MAINTENANCE HANDBOOK

on

BONDING & EARTHING

for

25kV AC TRACTION SYSTEM

TARGET GROUP : TRD Maintenance Staff

CAMTECH/E/2008/BE/1.0

April 2009

Centre for Advanced Maintenance TECHnology

(A Unit of RDSO)

महाराजपुर, ग्वालियर – 474 005
Maharajpur, GWALIOR - 474 005
QUALITY POLICY

“To develop safe, modern and cost effective Railway Technology complying with Statutory and Regulatory requirements, through excellence in Research, Designs and Standards and Continual improvements in Quality Management System to cater to growing demand of passenger and freight traffic on the railways”. 
FOREWORD

Bonding and Earthing of rail plays a very important role in safe and reliable working of TRD installations.

This maintenance handbook contains general description, type of bonds, arrangement of bonding and earthing at different traction installations, Rules applicable to Permanent way staff, Rules for S&T installation, maintenance schedule, working procedure for Permanent way, TRD and S&T staff etc.

I am sure this handbook will prove to be very useful for our field personnel working in Traction Installations.

CAMTECH, Gwalior
Date:

S. C. Singhal
Executive Director
PREFACE

In 25 kV AC, 50Hz Single Phase Traction System bonding and earthing is very essential for overhead equipment and associated railway track. Provision of bonding and earthing at TSS, FP, SSP, ATs, S&T equipments etc. complete the return circuit and also ensures safety.

It is clarified that this handbook does not supersede any existing provisions laid down by RDSO or Railway Board. The handbook is for guidance only and it is not a statutory document.

I am sincerely thankful to officers and staff of the T.I. Directorate of RDSO/LKO for their valuable suggestions and comments. I am also thankful to all field personnel who helped us in preparing this handbook.

Technological up gradation & learning is a continuous process. Please feel free to write to us for any addition / modification in his handbook. We shall highly appreciate your contribution in this direction.

CAMTECH, Gwalior                      Jaideep
Date:                      Director Electrical
## CONTENTS

<table>
<thead>
<tr>
<th>Chapter No.</th>
<th>Description</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Foreword</strong></td>
<td>iii</td>
</tr>
<tr>
<td></td>
<td><strong>Preface</strong></td>
<td>iv</td>
</tr>
<tr>
<td></td>
<td><strong>Contents</strong></td>
<td>v</td>
</tr>
<tr>
<td></td>
<td><strong>Correction Slip</strong></td>
<td>vii</td>
</tr>
<tr>
<td>1.</td>
<td><strong>GENERAL DESCRIPTION</strong></td>
<td>01</td>
</tr>
<tr>
<td>1.1</td>
<td><strong>INTRODUCTION</strong></td>
<td>01</td>
</tr>
<tr>
<td>1.2</td>
<td><strong>TERMS AND DEFINITION</strong></td>
<td>02</td>
</tr>
<tr>
<td>1.3</td>
<td><strong>REQUIREMENT OF BOND CONNECTION</strong></td>
<td>03</td>
</tr>
<tr>
<td>2.</td>
<td><strong>BONDING AND EARTHING ARRANGEMENT</strong></td>
<td>05</td>
</tr>
<tr>
<td>2.1</td>
<td><strong>TYPES OF BOND</strong></td>
<td>05</td>
</tr>
<tr>
<td>2.2</td>
<td><strong>BONDING AND EARTHING ARRANGEMENTS</strong></td>
<td>08</td>
</tr>
<tr>
<td>3.</td>
<td><strong>WORK INSTRUCTIONS</strong></td>
<td>19</td>
</tr>
<tr>
<td>3.1</td>
<td><strong>APPLICABLE TO PERMANENT WAY STAFF</strong></td>
<td>19</td>
</tr>
<tr>
<td>3.2</td>
<td><strong>APPLICABLE TO S&amp;T INSTALLATION</strong></td>
<td>22</td>
</tr>
<tr>
<td>4.</td>
<td><strong>MAINTENANCE SCHEDULES</strong></td>
<td>24</td>
</tr>
<tr>
<td>4.1</td>
<td><strong>FOOT PATROLLING</strong></td>
<td>24</td>
</tr>
<tr>
<td>4.2</td>
<td><strong>HALF YEARLY SCHEDULE</strong></td>
<td>25</td>
</tr>
<tr>
<td>4.3</td>
<td><strong>ANNUAL MAINTENANCE</strong></td>
<td>25</td>
</tr>
<tr>
<td>4.4</td>
<td><strong>TOOLS REQUIRED</strong></td>
<td>25</td>
</tr>
<tr>
<td>5.</td>
<td><strong>DOs AND DON’Ts</strong></td>
<td>27</td>
</tr>
<tr>
<td>5.1</td>
<td><strong>DOs</strong></td>
<td>27</td>
</tr>
<tr>
<td>5.2</td>
<td><strong>DON’Ts</strong></td>
<td>29</td>
</tr>
<tr>
<td>Chapter No.</td>
<td>Description</td>
<td>Page No.</td>
</tr>
<tr>
<td>--------------</td>
<td>------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>ANNEXURE – A</td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>ANNEXURE – B</td>
<td></td>
<td>32</td>
</tr>
<tr>
<td>ANNEXURE – C</td>
<td></td>
<td>34</td>
</tr>
<tr>
<td>ANNEXURE – D</td>
<td></td>
<td>35</td>
</tr>
<tr>
<td>ANNEXURE – E</td>
<td></td>
<td>37</td>
</tr>
<tr>
<td>REFERENCE</td>
<td></td>
<td>38</td>
</tr>
</tbody>
</table>
ISSUE OF CORRECTION SLIP

