all the electrical circuits for foul (burning) smell, smoke and sparks.

Rolling Stock (Wagons) maintenance staff:

1. Pay special attention to oil tank wagons and arrest leakages.

2. Ensure proper marshalling of wagons containing inflammables.

Rolling Stock (Coaches) maintenance staff:

1. Pay special attention to prevent cooking in the passenger compartments by the passengers.
2. Take stern steps to prevent unauthorised hawkers and vendors using 'sigris' and stoves on trains.

Station Staff:

1. Station staff to ensure that updated telephone numbers of fire stations are available on the records.
2. Ensure firefighting equipment such as fire extinguishers are available, fire buckets are filled with sand and water.
3. Ensure rag picking activity is properly done and not allow to lit fire by dumping the waste material in between two tracks.

Train Manager:

1. After completion of the loading, Train Manager must ensure that all the lights in the luggage portion of the SLR is in switched 'off' condition to eliminate possibility of short-circuiting.
2. Dangerous articles, such as explosives of any variety including fireworks, inflammable materials such as oil, grease, ghee, paint, dry grass, and leaves of any variety, etc., are prohibited to be carried by any person in the compartment.
3. Adequate space must be left between roof and the top layer of the packages loaded in the SLRs including the private parties/leaseholders.

Commercial staff:

1. Booking of explosives, dangerous, inflammable articles, empty gas cylinders, dry grass, and dry

leaves, etc., should not be booked as luggage in passenger carrying trains.

2. Dangerous articles, such as explosives of any variety including fireworks, inflammable materials such as oil, grease, ghee, paint, dry grass, and leaves of any variety, etc., are prohibited to be carried by any person in the compartment.
3. Commercial Supervisors to ensure that proper precautions are taken while stacking combustible material in Goods Shed/Commercial Plots. Surprise checks in Goods Shed like clubbing of commodities which may lead to chemical reactions, and passenger carrying trains for luggage / parcels in co-ordination with RPF in trains, stations and in Parcel Offices. Also ensure that these are stacked away from residential areas. Ensure that the Commercial plot holder takes all safety precautions as per the agreement. Also, ensure that the maximum height of combustible material stacked should not be more than 20 feet in height, adequate gap between stacks, etc.,
4. Parcel staff shall ensure that hamals (labour) shall not smoke or light a cigarette / beedi while loading/unloading parcels.
5. Motor vehicles offered for transport by rail, ensure that the petrol tank is empty.
6. Drought relief material, such as, paddy grass should be handled properly while loading/unloading in wagons so as not to be swept away by wind towards Diesel loco and cause loco catching fire.
7. Do not allot and allow VPUs to be used in lieu of kitchen cars in FTR specials.

8. TTEs: Manning the coaches shall keep a vigilant watch on passengers boarding / alighting trains that they are not carrying any kind of inflammable articles with them. Also keep a watch on any unclaimed baggage, if found take suitable action for disposal of the same.

Electrical staff:

1. Ensure all electrical connections are intact and there are no loose fittings in the coaches.
2. Do not allow battery boxes in open condition and also MS sheet covering is provided wherever required.
3. Ensure correct rated fuses/MCBs are provided in electrical circuits.
4. Ensure the availability of fire extinguishers in AC coaches.

TXR staff:

1. After arrival of trains at destination stations shall ensure that all the doors and windows are closed at the platforms and then taken for further maintenance.
2. Ensure full watering of all passenger coaches.
3. Ensure that ACP apparatus is functioning properly.
4. Similarly, before bringing the formation onto the platforms after maintenance shall ensure that all the doors and windows are in closed condition.
5. Also ensure that all the stabled coaches / spare coaches windows and doors are in closed condition.

Pantry car staff:

1. Chimneys and exhaust fans of Pantry Cars should be regularly cleaned to prevent choking with soot and over-heating.
2. Ensure the placement of gas cylinders in the gas

room only and they shall be properly clamped.
3. Electrical junction boxes should be covered.
4. Staff should be trained to use the fire extinguishers.
5. Specified number of fire extinguishers should be available in good condition.
6. Ensure no garbage is dumped in the vestibule pathway.
7. Ensure the availability of gas leak certification from the authorised agency at periodical intervals.

Security staff:

1. Ensure that the maximum height of combustible material stacked should not be more than 20 feet per stack.
2. Ensure the combustible material is stacked away from the residential areas.
3. Ensure that smoking is not taking place in banned locations.
4. Ensure that the labour and the hawkers are not cooking food using open oven / chullah / sigris.
5. Do not allow gas cylinders to be loaded in the passenger compartment.
6. Escorting RPF staff shall also look out for Passengers carrying inflammable articles along with them in trains and arrest such activities. They also require keeping a watch on unclaimed baggage on running trains.

25.9 Action Taken Against Fire in Trains

Necessity of Immediate Action

In case of fire on train, typical time available for rescue is a few minutes before smoke fills up and passengers start getting disoriented. Smoke (toxic/nontoxic) can cause suffocation and loss of consciousness in two minutes. Fire in personal clothing causes loss of consciousness in 10-15 seconds and Death or incapacitation (followed by death) can happen in

five minutes. A fire in train destroys the train carriage(s) completely in a few minutes.

In most of the cases, relief reaches a burning train after the carriages are completely burnt and passengers dead or badly burnt. Under such situation, role of on-board Railway officials becomes vital, and they should get into action to save the precious lives on priority. On-board officials who accompany trains need to react immediately to put-off / extinguish fire and rescue passengers / save the railway property.

All on-board Railway officials need to have basic knowledge on fire, firefighting methods, handling of Fire Extinguishers and operation of Fire Suppression system now being introduced in Coaches. They must be imparted hand on practice in the methods of rescue through various training programs.

In case of LHB rakes, coupling unlocking key may be provided to Train Manager and LP for detachment of coaches if required.

A Railway servant noticing a fire, likely to result in loss of life or cause damage to property, shall take all possible steps to save life and property, to prevent it from spreading and to extinguish it.

25.10 Instant Action Team

An instant action team comprising of all or some of the following personnel as available on the train may be immediately formed:

1. Train crew (Assistant Loco Pilot, Loco pilots, Train Manager).
2. Train Superintendent, TTEs and other commercial on-board staff.
3. AC Coach attendants/mechanics, Power Car staff, other electrical onboard staff.
4. TXR staff, On-board Housekeeping Staff (railway and / or contractor).
5. S&T on-board staff.
6. RPF/ GRP staff.
7. Pantry car (railway and / or contractor) staff.

8. On board Railway employees either on duty or on leave travelling as passengers.
9. Doctors travelling by the train.
10. Passengers travelling on the train who volunteer for rescue and relief work.
11. Railway staff working at site or available near the site of the fire incident.

All on-board staff including RPF/GRP/AC and Mechanical Staff including Contract staff needs to share the details with mobile number with TTE Batch in Charge and Train Manager for better coordination in case of any contingency. Similarly, Batch in charge mobile numbers may be shared with passengers through SMS.