The correction slips to be issued in future for this handbook will be numbered as follows:

CAMTECH/E/2008/BE/1.0/ C.S. # XX date---

Where “XX” is the serial number of the concerned correction slip (starting from 01 onwards).

CORRECTION SLIPS ISSUED

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Date of issue</th>
<th>Page no. and Item no. modified</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
1.1 INTRODUCTION

Bonding and Earthing is an essential part of the 25kV AC, Traction System. Bonding is a solid electrical connection between two or more conductors or non-current carrying metallic parts i.e. traction mast, structure, support and rails. Wherever, earthing is a solid electrical connection of an object to the earth electrode. Bonding of rail facilitates passage for the traction return current from rail to earth and vice-versa. The bonding and earthing of the system connects the earth leg of traction transformer at the TSS to the traction rail and buried rail. Bonding of rails spread of flow of return current into the earth and consequently reduces the voltage between rail and earth to ensure safety of personnel as well as provide low resistance path for traction return current and signaling current.

In 25kV AC, Traction System, the traction current is drawn from the contact wire of OHE by the electric rolling stock and the return current flows through traction rail to the earthed structures and to the buried rail by means of bonds. Maximum amount of the return current reaches to TSS/FP through the earth circuit and rest of the return current flows through traction rail to buried rail which is provided in front of TSS/FP.
1.2 TERMS & DEFINITIONS

1.2.1 Traction Rail

The rail running under the electrified section is called traction rail. It is properly earthed and provide path to the return current. It is not used for signaling purposes.

1.2.2 Wired Track

A track provided with 25kV AC, 50Hz overhead equipment is called wired track.

1.2.3 Short Direct Connection

The shortest possible length with minimum bonds required for making the close electric circuit is known as short direct connection.

1.2.4 Rail Length

A continuous length of rail with or without welded joints (no fish plate joints) is known as rail length.

1.2.5 Earth

An object is said to be ‘earthed’ when it is electrically connected to an earth electrode. The object is called solidly earthed when it is electrically connected to an earth electrode without intentional addition of resistance or impedance in the earth connection. The resistance of the earth electrode shall not exceed 10Ω.
1.2.6 Earth Electrode

A metal plate or pipe or any other good electrical conductor which connects general mass of the earth to the equipment.

1.3 REQUIREMENTS OF BOND CONNECTION

i. All types of bonds shall be of mild steel having cross sectional area not less than 200 sq mm.

ii. A structure bond shall be rigidly connected by means of galvanized steel fasteners to the traction rail and the metallic part of traction mast, structure and support.

iii. A rail bond shall be rigidly connected by means of galvanized steel fasteners longitudinally across the fish plate joints of the traction rail and the track circuited rail in a track circuited section except at the insulated joint of the track circuited rail.

iv. Where it is not possible to provide a rail bond a welded bond shall be used. The bond shall be connected to the rails by means of electric or gas welding.

v. A cross bond shall be rigidly connected by means of galvanized steel fasteners between two traction rail of a track or non-track circuited rail of an adjacent track.

vi. The bond for connecting return conductor to the traction rail and the buried rail shall normally be made of GI nuts and bolts along with spring washer and check nuts.
vii. The cross section of an earth wire used for bonding shall not be less than 50 sq mm copper equivalent. This bond is provided on traction masts, structures, supports and the metallic parts supporting the traction overhead equipment in a tunnel or in double rail track circuited section.

viii. In single track circuited sections equipped with the traction rail shall be bonded to ensure that

a. The A.C. voltage drop along its length is reduced to minimize the risk of A.C. voltage being applied to the track relays.

b. As low resistance path as possible is provided for traction return and signaling currents. Fish plate joints can not be relied upon for low resistance.

ix. In double rail track circuited sections both rails shall be longitudinally bonded to ensure a low resistance path for traction return and signaling currents and also distribute the return current more evenly in both the rails. Impedance bonds shall be installed at insulated joints to provide a continuous path for the traction return current.

x. In station or yards where a track is not wired for its entire length it shall be deemed to be wired for a distance of upto 50 mtrs beyond the traction mast at which the overhead equipment has been terminated. Rail bonds and one cross- bond shall be provided for a distance of upto 50 mtrs. beyond the last traction mast.

*****
CHAPTER 2

BONDING AND EARTHING ARRANGEMENTS

2.1 TYPE OF BONDS

The following type of bonds are being used in 25 kV AC electric traction systems.

2.1.1 Structure Bond

This type of bond connects the traction mast or structure to the rail by means of M.S. flat strip of size 40mm x 6mm as shown in fig 2.1

![Structure Bond Diagram]

2.1.2 Rail Bond

This bond connects rail joints across two consecutive lengths of rails. It is also called a longitudinal bond. It is made of M.S. flat strip of size 40mm x 6mm as shown in fig 2.2 on next page.
2.1.3 Cross Bond

This bond is provided between two rails of a track or two rails of an adjacent track. It is also called transverse bond. It is made of M.S. flat strip of size 40mm x 6 mm as shown in fig 2.3.

![Cross Bond Diagram]

Figure 2.3 Cross Bond

2.1.4 Impedance Bond

An impedance bond provides a low impedance path for the traction return current and a relatively high impedance path for signaling current as shown in fig 2.4 on next page. It is installed by the signal department.
2.1.5 Earth Wire

It is used in double rail track circuited areas. In tunnels, earth wire run on traction mast/structure or metallic parts supporting OHE. It shall be electrically discontinued into sections if wire length exceeds 1000 mtrs. as shown in fig 2.5. At the mean point of sub-section, the earth wire shall be connected to two adjacent supports to 10 ohm earths. Nominal cross section of earth wire shall be 50 sq mm copper equivalent.
2.2 BONDING AND EARTHING ARRANGEMENTS

At different traction installations the bonding and earthing is provided in various configurations as per the requirement of the system. Important arrangements and their types are described below:

2.2.1 Bonding of Structure

This bond is provided to connect all non current carrying metallic parts of traction masts, structure, supports or metallic parts of concrete/ wooden masts to the traction rail or to earth wire. In case of a portal structure, only one leg of the portal shall be provided with the structure bond, whereas for head span masts each mast of the head span shall be bonded to the traction rail nearest to it.

The traction masts, structures and supports located on railway platforms to be bonded to the nearest traction rail. A cross bond shall also be provided at the location of the structure bond to connect the rail to the adjacent traction rail.

2.2.2 Bonding of Rails in a Weigh Bridge

Rail bonds shall be provided on both the rails of a wired track on a weigh bridge for a length of up to 50m on both sides of the weigh bridge. If the rails are on wooden or concrete sleepers/ supports, they shall be connected to a 10 ohm earth.
2.2.3 Bonding of Girder Bridge

i. Steel structures of a girder bridge shall be connected to a traction rail or to an earth by means two mild steel flat strip of size 40mm x 6mm each. The traction rails on the bridge may be two or more. These rails shall be connected by cross bonds at distance not exceeding 100m apart.

ii. In a single rail track circuited section the traction rail shall be provided with rail bonds not only over the entire length upto which the track circuited rail exists but also for a distance of 50m on both side of the track circuited length. In addition, the traction rail shall be cross bonded to the traction rails. If any of adjacent tracks whenever they exist at intervals of not less than 100m, the traction rails of such adjacent tracks shall also be provided with rail bond over the entire track circuited length and for a further 50m on both side. In case the length of a track circuited rail is not more than 350m, a cross bond shall be provided between the rails of the track immediately outside the track circuited length at both of its end.

2.2.4 Earthing of Metallic Parts inside a Tunnel

All non current carrying metallic parts of the overhead equipment running inside the tunnel shall be connected to earth wire. The earth wire shall be connected to an earth as well as to the traction rails at both ends just outside the tunnel.

If earth wire length exceeds 1000 mtrs. it shall be electrically discontinued into sections by providing a cut-
in-insulator so that no section of the earth wire is greater than 1000 mtrs electrically. Each such section of the earth wire shall be connected to an earth at two traction masts, structure or supports at distance not exceed 500 mtrs apart.

No cross bond shall be provided between the rails of same track or between the rails of different tracks in a double rail track circuited section.

2.2.5 Bonding of Over Line Structure

The metallic parts of foot or road over bridges or other over line structures over wired tracks shall be connected either to a traction rail or to an earth (10 ohm) by means of two mild steel flat strips of size 40mm x 6mm each.