25.11 Role of members of Instant Action Team

The members of instant action team should carry out the following task by distributing the work among them:

1. Do not panic.
2. Pull the Alarm Chain and stop the train immediately. Inform the Loco Pilot and Train Manager of the train.
3. Inform all concerned about the fire and seek their assistance in extinguishing the fire.
4. Do not wait for others to arrive or help to arrive. Start with rescue and fire controlling immediately.
5. Inform the local administration, local hospital and take help of local people, if available.
6. Report it to the nearest station/control/fire station. (fire services: 101, it can be dialled by mobile also), Disaster Helpline no.138 & Security Control no.182
7. Open emergency windows/break glasses for evacuation of the passengers.
8. Responsibility may be assigned to certain specific members of team for keeping the doorway and vestibules clear of obstructions.
9. Evacuate passengers to coaches which are away from fire through vestibules if fire is not extinguished. After complete evacuation, rolling shutters of coaches on fire to be closed to contain spread of fire to other coaches.
10. More people expire due to suffocation from smoke rather than due to actual burning.

During Fire, the poisonous gases such as Carbon Monoxide (CO), Carbon Di-oxide (CO2) etc. being lighter in weight circulates in the upper part of coach/space while oxygen is present in the lower part of the space. While running or walking, passengers may inhale poisonous gases quickly and thus resulting suffocation and asphyxiation. Passengers should be advised to crawl on the floor instead of running. They should also be advised to take a wet cloth and cover their nostrils. This reduces the smoke inhalation & subsequently its bad effects.

11. Insist that passengers should save themselves first and not to bother about their luggage which can be retrieved later on.
12. Advise passengers to remain calm and not panic.
13. Isolate the affected coaches/wagons from other coaches/wagons by decoupling both Mechanical & Electric couplers. Create and maintain adequate distance between the affected coach and other coaches so that fire does not spread to other coaches due to proximity.
14. Locate fire extinguishing equipment viz, fire extinguishers, water bucket with water/sand, etc. and use these to extinguish fire. Use water from coaches to extinguish fire.
15. Whenever alarm is triggered through Automatic Fire Detection system in coaches (Power car/ SLR, Pantry car & AC coaches) fitted with Fire Detection System (Manual/Automatic), extinguish fire as per the instructions pasted in coaches.
16. Try and put out the very source of the fire before it becomes a big blaze.
17. Turn off Electrical Appliances. In case of fire from electricity, switch off the source.
18. In case of the fire is discovered when the train is near the tank or a watering station, the Train Manager and Loco Pilot shall use their discretion to proceed there, but no such attempt shall be made until the portion of the train in rear of burning vehicle has been detached.
19. Provide wheel skids to prevent roll back of isolated coaches and train as well. Train shall be protected by Loco Pilot and Train Manager at both ends according to the provision of GR.
20. Loco Pilot to put flasher light of loco “ON” or make all possible efforts to attract attention of Loco Pilot of crossing train to stop his train and ask him for assistance.

25.12 When a Person is on Fire

1. Approach him holding the nearest available wrap in front of you.
2. Wrap it round him.
3. Lay him flat and smother the flames.

4. He may roll on the floor, smothering the flames.
5. On no account should he rush into the open air.
6. Call for assistance.

25.13 Handling of Injured Passengers

1. Building up confidence of injured passengers by suitable advice is of great importance.
2. First aid should be rendered to the injured passengers.
3. Ordinarily give nothing ORALLY to injured one, but if medical treatment is delayed more than 4 hours, give Oral Rehydration Solution (ORS) drinks preferably bio carbonated soda.
4. In serious case, remove the patient quickly to hospital as the injured may require an aesthetic, medical soothing.

25.14 General Safety Instructions and Roles of Various Stakeholders

Crew (Loco Pilot/Assistant Loco Pilot/ Co-Pilot/ Train Manager)

1. Stop the train immediately and switch on the flasher light after observing fire or on receiving intimation about fire. Arrange to stop the train coming from other direction so as to pool help to tackle fire.
2. In the event of fire in a tunnel or over a bridge, the LP/ALP will not stop the train in the tunnel or over the bridge as far as possible. The LP/ALP, however, should slow down the train while clearing the tunnel/bridge. The stopping distance in case of LHB rakes after Alarm Chain Pulling is less and the Loco Pilot has little scope of stopping beyond a tunnel or bridge in case of fire. In some cases, the railway bridges are not having any pathway. Thus, the Loco Pilot should apply his best judgment in case of handling such an eventuality while passing through a tunnel or bridge.
3. Loco Pilot & Train Manager will immediately inform the control directly by mobile telephone or talking to nearest Station Master on walkie-talkie about the incident of fire and preliminary details about the fire.
4. Train Manager and Loco Pilot will protect their train, as per provisions of GR & SR, secure the train to prevent rolling down and protection of adjacent line, if any.
5. Arrange for isolating the affected coaches from other coaches by decoupling both Mechanical & Electric couplers.

i) The vehicle behind the one on fire shall be detached and the front portion of the train moved forward so as to prevent the rear vehicles catching fire.
ii) As soon as the front portion of the train has moved forward a sufficient distance, to secure the desired object, the burning vehicle shall be detached and the vehicles in front of it shall then be moved forward to a safe distance.
iii) If required hand shunting may be carried out by taking help of passengers & railway staff travelling in the train.

6. Provide anti-rolling arrangements on isolated coaches and train as well by taking help of railway staff travelling in train & passengers.
7. Report it to the nearest station/control/fire station, Civil police, RPF/GRP Control post through mobile telephone.
8. Use available fire extinguishers, sand, loose earth, water, blankets etc. to extinguish the fire and help passengers trapped in fire.
9. Train Manager of the train to arrange stretcher and first-aid box for providing assistance to the injured passengers.
10. Render first aid to injured passengers, by obtaining assistance of the railway staff, doctors and/or volunteers on the help of ambulance service, means available.
11. If the fire cannot be controlled, inform the traction power controller through the emergency telephone or any other mode of communication to arrange the affected section of the over-head equipment to be made dead after isolating the affected coaches.
12. In case of fire in Freight train, in addition to action to be taken on relevant points above, the crew shall carry out the following:
    i) The train will be controlled immediately and brought to the nearest station/yard in the loop line or yard line in consultation with the nearest station & Section Controller.
    ii) The affected wagon or wagons shall be separated from the rest of the train.
    iii) Provide anti-rolling arrangement on the isolated wagons and train.
    iv) Train Manager and Loco Pilot shall try to extinguish the fire from nearby tank or water columns at stations.
    v) Train Manager of the train should lodge a FIR, if required.
13. In the event of fire on electric engine
    i) Loco Pilot shall immediately switch off the circuit breaker and lower

the pantograph as provided in GR&SR.

ii) The locomotive should be separated from the rest of the train after securing the train to avoid rolling down of the train. Anti-Rolling Arrangement should be provided in locomotive after moving adequate distance from rest of the train.

14. In the event of fire on EMU/MEMU, in addition to above mentioned action, following is also to be carried out.
    i) The train shall then be brought to a stop at once.
    ii) The Loco Pilot/Motorman shall immediately switch off the circuit and lower the pantograph.
    iii) The Train Manager shall give all possible assistance to the Loco Pilot in putting out the fire, isolate the other coaches from the affected coach and help the passengers.

Trains Superintendent/TTEs and other commercial staff

1. Pull the Alarm Chain and stop the train immediately. Inform the crew of the fire incident.
2. Observe any alarm or buzzer from smoke detectors provided in AC coaches. In case of any buzzer from smoke detectors, find out where smoke or fire is from.
3. Report to the Commercial Control immediately & also dial 101 to call fire service people by giving the location as Km No. & Train No. Also call 138 Helpline to arrange rescue & relief on war footing.
4. Use fire extinguishers available in coaches to extinguish fire or use water available in coaches.
5. Evacuate passengers to the adjacent coaches which are away from the fire through vestibules if fire is not extinguished. After complete evacuation, rolling shutters of coaches on fire to be closed with the help of available railway men and passengers to contain spread of fire.
6. Advise passengers to take a cloth, wet it in their drinking water and cover their nostrils. This reduces smoke inhalation and subsequently its bad effects.
7. Insist that passengers should save themselves first and not to bother about their valuables/luggage which can be retrieved later.
8. Take assistance of volunteers from passengers, travelling Railway employees, doctors on trains, on board contractor staff etc. in rescue operation.

9. Call the doctor after checking the charts & advise him about the passengers affected by fire.
10. Take the help of other railway staff including RPF and GRP and Samaritan passengers to help the doctor in providing first aid and other aid to the affected passengers.
11. Arrange stretcher and first aid box for the injured passengers.

Pantry Car Staff

1. In case of fire in pantry car
   i) Immediately pull chain to stop the train.
   ii) Inform TTEs etc of the fire incident and seek assistance.
   iii) Immediately switch off all electrical appliances and isolate them electrically.
   iv) Close all cooking gas appliances in the pantry and remove the gas cylinders into the open away from fire.
   v) Protect the inflammable material available at pantry car.
   vi) Extinguish fire by using fire extinguishers available at pantry.
2. In all other cases of fire, follow the instructions laid down above for instant action team.
3. Provide necessary assistance to TTEs and other staff in extinguishing the fire and extricating the trapped passengers.
4. Cooking in pantry should not be done unless specifically permitted.
5. Storage of gas cylinders in pantry cars should not be done unless specifically permitted.

C&W Staff and On-Board Housekeeping Staff

1. Open the doors of both sides of coaches.
2. Open Emergency Windows for Evacuation of the passengers.
3. Evacuate the passengers to the adjacent coaches which are away from the fire through the vestibules if the fire is not extinguished. After complete evacuation, close the rolling shutters of coaches on fire to contain the spread of fire.
4. Help the train crew in physically isolating/separating the affected coaches from the remaining train.
5. Follow the instructions laid down above for instant action team.
6. Provide necessary assistance to TTEs and other staff in extinguishing the fire and extricating the trapped passengers.

AC Coach Maintenance Staff

1. Immediately isolate the affected coach/coaches electrically.

2. Break the box and take out hammer to break glass panes of AC coaches so that fresh air flows in and smoke goes out.
3. Follow the instructions laid down above for instant action team.
4. Provide necessary assistance to TTEs and other staff in extinguishing the fire and extricating the trapped passengers.

Power Car Staff

1. In case of fire in power cars,
   i) Stop train by pulling alarm chain immediately.
   ii) Inform Train Manager / Loco Pilot / TTEs etc of the fire incident and seek their assistance.
   iii) Shut down the power car engines and disconnect power supply.
   iv) Use fire extinguishers and fire ball provided in engine room in case of fire in power car to extinguish fire.
   v) In case fire is not controlled, detach power car from the train in consultation with crew and Train Manager and taking help of Railway men and fellow passengers.
2. In all other cases of fire, follow the instructions laid down above for instant action team.
3. Provide necessary assistance to TTEs and other staff in extinguishing the fire and extricating the trapped passengers.
4. When alarm is triggered through Automatic Fire Detection System in Power Car fitted with Fire detection system, operation of Fire Suppression system must be ensured.

RPF/GRP

1. Pull alarm chain to stop the train.
2. Rush to the affected coach/coaches immediately and provide necessary assistance to TTEs and other staff in extinguishing the fire and extricating the trapped passengers.
3. Follow the instructions laid down above for instant action team.
4. In case doctor/doctors are available, necessary assistance will be provided to ease working of doctor.
5. Separate the area of incident by establishing temporary barriers and ensure that the on lookers and spectators do not enter the affected area to disturb the scene or hamper the rescue operations.
6. Baggage of passengers should be isolated and protected and should be taken care of, till they are handed over to claimants or taken over by Railway authorities.

7. RPF personnel should respond to any call for assistance to rescue victims and transport them to the nearest hospital.
8. Check, save and record the evidence/clues of the fire.
9. Help Train Manager in lodging of FIR.

Station Master at Station or Nearby Station of Fire Incident

1. Inform the nearest Fire Brigade office of the location of the incident and requisition their services.
2. Advice the Section Controller and/or TPC of the fire incident indicating the affected section and/or for OHE isolation.
3. Inform the local hospitals and requisition the services of the doctors and para medical staff as per the requirement.
4. Inform all officers and supervisors of all departments available at the station.
5. The controlling station master shall proceed to the site with staff of various departments to help in rescue and relief operations.
6. Station Master shall not allow any train to enter on the adjacent track of the affected section.
7. After clearance of affected train from the section, advice Section Controller.
8. On receipt of advice from Section Controller allow the train service on the section on releasing the emergency power block and OHE power is switched on in the section.

Section Controllers

1. Section Controller, on receipt of fire incident, shall advice adjacent stations/station master's to regulate the train services in the affected section.
2. Depending on the requirement, order ART/ARME.
3. Immediately inform Traction Power Controller (TPC) to switch off OHE power supply in the affected section, if required.
4. In case of fire in Freight train, train will be controlled immediately and brought to the nearest station/yard in the loop line or yard line in consultation with Dy. CHC/CHC.

Traction Power Controllers

1. The Traction power controller shall switch off the OHE power supply of both the lines of relevant affected section on the advice of Section Controller.
2. Advice Section Controller in writing that OHE power supply has been

switched-off in the affected section.
3. On advice of Section Controller, TPC shall switch-on the OHE power supply in the affected section.

Role of Dy. CHC/CHC

1. Inform the Fire Brigade office of the location of the incident and requisition their services.
2. Inform casualty of Divisional Hospital to inform Doctors.
3. Inform the local hospitals and requisition the services of the doctors and Para medical staff as per the requirement.
4. Promptly inform all the concerned officers.
5. Order ARME/ART immediately & arrange Diesel/Electric power accordingly with Crew & Train Manager.
6. Hooter to be sounded in the Divisional control and in the Loco shed.
7. Promptly inform C&W, Engineering, Loco, Commercial, Security, and TRD Controllers.
8. In case of fire to a passenger carrying train, Civil authorities should be promptly advised.
9. In case of fire in Freight train, that train will be controlled immediately and brought to the nearest station/yard in the loop line or yard line.
10. Fill the proforma about the accident as applicable and advise all concerned.

In the event of Fire Caused by Petrol or any other Inflammable Liquids, Acids, Gases, Explosives, Dangerous Goods etc.

1. Segregate the affected wagon, coach or area involved.
2. On opening a coach/wagon do not enter it immediately to escape fumes, which may be dangerous. Allow the fumes to let away from the affected area.
3. In case of fire due to LPG tank wagon, close the valves to isolate LPG feed or by other suitable controls.
4. If you smell gas or vapour, hold a wet cloth loosely over your nose and mouth and breathe through it in as normal as possible.
5. Use DCP/Foam type fire extinguishers and sand to extinguish gas or oil fire.
6. Do not use water or soda acid type fire extinguishers.
7. Do not bring burning object near the site of fire.
8. Warn the people living in the surrounding area.
9. Stay away from ends of tanks, as tanks normally burst from the ends.