2.2.6 Bonding of Exposed Metallic Parts

All exposed metal works which are not likely to come in direct contact with 25 kV overhead equipment, such as platform shed/structure, metallic fencing, wires, pipes etc. located within a distance of 20 meters from the nearest electrified track shall be connected to an 10 ohm earth or traction rail. If parallelism with the overhead equipment exceeds 350 meters, all the exposed metallic parts shall be connected to earth (10 ohm) at distance not exceeding 350 meters apart.

2.2.7 Bonding of Earthing Heel of Isolator Switch

The earth heel of an isolator switch shall be connected by two mild steel flat strips of size 40mm x 6mm each to the metallic traction mast, structure or support. The connection shall be as short and as direct as
possible. Such a traction mast structure, support shall be connected to a traction rail or an earth (10 ohm).

2.2.8 Bonding at Level Crossing

All the traction rails shall be provided with cross bonds at only one location which shall be within five meters from either of the transverse edges of the level crossing.

2.2.9 Bonding of Rails in a Tunnel

All the traction rails shall be provided with rail bonds not only over the entire length inside the tunnel but also for a length of upto 50m on both ends outside the tunnel. A cross bond shall be provided between the traction rails at either ends of the tunnel.

If any one track in a tunnel is track circuited an earth wire shall be run on traction mast, structure and metallic parts of the overhead equipments. The earth wire shall be connected to an earth as well as to the traction rails at both ends just outside the tunnel. If earth wire length exceeds 1000 mtrs. it shall be electrically discontinued into sections by providing a cut-in-insulator so that no section of the earth wire is greater than 1000 mtrs electrically. Each such section of the earth wire shall be connected to an earth at two traction masts, structure or supports at distance not exceed 500 mtrs apart.

No cross-bond shall be provided between the rails of the same track or between the rails of different tracks in a double rail track circuited section.
2.2.10 Bonding of Tracks in Loco/EMU Sheds and Stabling Sidings

The traction rails of loco/EMU sheds and stabling siding shall be provided with cross-bonds at distance of not more than 100m apart. Further all sidings or dead ends whether wired or not shall be connected by rail bonds. The rails on wooden or concrete sleepers in loco/EMU inspection pits shall be provided with rail bonds for the entire length of the pit and also upto a length of 50m on the both sides and connected to 10 ohm earth.

2.2.11 Bonding of Rails on Wooden/ Concrete Sleeper

Traction rails on wooden/ concrete sleepers shall be provided with cross bonds at an interval of 350m approximately. No rail bonds shall be provided. The wired track shall be deemed to be on wooden/ concrete sleepers if there are not more than 6 metallic sleepers in any length of track not exceeding 350 meters as shown in figure 2.6.

![Diagram of bonding of rails on wooden/concrete sleepers](image)

Figure 2.6 Bonding Of Rails On Wooden/ Concrete Sleeper
2.2.12 Bonding Adjacent to TSS/FP

All the traction rails shall be provided with rail bonds for a distance of 1000m on both sides opposite to the feeding posts. In addition, all the traction rails shall be cross bonded at a distance of 300m, 500m, 750m and 1000m on both sides of the feeding post as shown in figure 2.7 on next page.

In double rail track circuited section, impedance bond shall be provided for each of the main running track opposite to the feeding post. If it is not possible to provide impedance bond, convert it into single rail track circuited section. All the traction rails shall be provided with rail bonds for a distance of 1000m on both sides opposite to the feeding posts. In addition, all the traction rails shall be cross bonded at a distance of 300m, 500m, 750m and 1000m on both sides of the feeding post as shown in figure 2.8 on next page.
Figure 2.7 Non Track Circuited Section

Figure 2.8 Single Rail Track Circuited Section
2.2.13 Bonding in Single Rail Track Circuited Section

All traction rails in single rail track circuited section shall be provided with rail bonds over the entire length and for a further 50 mtrs at both sides. In addition such traction rails shall be cross bonded to traction rail of adjacent track at intervals at 100 mtrs. and rail bonded over the entire length of the track circuits and for a further 50m on both sides. In case the length of a track circuited rail is not more than 350m, a cross bond shall be provided between the rails of the track immediately outside the track circuited zone at both of its ends as shown in figure 2.9.

![Figure 2.9 Single Rail Track Circuited Section](image)

Figure 2.9 Single Rail Track Circuited Section

In single line section provided with single rail track circuit the non track circuited rail shall be provided with rail bonds over the entire length and for a further 50 mtrs on both sides. It shall also be connected to an earth at a distances not exceed to 100 meters from each other. The connections of the non track circuited rail to each of the earths shall be made by two separate mild steel flat strips of size 40mm x 6mm each. The need for providing an earth wire is thus obviated.
2.2.14 Bonding in Double Rail Track Circuited Section

In a double rail track circuited section both the rails shall be provided with rail bonds. The insulated joints of the double rail track circuited shall be bridged by impedance bond since no traction rail is available for structure bonding. An earth wire shall be run on the traction mast or structure or support.