10. Cool tanks that are exposed to flames with water from the sides only after the fire is put out.
11. Withdraw immediately in case of rising sound from venting safety device or any discoloration of tank due to fire.
12. Inform the nearest Railway or Civil Fire Stations intimating that the fire has been caused by Petrol or any other inflammable liquids, acids or gases.
13. In case of fire from cylinders, following steps shall be taken if no undue risk is involved:
    i) Move unheated cylinders to a safe place after ensuring closing of valves.
    ii) Cool the hot cylinders by spraying water from a safe position. The person directing the spray should take up a position where he would be protected from possible explosion.
    iii) If the cylinder containing inflammable/toxic gas which develops leak during transport, remove it to an isolated open place away from any source of ignition and advice the filler or consignor as required.
    iv) Inform the Chief Controller of Explosives by fax/ telephone.
    v) Inform Officer in charge of nearest police station.

25.15 Fire Risk Management and Safety Review

25.15.1 Safety Drive & Campaigns

Safety Drives and Campaigns must be launched at periodic intervals to thoroughly examine all fire safety measures to eliminate any potential fire hazard.

25.15.2 Safety Audit and Inspections

For ensuring implementation of prescribed rules and guidelines for safe operation of trains and fire safety, audits and inspections are conducted by Zonal Railways on periodic intervals. The basic purpose of these audits and inspections is to identify weak areas in asset maintenance as checking fire buckets, fire extinguishers, automatic fire alarms etc., safety procedures and systemic defects and to provide ways and means to prevent fire.

25.15.3 Training, Mock drill exercises and Counselling of Railway Officials.

All on-board officials of all departments including crew and Train Managers whether departmental or contractual may be given basic training in firefighting and use of various firefighting on-board equipment. Training to TTEs in the use of fire extinguishers at station level organized by Station Manager once in a year may be ensured. For Train Managers, training should be given for use of fire extinguishers during refresher course once in three years. Basic training in rescue operations may also be provided to such officials. Mock drills may be conducted for checking the preparedness of ARMVs/ARTs as well as concerned staff.

25.15.4 Fire and Hospital Directory

Every station should have the contact details of local or nearby Fire Stations and hospitals. In case of Fire emergency, station staff should inform Local Fire Stations immediately for necessary help. Hospitals may also be informed as per the need for necessary help. For this purpose, every Zone / Division may prepare a directory of authorized personnel and contact numbers of local area fire stations and hospitals. It may also be circulated to running staff and escorting staff of trains.

Board has desired that there should be detailed investigation into Train Accidents on account of Fire. A Committee was nominated by the Board with Adviser (Safety) as Coordinator, and EDME(Coaching), EDEE (Dev.) and IG/RPSF as members, to suggest ways and means for conducting conclusive enquiry of train accidents due to fire. The recommendations of the Committee have been accepted by the DG/RPF and the Board.

Following instructions are issued for necessary compliance:

i. In Train Accidents involving Fire, the Safety Organization will take the assistance of trained RPF officers/Inspectors in conduct of Accident Enquiries. The nominated RPF personnel would

associate with the Safety Deptt. in conducting enquiries into Train Accidents involving Fire and other matters.

ii. A skeletal Fire Wing needs to be nominated within the RPF deptt. on the Divisions to provide the required expertise in Train Accident Enquiries. One IPF and SIPF (Fire) each will be earmarked on every Division with immediate effect who will provide this expertise. The nominated IPF/SIPF (Fire) shall be given training in Fire Safety as early as possible. The names of such trained RPF staff (IPF and SIPF) will be maintained in the Security Control of the Divisions so that they can be contacted at short notice and rushed to the site of mishap in times of need.

iii. One nominated ASC/Headquarter on each Zonal Railway will coordinate the Training and other issues of the IPF and SIPF (Fire). He will also coordinate with the different Training Institutes to ensure that training on fire is imparted to the nominated IPF and SIPF (Fire) on the Divisions.

iv. An Electrical Officer may be nominated as part of Inquiry Committee investigating the cause of fire provided there is a doubt or possibility of Electrical Short Circuit or where the prima-facie cause is not known, especially for Fire in Passenger carrying trains. He should also be trained along with officials of RPF at Fire Training School, Nagpur.

v. Responsibility to provide suitable fire safety systems on stationary and rolling installations will lie with the respective infrastructure departments. Training of staff of the executive deptts. (Frontline Staff) regarding fire must be ensured by the concerned deptts.

The above instructions regarding RPF providing expertise in train accidents enquires should be implemented with immediate effect. Fire Training of the nominated RPF Supervisory Staff of the Divisions may also be initiated as early as possible. Augmentation in manpower strength and creation of additional posts, where

required on need basis, shall be processed separately by RPF Department.

This issues with the approval of the Board (MT, ME, MM, ML, MS, CRB).

Reference: Letter no. 2009/Safety (A&R)/14/1 dated 07.08.2009 is issued and signed by J.S. Bindral, Jt. Director Safety-II.

FIRE PREVENTION
ELECTRICAL LOCO FAILURES

26

26.1 Transformer, Tap changer, CGR/RGR:

Transformer:

1. DGA of transformer and GR oil should be carried out as per RDSO SMI No. 138 during every IC schedule. All the Electric Loco Sheds & Workshops should have minimum two DGA plants in working order. DGA plants should be covered by an AMC and calibration should be done on daily basis with standard gases as recommended by OEM. Transformer no wise records of DGA should be computerized and maintained. Special watch should be kept on the transformers who have completed more than 12 years in service.
2. Break down value of the transformer oil and GR oil should be checked as per IS:6792/1992 during every IC. All the sheds and workshops should have minimum two BDV testing machine which should be calibrated every 6 months.
3. The centrifuging of transformer oil and GR oil should be done during every AOH besides during changing of transformer and GR.
4. The centrifuging of the transformer oil should do as per RDSO's guidelines and IS-1866-2000. The cold centrifuging for a minimum of 4 hours must be done before the switching on the heaters of the

centrifuging plant. During centrifuging, the filters of the plant should be changed as and when required, preferably after 4-6 months. All sheds should have a minimum of 2 centrifuging plant of the capacity of 3000 LPH or more. Sheds and workshops should maintain these plants in perfect working order and should cover them by AMC.

5. During POH of locomotives, core of the transformer should be lifted for cleaning, checking, tightness of pressure bolts, gasket changing etc. Also, the transformers who have completed 18 years or likely to be completing 18 years of life in service should be thoroughly checked during POH by the workshops and their rehabilitation should be planned as per the recommendations of the committee on codal life of the equipment. RDSO's guidelines and Railway Board's instructions for carrying out rehabilitation work on transformers by the workshops or from outside agencies should be followed. Gaskets in different locations of sources approved by RDSO should only be used. The cleats in GR and TFP neck portion should be of SRBGF from sources approved by CLW.
6. **PHGR:** All the PHGR should be modified so as to avoid stucking up of the PHGR during service.
   a) The working of PHGR should be ensured during every inspection, trip inspection or testing of locomotive. The same should be recorded in logbook if it stops working. All the operating staff should be counselled.
   b) If the locomotive is to be attended after PHGR has stopped working for some time or PHGR is not found working, in this case the oil accumulated in the pipeline of PHGR should be flushed and cleaned with new oil that accumulated dirt and other impurities do not enter into the GR oil.
7. **GR:** The maintenance of GR should be done as per RDSO's guidelines which are as under -
   a) Materials are procured from RDSO approved sources only. Replacement of material should strictly be in terms of AOH/IOH kits by sheds and POH kits by the workshops during POH, this

will be in addition to other parts required to be replaced as and when required.

b) The items of one GR components should not be intermixed with other GR. There should not be any piecemeal replacement of items,

c) GR should be opened for thorough checking, flushing with oil after every 6 months. Records for this GR-tap checking and replacement of items should also be kept, maintaining the history of individual GR by sheds.

d) Oil discharge duct on tap changer should be removed and canopy arrangement should be adopted and ensured as per RDSO's Modification Sheet no. WAM4/187.

e) Flexible connections in between CGR and GR in place of soild connection

f) should be adopted as per RDSO's Modification Sheet no. WAM4/136. Struts should be provided between RGR and CGR as per RDSO's Modification Sheet No. WAM4/152.

g) Checking of transformer and GR safety valves should be done whenever GR cover is opened, or transformer is taken out for maintenance. The availability of through and through drainpipe from transformer safety valve to the end gear of the locomotive must be ensured during AOH/IOH by the sheds.

h) The filling up and topping up of the oil in GR should invariably be done directly from centrifuging plant (not manually by carrying in container).

8. **CGR/RGR**

a) CGR/archutes with modified catch assembly should only be used. This is as per RDSO's Modification Sheet No. WAM4/45

b) Gap between CGR contacts should be maintained as specified and CGR contact tips should always be replaced whenever, it is necessary. This is essential to minimize the arching in CGR.

c) The condition of CGR archutes should be thoroughly checked during AOH/JIOH/POH and should be replaced, if required.

Important Dos and Don'ts:

Dos

1. Calibration of DGA plant by a standard gas on daily basis.
2. Cold filtration of transformer oil for minimum 4 hours.
3. Maintain GR as per OEM's recommendation
4. Use RDSO approved items for GR and follow the replacement in kits
5. Check the operation of the safety valve of transformer.
6. Closely monitor the DGA of old transformer.
7. Thorough checking of transformer and GR in case of loco tripping through QLM only.
8. Oil fills up through filtration plant only.
9. Maintain the oil level in winter and summer season, as stipulated.

Don'ts

1. Don't conduct DGA for more than twice without calibration.
2. Don't switch on the heater just at the beginning of oil filtration.
3. Don't have piecemeal replacement of items during AOH/IOH/POH.
4. Don't carry out patch repair on vita components like contact plate and do not use items from un-approved sources.
5. Don't block the movement of safety valve.
6. Don't allow transformers to have abnormal gas contents for service.
7. Don't allow transformer/GR without thorough checking and working of QLM circuits.
8. Don't allow filling up of oil by carrying in container in sheds or a trip inspection point.
9. Don't allow transformer/GR with above 20 °C or below - 20 °C mark of oil in service.

26.2 Cables:

1. Re-cabling of locomotives having Elastomeric cables should be done after 18 years i.e. during Mid Term Rehabilitation of locomotive or second POH in freight locomotives, third POH of coaching locomotive.
2. Use of electrometric cable and thin-walled cables should strictly be as per RDSO's specifications only.

3. While laying out or replacing the power, auxiliary and control cables shall bend are to be avoided.
    a. Use of neoprene base rubber insulated sheets should be extensively used for protection of cables against mechanical damage at bends or at the critical locations where there are chances of cables coming into contact with shall edges of locomotive metallic part.
4. All the cable cleats should be of SRBGF (IS: 10192 UP1 grade) and procured from CLW approved sources only. The drawing of CLW/Chittaranjan should be used as standard for WAG7 and WAP4 class of locomotives. However, for WAM4 & WAG5 class of locomotives drawings of ELW/Bhusawal should be followed. In no case use of wooden cleats, wooden supports or any other wooden or Bakelite material should be used in the vicinity of the power/auxiliary/control cables.
5. All cable cleats must be checked for presence of positive gap in full tight condition.
6. All the cable lugs and ferrules must be of the sizes, which is suitable for a particular size of cable only. Availability of all the sizes of cable lugs and ferrules must be ensured by the sheds and workshops so as to eliminate the use of wrong size of cable lugs, even by mistake or otherwise.
7. Lying out of the cables should be such that power, auxiliary and control cables should not get mixed. This is to be ensured by CLW and POH shops during MTR/POH
8. PVC cable bunching ties should be used as wrapping straps for securing the control and auxiliary cables.
9. Polyolefin heat shrinkable sleeves should only be used to cover the bare portion of cable and part of the cable lug/ferrule on power as well as auxiliary cables.
    a. On the edges of cable lugs/ferrule and the heat shrinkable sleeves, the use of self-fuse fire retardant insulating tape should

be used to avoid ingress of dust, dirt & moisture (details of the tape would be given by RDSO).

10. During the major schedules i.e. AOH/IOH/POH, all the holes through which the cables pass, should be checked for sharp edges, burrs and availability of proper size of grommets should be ensured in proper condition.
11. In no case the joining of the cables should be permitted even for emergency operations for short duration. The cable lay out should be in one piece and with end to end having proper lugs.
12. The ferrule of traction motor connection cables should be checked during every disconnection of traction motor in locomotive i.e. during every lifting. The replacement of ferrules should be strictly as per the size of cables since presently, 240 mm sq, 270 mm sq and 300 mm. sq of power cables are under use as traction motor power cables.
    a. The traction motor cable ferrules size is also to match with the size of cable connectors (PG clamps) so as to avoid any looseness of the connection in junction box or flash over. Also, to avoid cables coming out of the clamp.
13. Proper care should be given so that traction motor cable is not under tension Proper supporting cleats with chain arrangement with the body must ensure during maintenance of locomotives.
14. Use of 10 sq.mm cables from HBA to HOBA cables in place of 3 sq.mm cable
15. Sharing of current among the cables going from transformer secondary bushing (A3 & A4) to rectifier i.e. 4 nos. each is not equal. Out of these four cables, on cable is drawing nearly 40% of the total current. Thus, overloaded and prop to pre-mature failure. Hence, these 8 cables going from transformer to rectified should be checked for their condition. If the condition is found to be bad is overheating mark or insulation getting brittle or otherwise should be change as and when noticed. This problem is more severe in V/AP4 and WAG7 class electric locomotives. During POH/IOH/AOH all the

locomotives cable lay o should be changed as per RDSO's SMI - 0231 date-20.01.06.

16. The cable cleats which are not to be opened or loosened during routine maintenance should be opened for cleaning and replaced with SRBGF with the provision of additional neoprene rubber sheet during IOH & POH of the locomotive.

Important DOs & DON'Ts for Cables:

Do's

1. Always use proper size of cables, cable lugs and ferrules.
2. Always use proper crimping tools and ensure their calibration for proper crimping force annually.
3. Always use SRBGF cable cleats.
4. Proper cable bunching with numbering and layout should be ensured.
5. Cable layout should be smooth at bends and corners.
6. Proper use of heat shrinkable sleeve and fire-retardant tapes at edges or the cable where conductor is exposed.

Don'ts

1. Don't adopt short cut in cable material not available or otherwise.
2. Don't use improper crimping tool or defective crimping tools.
3. Don't use wooden cleats or a wooden material in the locomotive.
4. Don't intermix the power/auxiliary and control cables.
5. Don't keep power/auxiliary cable under tension.
6. Don't cut/remove the cable insulation unnecessarily or cut the cable strands to fit into an improper size lug or ferrule.