If earth wire length exceeds 1000 mtrs. it shall be electrically discontinued into sections by providing a cut-in-insulator so that no section of the earth wire is greater than 1000 mtrs electrically. Each such section of the earth wire shall be connected to an earth at two traction masts, structure or supports at distance not exceed 500 mtrs apart.

No cross bond shall be provided between the rails of the same track or between the rails of different track in a double rail track circuited section.
2.2.15 Bonding at Oil Depot Sidings

i. Unwired sidings leading to an oil depot or installation shall be provided with duplicate insulated block joints as near as possible to the turn out from the main track and before entry into the oil depot or installation from which they take off as shown in figure 2.10.

![Figure 2.10 Oil Depot Siding](image)

Figure 2.10 Oil Depot Siding

ii. Where a siding or a secondary loop line is to be wired to serve the purpose of loading and unloading of petroleum products, the following arrangements to be made and precaution to be taken:

a. A neutral zone shall be set up at either end of the length of the siding or secondary loop line over which the vehicles, containing the petroleum products are to be berthed and loaded/ unloaded. The neutral zone shall be created both in the track as well as in the traction overhead equipment by provision of insulating joints and section insulators with isolators. The neutral zone is to be kept isolated when the loading/ unloading operations are in progress so as to avoid propagation of stray current.
b. Both the rails of the siding or secondary loop line shall be provided with longitudinal bonds. Besides transverse bonds shall be provided between the rails at distances not exceeding 30 mtrs. apart.

c. The rails of the siding or secondary loop line shall be connected to an earth at both ends immediately outside the neutral zone.

d. An equi-potential link/ switch shall be provided between the metallic portions of the petroleum installation i.e. the earth and the rails of the siding or the secondary loop line. This equi-potential/ link/ switch is to be kept closed during the loading/ unloading operations.

e. Each and every non-current carrying part of a traction mast, structures, support and other metallic structures in the vicinity of the sidings or secondary loop line shall be provided with structure bonds. Only copper rivets shall be used for connection between the non-current carrying metallic part or rail and the bond.

f. Proper electrical continuity shall be maintained between the petroleum installations and the rails on which the vehicles are kept for loading or unloading petroleum products. Ensure the OHE has already been made dead and earthed.
CHAPTER 3
WORK INSTRUCTIONS

3.1 APPLICABLE TO PERMANENT WAY STAFF

Precautions are required to be taken on account of the following:

a. Proximity of a live conductor

The risk of direct contact with live OHE is ever present while working in electrified sections such as painting of steel work or through spans of bridges, platform and covered sheds.

b. Build up potential due to return current in rails

The return current in the rails may cause a potential difference:
• Between rail and the surrounding mass of earth.
• Between the two ends of a fractured rail.
• Between the two rails at an insulated joint.
• Between earth and any other metallic mass.

c. Build up of potential due to induction in metallic bodies situated close to OHE

It is important that dangerous voltage may be induced in metallic masses such as fencing posts in the vicinity of traction conductors. To avoid possibility of shock due to such voltages the metallic structures are bonded together and earthed.
3.1.1 Continuity of Track

During maintenance or renewal of electrified tracks, continuity of the rails shall invariably be maintained. Temporary metallic jumpers shall be provided in bridging gaps during removal of fish plates or rails, as under:

a. In case of a rail fracture, the two ends of the fractured rail shall be first temporarily connected by a temporary metallic jumper of approved design as shown in figure 3.1. In all cases of discontinuity of rails the two parts of the rail shall not be touched with bare hands. Gloves of approved quality shall be used.

Figure 3.1 Temporary jumper

b. In the case of track renewals, temporary connections shall be made.

c. In the case of a defective or broken rail bond, a temporary connection shall be made.

d. Before fish plate are loosened or removed temporary connections shall be made.
e. Permanent way staff is advised to keep the tracks clear and avoid contact with the rails either when electrically hauled train is approaching or reaching the work spot by 250m.

**Track circuited rails**

In track circuited areas where the rails have insulated joints shall not be bridged with bare hand or any metallic article. Contact with an insulated section of rails and non-insulated section of rails of the same or other tracks shall also be avoided.

**Presence of S&T staff**

An authorized representative of the signaling department shall be present for all work in track circuited areas on track involving discontinuity of rails or jumpering of insulated rail joints.

**Traction mast foundation & bond**

The top of foundation blocks of track structure and bond shall be kept clean and tidy.

**3.1.2 Major Track Maintenance Works**

An authorized OHE staff shall be present, when relaying work or any major work on track is carried out, to ensure the following points:

i. Power block is taken correctly and permit to work is issued.

ii. The structure bonds, track bonds, cross bonds, longitudinal bonds etc are not disturbed and if
disconnected for the work, they are reconnected properly when the work is completed.

iii. The buried rail connections to the rails at the feeding posts are proper and not disturbed.

iv. The setting distance of the structure is not affected during slewing.

v. The track level is not raised beyond the permissible limits during the works.

vi. Excavation or digging near a mast foundation is done in such a manner that the foundation is not exposed.

vii. The clearance particularly at over line structure is maintained to the required standards.

viii. Precautions for the safety of staff working under the OHE are taken correctly.

The engineering officials in charges of such major work shall ensure that intimation to their counterparts for maintenance work is given with adequate notice.

3.2 APPLICABLE TO S&T INSTALLATION

3.2.1 Precautions

The flow or return current in the rails may cause a potential difference to build up between:

a. Two rails at an insulated joint of the track circuit or at an ordinary joint in case the fish plates are broken.

b. Two ends of a fractured rail.

c. An insulated rails and the rails used for the traction return current.
d. The rail and the surrounding mass of earth.

e. Whenever staff has to work on installations which are in direct or indirect contact with the rails they shall use tools (insulated and non-insulated) of the type approved for the purpose by the competent authority.

3.2.2 Earthing of S&T Equipment

Earthing of the following S&T equipments are essential in 25kV AC 50Hz single phase electrified section:

a. Signal posts provided with protective wire mesh screen.

b. The lever frame and other metallic parts of the cabin in contact with the lever frame.

c. Metallic sheath wherever applicable and armoring of all underground cables. The earthing of the sheath and armoring of main cable at either end is a matter of paramount importance because unless the cable is earthed properly at both ends it will not be possible to obtain the screening effect of the cable from induced voltage.

d. Block instruments working on earth return through the respective block filters.

e. All telecommunication equipment.

f. The surge arresters provided in block filters as well as those provided for telecommunication equipment in switching station.

*****
CHAPTER 4

MAINTENANCE SCHEDULES

4.1 FOOT PATROLLING

An experienced OHE lineman (accompanied by a khalasi if deemed necessary by local condition) should be deputed to patrol the section on foot by day including yards once a fortnight and suburban section once a week.

The lineman on foot patrol should be equipped with signal flags (Red & Green), an emergency telephone instrument and essential tools, nuts, bolts and washers required for attending defects on the spot.

i. Lineman shall check the general checking of bonds such as tightness of loose connection of bonds. Nut bolt and washer to be provided on disconnected bonds, dressing of bonds etc.

ii. Lineman shall note the mast location of eye broken bonds, missing bonds, damaged bonds, rusted bonds etc. same bonds shall be provided after rectification.

iii. Lineman shall check the general checking of earthing of over line structure, platform sheds, buried rail to traction rail connection in front of traction sub-station, switching station i.e. sub-sectioning post, sectioning post, CLS AT’s and along feeder etc.
4.2 HALF YEARLY SCHEDULE

i. General condition of bonds should be checked by supervisor.

ii. All earthing connection should be specially checked for continuity and soundness of connection for each section.

iii. Measure and record the earth resistance. It should be less than 10 ohm.

4.3 ANNUAL MAINTENANCE

i. Check all points stated in half yearly schedule.

ii. Check all bonds thoroughly for their looseness, rusty nut, bolt & washers, rusty bonds, eye broken bonds, dressing of bonds. Replace short length bonds. Check flash mark on bonds at mast and rail. Provide PVC sleeve on missing or defective bonds.

iii. Provide missing bond as earliest as possible.

iv. Remove the bonds and clean them. Do one coat of black paint and reconnect properly.

4.4 TOOLS REQUIRED

The following tools are required for carrying out bonding work:

1. Scale or measuring tape.
2. Marker and center punch.
3. Template provided with mild steel brush.
4. Hammer ½ & 4 kg.
5. Rail bracket for drilling.
6. Drills of required sizes.
7. Ratchet with spanner.
8. Wooden and iron packing for ratchet.
9. Straight fluted reamer 17 mm & 22mm.
11. Chisel, road punch, sledge hammer.

*****
CHAPTER 5

DO’s AND DON’TS

5.1 DO’s

1. Use IS approved MS flat strip of size 40mm x 6mm for bonding purpose.

2. Ensure loop of bond is close to mast and away from track.

3. Ensure presence of OHE staff during engineering works.

4. Ensure proper intactness of bonds in track circuited areas.

5. Secure structures or other bonds in station/platform area to avoid human injury.

6. Bond all the traction structure to which OHE is attached to the rails.

7. Ensure intactness of all insulating sleeves on traction bonds passing under positive rail of track circuits.

8. Take prompt action to replace the missing/damaged sleeves to avoid signaling failure.
9. Avoid jointing in bonds. If it is unavoidable, it should be welded only.