26.3 Smoothing Reactor:

1. Repair and maintenance of the smoothing reactors should be carried out as per RDSO Modification Sheet No. WAG5/15. As per the modification sheet the gaps between core and inner coil and gap between outer coil and inner coil should be maintained, besides the other routine maintenance practices.
2. Terminal checking and modification on terminals of SL should be done as per RDSO's Modification Sheet No. WAM4/147.

3. Use of the materials specially SRBGF wedges, sheets, stainless steel cross channels and pressing bolts should be used. This is as per TC No. 42 issued by RDSO.
4. SL cover should be opened during every IC and blowing of SL should be done for removal of dust and dirt.
5. During IOH/POH of locomotive SL should be taken out for cleaning, baking and varnishing and check the condition of insulation specially at the corners.
6. All the SL30 should be checked for gaps between inner coil and core and outer coil and inner coil as per Modification Sheet No. WAG5/15. If gaps are not within the permissible limit, specially between core and inner coil, the SL should be taken out for repairs. This is very much essential for proper cooling of SL.
7. Whenever SLs are repaired, rehabilitated or manufactured as new all the above ARDSO guidelines should be taken care of.
8. All the cable connections of SL should be thoroughly checked during IC inspection and during AOH of locomotive by sheds.

Important Dos and Don't for SL:

Dos

1. To ensure proper cooling of SL. The SL cover should be intact.
2. Check the SL for proper gaps at corners.
3. Repairs should be as per RDSO's guidelines

Don'ts

1. Don't allow loose SL cover and cover with holes, in service.
2. Never allow an SL with almost zero gap between core & inner coil and inner coil and outer coil, in service.
3. Don't employ non-standard maintenance/repair practices.

26.4 Relays & Circuits:

1. All the QLM relays having mechanical locking arrangement should only be used.
2. In general, QLM relay should not be dismantled during overhauling or testing. Only the measurement of contact gaps and pressure of fixed and mobile tip contact should be done. For this OEMs guideline should be followed.

3. QLM relays should be taken out from locomotive during AOH for testing a setting on test bench. During setting, following cares should be taken-
   a) Relay should be set only after 20 to 25 pick-up and drop out operation.
   b) After setting the dial should be checked which may show the different current setting from the actual. The same should be written on the relay.
   c) As per practice in vogue, the sealing of QLM relay has to be ensured during every inspection trip checking of locomotive. The breakage of the seal is to be reported by the drivers.
4. Thorough investigation of locomotive should be done for the cases having QL dropped with any apparent reason. No locomotive should be allowed without proper trouble shooting and fact finding.
5. Besides the QLM's appropriate setting, the operation of another protective relay should be ensured. RDSO SMI No. 0238 dated 20.03.2006 should be follower
6. The continuity of the QLM circuits from TFILM to QLM should be checked during every inspection i.e. IA, IB & IC or whenever center hood is disconnected for maintenance purposes.
7. The CT ratio of TFILM should be checked on proper test bench during IOH locomotive. However, sheds are advised to have a drive for one round of the checking and keep the record of the same immediately. CTs with more than 5% of the ratio error should be discarded.
8. The rating of CCPT fuse should be reduced to 10 amp from 16 amp.
9. All the fuse in the control circuit should be of appropriate and specified rating only.
10. During AOH/IOH of locomotive the condition of fuse base and their connection should be checked. During POH, the fuse base should be replaced by 100% irrespective of their conditions.
11. The condition of air flow relays must be ensued during every inspection. Including the trip inspection. No locomotive should be

allowed in service with a flow relay isolated except for a very short run and with a continuous watch b the crew on the associated machine.

12. Use of flap type air flow relays should be discontinued and RDSO instruction and approved sources for air flow relays should be used.
13. Procurement of spares for all the relays should be from OEMs except the same items as relay covers and fasteners.
14. Transformer earthing connection (A0) with the locomotive body must be ensured whenever transformer is lifted and fitted back. Even sheds may ensure this connection during every inspection of locomotive visually.
15. Provision of HRC fuse in RPS circuit must be done as per RDSO's Modification sheet No. WAM4/201.
16. The separation of Q20 terminals on BA3 panel should be done by a thin glass fibre separator. This is to avoid shortening of terminals due to creep-age since there is a potential difference of 750 V between these two terminals.
17. Q44 and Q118 relays should be checked for their timings in test bench during every inspection of locomotive. With the adoption relays with electronic timer. complete replacement of timer unit should be done in lieu of going into the patch repairing work. The timer should be replaced by 100% during POH of locomotive irrespective of its condition.
18. All relays should be provided with proper relay covers having sealing gasket to avoid ingressing of dist/dirt and moisture.
19. All relay foundation should be thoroughly checked during every inspection of locomotive by the sheds.
20. Special attention to be given to the relay base of Q45 relay to ensure proper clearance between 415 V and 110 V connection to avoid any flash over between them.

Important Do's and Don'ts for Relays & Circuits:

Do's

1. Relays must be checked on test benches as per schedule.

2. Calibration of test benches meters should be ensured periodically.
3. Use proper gauges, tools for measurement and adjustment of contact gaps, contact pressure & dial setting.
4. The relay room should be dust free.

Don'ts

1. Don't try to adjust the relays setting without test benches.
2. Don't set the relays with the use of uncalibrated meters on test benches.
3. Don't use tools, gauges which may lead to damage to the relay parts.
4. Don't open relays and repair anywhere.
5. Don't use materials from unapproved sources.

26.5 Operational System:

1. During multiple unit (MU) operation LSOL circuit should be maintained in proper afunctional order. In all the locomotives it should be commissioned.
    a. During multiple loco operation, it should be ensured that LSGR glowing for leading and trailing locomotives should be made independent i.e. in case of GR get stuck up on ½ notch or at any notch. The signal to the driver should come independently for each locomotive. This will only ensure and will not give misleading information about GR position whenever driver goes to trailing locomotive for trouble shooting. In the case of tripping of only trailing locomotives, for this purpose, it is recommended to remove wire no. C16 (21 from driver's desk SB) from the multiple jumper connection of all the locomotives nominated for multiple operation.
2. The QPDJ bypassing arrangement should be isolated in all the locomotives to ensure operation of DJ with adequate air pressure. This should be implemented as per RDSO Modification Sheet No. WAM4/206.
3. Movement of Dead Locomotive:

26.6 BA/TK panel (EPM contactors, CTF reversors)

1. The separation of phases in TK panel with a provision of glass fibre separator should be ensured as per RDSO Modification Sheet No. WAM4/43. Separator should not be of either bakelite or of any wooden material.
2. The maintenance and replacement of contact tips, testing of magnetic coil should be done as per maintenance schedule. The contact pressure should be measured and maintained during every inspection of locomotives.
    a. As far as possible, the replacement of tips should be in pairs only.
3. Proper placement fastening of archutes have to be ensured for all E contactors to avoid flash over. The replacement of archutes should be ensure as and when required.
4. All the scheduled maintenance practices for EP contactors i.e. contact pressure contact gap, proper condition of fixed and moving contact tips should be ensured during every inspection of locomotive. The traction motor line contactors tips should be replaced during AOH/IOH/POH of the locomotive be sheds and workshops.
5. The condition of reverser drum fixed, and mobile contacts pressure a matching of contacts must be ensured during every inspection of locomotive All low-capacity reversers to be upgraded to 1500 Amp.
6. The condition of flexible shunt should be checked for EP/EM contactors and reverser during every inspection of locomotives, and they should replace immediately as and when required to avoid flash overs.