10. Always take care of longitudinal bonds, transverse bonds and structure bonds in petroleum siding on both the rails and in the vicinity of the track.

11. Use only copper rivet to connect the non current carrying metallic part or rail and the bond.

12. Ensure insulated joints connect to 10 ohm earth in the petroleum siding.

13. First connect two ends of the fractured rail by a copper jumper before attending the rail fracture.

14. Do two coats of red oxide and one coat of black paint on the bond excluding eye holes at both ends.
5.2 DON’Ts

1. Never stack heavy materials on the bonds and earth pits.

2. Never open buried rail to traction rail bond directly.

3. Do not touch the two ends of the fractured rail.

4. Never use steel/ metal reinforced measuring tape in electrified section.

5. Do not bridge insulated joints in track circuited areas with bare hands or any metallic article.

6. Do not joint any bond by nut & bolt for increasing its length.

7. Do not open the bonds of PTFE’s locations without providing temporary jumper.

8. Do not cover bonds with ballasts.

******
ANNEXURE – A

WORK INSTRUCTIONS FOR PERMANENT WAY, TRACTION AND S&T STAFF FOR CHANGING THE RAILS CARRYING OUT TRACK CIRCUITING AND AUTOMATIC SIGNALLING WORKS

1. Before any alteration to alignment or level of electrified track is commenced, due notice of 48 hrs. in advance shall be given to those responsible for the OHE so that OHE may be adjusted to the new condition (at PQRS site, work will be done under the Joint Supervision of permanent way inspector, Electric supervisor/ TRD and S&T staff continuously).

2. A permit to work must be obtained, if work is to be carried out or any worker is required to come within 2 meters of the 25 kV live overhead equipment.

3. When unloading the rails along the track, care shall be taken by PWI/PWM or mate to ensure that the rails do not touch each other to form a continuous metallic mass of length greater than 300 m.

4. In case of track renewals, temporary connections shall be provided with the other rail of the track at both ends by TRD staff. In case of renewal of both the rails of track simultaneously, temporary connection shall be provided within rails of adjacent track at both ends by TRD staff.

5. Before fish plates are loosened or removed, temporary electrical connection between the two rails shall invariably be made.

6. In case of defective or broken rail bond, a temporary connection shall be made.
7. In case of “rail fracture”, the two ends of the fractured rail shall be first temporarily connected by a temporary metallic jumper of approved design. In all cases of discontinuity of rails, the two parts of the rails shall not be touched with bare hands or uninstalled tools. Gloves of approved quality shall be used.

8. Permanent way staff shall keep clear of the tracks and avoid contact with the rails either when approaching or reaching the work spot when an electrically hauled train is within 250m.

9. In track circuited area, insulated joints shall not be bridged with bare hands or any metallic articles.

10. Use of steel measuring tapes or long metallic wires is prohibited in electrified sections.

11. Before replacing the rails/glued joints in track circuited area the permanent way inspector will ensure that traction distribution staff and S&T staff are available at site for removing and replacing the “traction bonds” and jumper/bonding connections where required.

   In such case, PWI will cancel the block to resume the normal traffic only after ensuring that the traction bonds cable jumpers, bond wires etc. have been reconnected by TRD and S&T staff. TRD and S&T staff should be made available at 48 hr. notice given by PWI for changing rails in case of planned works and on the same day in case of rail fracture.

12. The traction Section Engineer (TRD) shall see that all insulating sleeves on traction bonds passing under positive rail of track circuits are intact and take prompt action to replace the missing/damaged one.
ANNEXURE - B

JOINT PROCEDURE ORDER FOR ENSURING SAFETY DURING TRACK RENEWALS

Since the working of relaying unit involves removal of existing rails along with all the different types of traction bonds, it is absolutely essential that temporary jumpers for passage of return current are provided till such time the permanent bonds are fixed to the new rails.

Following procedure shall be followed by the site in charges of both the Engineering and TRD branches associated with relaying work.

1. Before energizing the OHE after completion of work at the end of each day, temporary jumpers/ temporary structure bonds shall be provided on the auxiliary rails and the new rail by the TRD supervisors as per instruction contained in ACTM. This shall be jointly witnessed by the PWI in a register provided for this purpose. TRD supervision shall keep the register in his custody.

2. PWI at site should ensure that temporary rail bonds are connected through auxiliary rail before opening/ dismantling of rail joints for replacing the panel.

3. It would be the responsibility of the PWI in charge to ensure the safety of the staff once the TRD supervision has attended to the above work to ensure that temporary bonds jumpers are not damaged by engineering staff during the course of working.