26.7 General (Locomotive body):

1. Locomotive body:

a. Cleaning of side body filter with pressurized water jet and air blowing must be done during every inspection of locomotives. The condition of side body filters should be

maintained, and replacement should be planned as and when required. 100% replacement of side body filter should be done during POH of locomotive by the workshops.

b. All locomotives opening at the cable entry points or otherwise must be blocked by suitable rubber materials.

c. All the drainpipes meant for draining out of excess compressor oil, transformer oil should be maintained in proper condition and checked during every inspection of locomotives. The position of drainpipe and its replacement should be done during every POH of locomotive by the workshops.

2. Water leakage:

a. All roof gaskets must be changed during POH & IOH of the locomotives. Condition must be checked during AOH of the locomotive also and same should be replaced, if found necessary.

b. The rubber gasket for central hood should be checked thoroughly with respect to its condition as well as proper placement during removal of central hood along with DJ/VCB.

c. All sheds and workshops should have water leakage testing facilities minimum at two locations i.e. on each side of Electric Loco Sheds for water leakage testing.

d. All pre-monsoon/rainy season precautions must be taken by loco sheds and workshops two months prior to the monsoon season so that all locomotives attended before the monsoon.

e. All apertures and opening from doors, sky light glasses should be blocked by proper fitment of rubber gasket and sealing compound by the sheds and workshops.

f. All traction motor should be checked for any ingressing of CP/P oil during every inspection. Immediate attention should be given.

g. Proper securing of footplates in corridors and HT compartment area must be ensured with all fasteners intact lest there would be physical damage to control or other cables coming into contact with the loose metallic footplates. This should be ensured by Loco Sheds after each and every opening of footplates during routine inspection, checking or otherwise.

26.8 Important instructions to the crew:

1. Wedging of Q44 relay should be strictly prohibited.
2. Wedging of Q118 relay should also be prohibited or can be permitted under driver's observation to work up to nearest loco shed or trip shed.
3. During every testing of locomotive proper working of Q46 relay and its circuit must be ensured.
4. In case of QOP dropping following instruction must be followed-
   (a) Locomotive should be taken for thorough investigation and checking to the nearest loco sheds if any traction motor is isolated by the driver on-line.
   (b) The working of locomotive with HQOP at off position should be restricted to the nearest trip checking point or loco changing point, preferably the working of train for one or two block section should only be permitted.
   (c) During working with HQOP at OFF position driver should be advised to have constant watch in HT compartment, rectifier and BA panel area and he should more frequently look back for any smoke emission from traction motor. This is essentially required to avoid unnecessary damage done to the traction motor besides the chance of fire from traction motors or cables.
5. Driver should be advised to check the relay panel for dropping of any relay in case of DJ tripping, even when the tripping has happened due to no tension.

6. Driver should check the relay targets of trailing locomotive, physically in case the tripping of trailing loco whatever may be the reasons.
7. The working of locomotive with MVRH isolated should be prohibited or restricted to clear maximum one or two block sections.
8. Driver should closely monitor of all the blower motors if corresponding air flow relay is isolated. The same should be done at the nearest trip inspection point or Electric Loco Shed.
9. Driver should not bypass/isolate any control circuits by carrying out tampering or shorting of control fuses.
10. Drivers, Loco Inspectors and maintenance staff should be given training for swift and correct operation of fire extinguishers. A planned activity to this effect must be included in a refresher course with the help of the demonstration and allowing the running staff to physically handle the fire extinguisher.
11. All drivers should be thoroughly and specifically trained for correct and precise operation of manual drive of GR. The driver's understanding of its functions should be frequently checked.

Important Do's and Don'ts for important operational instructions to the crew

Do's

1. All protective (DI/DU) relays should be in service with proper calibration
2. The fire prevention guidelines should be an integral of all the training/refresher course
3. Crew should be practically trained for proper use of fire extinguishers

Don'ts

1. Don't allow locomotive even for testing in sheds with any protective circuit isolated.
2. Don't advise any shortcut methods to the crew.
3. Don't allow any locomotive with less than 4 fire extinguishers in

perfect condition.

26.9 Rectifier:

1. The checking and testing of AC/DC RC networks should be done as per RDSO'S SMI No. 230 of May 04.
2. The condition of capacitors, especially at the terminals, should be closely checked during every inspection of locomotive against any symptom of loose connection or terminal is loose. The capacitors should be replaced immediately if they develop signs of bulging, flashing etc.
3. Proper indicating fuses of rectifiers should be used. In no case shorting by wires in lieu of fuse should be allowed.
4. The failed device of the rectifiers must be immediately changed.
5. The working of locomotive bypassing the QVSI must be prohibited.

Important Do's and Don'ts for Rectifier:

Do's

1. Replace immediately the failed device.
2. Check and replace the defective capacitor.
3. Use proper fuses.

Don'ts

1. Don't allow the locomotives with one device in failed condition
2. Don't allow deformed/flashed capacitor is service.
3. Don't use shorting wires in lieu of fuse.

26.10 Auxiliary motors:

1. All auxiliary motors should be provided with epoxy glass terminal boards as per RDSO guidelines.
2. All auxiliary motors must be provided with proper terminal covers with proper fastening and sealing with rubber gaskets.
3. The condition of cable lugs and cables must be checked against cutting of strands or lug getting loose during every inspection as well as changing of auxiliary machine.

4. The rotation of MPH, MVSL, MVRH & MVSI should be carefully checked and ensured whenever the auxiliary machines are changed or disconnected.
5. Even a slight oil leakage from MPH should not be permitted for long in service.
6. Extra care should be given for cleaning of MPH area during all the inspection of locomotive and whenever, MPH is changed.
7. All auxiliary machines including ARNO should be closely watched by maintenance and running staff against any abnormal sound which may lead to generation of heat, spark or smoke emission.

26.11 Compressors / Exhausters:

1. Compressors are to be maintained as per OEMs recommendations.
2. The replacement of spares during overhauling or otherwise should be in the form of a kit, especially for HP & LP valves to avoid throwing of excess oil and leakage.
3. The provision of removable type CP tray should be done in all locomotives during POH & IOH of loco to permit underneath cleaning as per RDSO drawing no. SKEL-3918.
4. Use of oil and heat resistant hoses for compressor/exhauster delivery pipes should be used as per RDSO's Modification Sheet no. WAM4/137 and 130A.
5. During every inspection locomotive accumulation of oil should be watched under BA panel and suitable remedial measure must be taken.
6. The filling up/topping up of the oil should be done with the help of proper funnel by the shed and outstation staff too.

7. The provision of underslung compressors should be made as per Railway Board's letter No.2002/Elect. (TRS)/441/1 Pt. III dated 12.12.2005.

26.12 Traction Motors

1. The flash overs in traction motors can be minimized by taking care of the following important schedules/attention of items during overhauling as well as in routine maintenance -

   (a) V-cone cleaning of the armature should be done strictly in every IC schedule.
   (b) The condition of arching studs/horns should be closely monitored for their gaps and proper shape. The replacement of arching of studs to be done during overhauling, if there is a sign of flashing or deterioration in its shape.
   (c) As per practice in vogue, the use of anti-tracking varnish, cleaning of BHRR, proper spring tension of carbon brushes, proper use of carbon brushes etc. should not only be continued but needs close monitoring and keep proper records.
2. During overhauling of traction motor ovality checking during commutator turning, proper mica under cutting and proper champheuring of commutator should be done
3. The condition of inter-connecting leads, terminal board and insulators should be thoroughly checked for flash marks or any other abnormality during overhauling or during lifting of locomotive, before reconnection.
4. All the insulating materials, insulators and other such items should only be procured from approved sources.