4. The length of section of track provided with the temporary jumpers shall also be indicated in the above register at the end of each working day.
5. No bonds/ temporary jumpers shall be opened by the Engineering branch without first informing the TRD supervisor.

6. Formation of auxiliary track shall also be done in the presence of TRD supervisor, who shall provide necessary temporary earthing connection to ensure safety of staff.

7. At the time of dismantling/ replacing track from the site, PWI concerned will provide continuity jumpers, in addition to other instructions for the precautions to be observed by permanent way staff.

8. The temporary jumpers shall be replaced by permanent bonds in the quickest possible time.

9. The implantation of OHE masts shall be maintained by the Engineering Branch as recorded in the SED.

10. All the staff should be clearly instructed not to interfere with the track after the work has stopped for the day and the entries in the register made.

11. All other bonds would be done by the supervision of TRD staff.
ANNEXURE - C

WORK INSTRUCTIONS FOR PERMANENT WAY AND TRACTION STAFF FOR CHANGING RAILS CARRYING OUT IN FRONT OF TRACTION SUB-STATION, SSP & SP.

1. Before any changing the rails in front of Traction sub-station/feeding post, sub-station post and sectioning post which bonds are connected to the traction rail to buried rail in electrified track is commenced due notice of 48 hrs. in advance shall be given to concerned TRD Depot Incharge.

2. A power block & traffic block must be obtained of that track to be replaced. Temporary connections shall be provided with the other rail of the track at both ends by TRD staff. In case of replacement of both the rails of track. Temporary connection shall be provided with in rails of adjacent track both end by TRD staff, before disconnecting bonds from rail or vise versa.

3. Before replacing the rails in front of TSS/FP, SSP and SP (Bonds which are connected the traction rail to buried rail and other bonds) of “Traction bonds” in electrified area, the permanent way inspector will ensure that traction distribution staff is available at site for removing the all bonds and jumper/ bonding connections wherever required.

4. After completion of replacement of rail ensure reconnection of all concerned bonds.

5. Permanent way staff shall be responsible to make hole in new rails for reconnection of bonds.

6. Before canceling the power and traffic block, TRD personal shall ensure with permanent way inspector that man and material have removed to resume normal traffic.
ANNEXURE – D

NEW DEVELOPMENT IN THE FIELD OF RAIL BONDING

FEATURES & BENEFITS

- CADWELD connections and its assemblies have become the reliability standard for high current connections.
- This process provides a simple, on site welded connection without requiring extra power, equipment, or special training normally associated with welding and brazing.
- CADWELD is an aluminothermic process which means it generates its own heat to produce super heated liquid metal for welding.
- CADWELD connections provide a molecular bond between conductors and ensure equal current sharing between conductor strands.
- CADWELD connections will never loosen.
- CADWELD connections will never increase in resistance.
- CADWELD connections will never corrode.

APPLICATION

CADWELD aluminothermic welding has following applications in the field of:

1. **Grounding**
   - Copper or steel tapes connections
   - Connection to ground rods
   - Connections to steel structure and masts.
2. **Bonding**

- Signal bonds connection to the rail.
- Power bonds connection to the rail.
- Any type of cables/tapes connections to the rail

**WELDING TOOL**

Welding tool with welder handle and graphite mould complete set of LH & RH pair is suitable for jointing steel flat 40 mm x 6 mm on rail web as shown in figure on next page.
ANNEXURE - E

SUGGESTIONS RECEIVED FROM VARIOUS RAILWAYS DURING SEMINAR HELD ON 7TH & 8TH AUGUST 2008 AT CAMTECH.

1. G.I. flat should be used instead of M.S. flat for bonding to avoid theft, rusting and painting works.

2. Painting of bonding should be done by conductive paint instead of synthetic paint.

3. Bonds which are under soil/ ballast should be covered with jute, clothes and painted to avoid rusting.

4. Continuity bond on check rail may be provided on bridges and level crossings etc.

5. On platform, structure/ upright should be bonded through a suitable size copper cable instead of structure bond lay inside a G.I. pipe and connect on rail as well as structure by lugs to avoid any infringement & human injury.

6. Bond should be tightened with lock nut to avoid frequent looseness.
REFERENCE


3. Field study and literature collected from various depots on Indian Railways.

4. SMI & Specification issued by RDSO on Lightning Arrester.
OUR OBJECTIVE

To upgrade maintenance technologies and methodologies and achieve improvement in productivity and performance of all Railway assets and manpower which inter-alia would cover reliability, availability, utilisation and efficiency.

If you have any suggestions and specific comments please write to us.

Contact person     Director Electrical

Postal address     Indian Railways
                  Centre for Advanced Maintenance Technology, Maharajpur, Gwalior,
                  Pin Code - 474 005

Phone              0751 – 2470740
                  0751 – 2470803

Fax                0751 - 2470841