26.13 Under frame and other equipments:

1. The under-frame brake rigging items should be kept in cleaned condition, specially, in the vicinity of brake blocks and wheels. There should not be accumulation of polythene items, paper and animal dung to avoid smoke emission due to likely sparks from brake blocks or otherwise.
2. Traction motor body, junction boxes also should be kept in cleaned condition in every inspection.
3. The removal of muck and foreign materials from the cable carrying duct junction box in the under frame of locomotive should be ensured during AOH IOH and during lifting of locomotive.
4. Checking of roof bars, its fixation arrangement of pantograph shunts should be checked during every inspection and replacement should be done, if required immediately.
5. Cleaning of panto foot insulators, roof line insulators, insulators of DJ/VCE lightening arrestor, bushing portion on the roof of the locomotive should be kept in cleaned condition during every inspection of locomotive. The accumulation of presence of any form of foreign material should be immediately attended.

26.14 Fire Fighting Arrangement:

a) Presently, the fire extinguisher of 05 kgs. Capacity DCP type are being used in each Locomotives with two nos. in each cab i.e. four nos, in each locomotive. The procurement and maintenance of DCP type fire extinguisher should be done as given below:-
    1. The procurement of DCP type fire extinguisher should be as per IS: 2171of 1995. (Specification for [portable fire extinguisher, dry powder (Cartridge type)

2. IS:307-1977 for carbon-dioxide.
3. IS:4947-1995 for gas cartridge for use in fire extinguishers.
4. IS:4308-1982 for dry powder for firefighting.

b) The maintenance and periodic checks on DCP type fire extinguishers should be as per IS: 2190 of 1992 (Code of Practice for selection installation & maintenance of portable fire extinguishers). The salient features of this are as per clause 10. 8 which deals with the quarterly checking, replacement of powder and its quality, checking of gas cartridge by weighment, checking of end fittings, life of fire extinguishers and sample checking.

However, the latest type of fire extinguishers type ABC &E with more user-friendly mechanism for operation as well as control of flow of powder with nil maintenance and pressure monitoring gauge can be used once their field trials are successful.

The fire detection and automatic fire fighting arrangement in Locomotives would also be tried with state of art technology and reliability.

ABOUT THE AUTHOR

27

Shri Hari Shankar Verma, author of this book, is an officer of the 1987 examination batch of Indian Railway Traffic Service. He joined IRITM as Director General on 22.05.2023. Shri Verma was born in Village Akori, Bairagarh, District Jalaun, Headquarter Orai. He completed school education at the village and a nearby village Ait, Post-office Ait and later moved to District Headquarter Orai for Graduation. Later he moved to Banaras Hindu University (BHU) for higher education. He did M.Sc. in Agriculture with a specialization in Mycology and Plant Pathology. He secured distinction in the final examination and set a record.

Shri Verma has supported his family from the young age of nine. He succeeded in the family business and became quite prominent as young businessman. Later, with a change of mind, he moved to Banaras for higher study. During student days, he was actively engaged in student politics and won several College and University elections.

He has cleared the Civil Service Examination, 1987, in first attempt and joined the Indian Railway Traffic Service on 25.08.1988 at Lal

Bahadar Shastri National Academy of Administration (LBSNAA), Mussoorie and later Railway Staff College [RSC, now National Academy of Indian Railway (NAIR)], Vadodara. He was initially allotted the Southern Railway as lien Railway and later the Railway lien changed to Western Railway.

He has been trained on Southern Railway, Western Railway and Central Railway. He had been given an initial posting at Jaipur, Western Railway (now North-Western Railway) as Assistant Commercial Superintendent, which later changed to Assistant Commercial Manager.

He had been posted on Central Railway as Divisional Operating Manager (DOM), Divisional Safety Officer (DSO), Jhansi Central Railway (now North Central Railway). On promotion to Junior Administrative Grade, he was posted as Principal Zonal Training Center (ZTC now ZRTI), Bhusawal, Central Railway. He has been Senior Divisional Operations Manager (Sr. DOM), Bhopal, Central Railway and later West Central Railway. He has also worked as Senior Divisional Safety Officer (Sr. DSO), Central Railway, Mumbai. On promotion to Senior Administrative Grade, he was posted as Chief Claim Officer (CCO), Chief Commercial Manager/ Freight Marketing (CCM/FM), Chief Passenger Traffic Manager (CPTM), Central Railway, Mumbai.

He has also worked as Additional Divisional Railway Manager (ADRM), Mumbai, Central Railway, Divisional Railway Manager/Salem/Southern Railway and Principal Chief Operations Manager (PCOM), South-Western Railway/ Hubballi. During his career spanning more than 35 years in the Railways, he has been decorated with several awards like Railway Minister award, General Manager award, Railway Minister's Silver Medal, and Certificate for promotion of Rajbhasha and a number of other awards and appreciation from seniors.



He is a pioneer in standardization and ISO certification in Operating Department. His efforts culminated in the ISO certification of ZTC, Bhusawal, which was the first ever for any training center in the country. Further, he also got ISO certification for the Divisional Control Office, Bhopal, Habib-Ganj railway station (now Rani Kamlapati Railway Station) and Habib-Ganj-Nizamuddin daily Express during his 5 years stint as Sr. DOM, Bhopal. Shri Verma excelled in each of his postings and achieved the highest targets of his time. As ADRM, Mumbai and later CPTM, he is credited with running of additional 278 daily suburban services in CR. He also started the first 15-car-rake on CR. It is noteworthy that all his achievements were marked by the maintenance of complete industrial peace.

As DRM, Salem he had been instrumental in easing traffic bottlenecks by way of yard remodelling, completion of long pending traffic facility works, restoration of Nilgiri Mountain Railway track, bridges and stations and infrastructural development of Salem Division Headquarter (as it was a newly created division).

During his tenure, Salem Division had received several Shields from the Zonal Headquarter.

As PCOM South-Western Railway, he had completed all long pending traffic facility works and facilitated doubling and construction of new lines. He achieved record performance in all operating parameters including highest ever loading, which was appreciated by MO&BD through a letter and a shield. He had been instrumental in making SWR the top performer amongst all Zonal Railways in Key Performance Indices (KPIs).

Over the last 13 months as DG IRITM, he has been instrumental in achieving quality in training and the standardization of the training process. **IRITM has been rated as 'Ati Utkrisht' (4 Stars)** as per the **National Standards for Civil Services Training Institutions** (NSCSTI) under the aegis of Capacity Building Commission of India (CBC). Chairman and CEO, Railway Board has personally appreciated his effort in this regard. Further, IRITM has also been awarded **ISO 21001, which is the latest Standard for Training Institute and named as Educational Organizations – Management System (EOMS)**.

He has written, designed and edited the reading material for first batch of Indian Railway Management Service (IRMS) probationary officers. Under his leadership, IRITM has been credited with conduction of training of first batch of as Indian Railway Management Service (IRMS) after Civil Service Examination, 2022. Following books has been authored or edited by him:

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