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1.0	19 Nov 26	2.3	First issue. Renumbered from ESM-07-02, updated train shunt check requirements and updated fixed shunt test Table 1

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1 Introduction

1.1 Purpose

The purpose of this document is to provide minimum requirements to be followed when carrying out maintenance activities associated with different types of track circuits.

1.2 Scope

This document covers information on track circuit maintenance which can affect safe operation and reliability of track circuits when worked on by signalling personnel.

This standard does not include requirements relating to the axle counter, predictors and other forms of train detection systems.

1.3 Document Owner

The General Manager Technical Services and Assurance is the Document Owner. For any query, contact standards@artc.com.au.

1.4 Responsibilities

Signal Maintenance Staff and Signal Maintenance Engineers are responsible for compliance to this document.

1.5 Reference Documents

ESM-00-12 Disconnection of Signalling Apparatus

ESI-07-03 Track Circuit History Cards

ESS-26-01 Signal Technical Maintenance Plan

ESW-26-01 Signals Service Schedules/Standard Jobs

ESM-07-03 Microtrax Coded Track Circuits

ESM-07-04 Unreliable Track Circuit due to Infrequent Train Operations

ESM-00-10 Testing and Certifying Equipment Worked on or Altered During Maintenance

ESI-07-03 Track Circuit History Cards

ESS-00-01 Re-railing – Precautions to be Taken

ESD-07-02 Track Bonding and Signalling Infrastructure in Electrified Areas

AS7715 Train Detection

ARISO Glossary of Terms

2 Track Circuit General

The absence and position of the train are significant requirements for the operation of a signalling system.

A number of items are available to perform this task and they have different characteristics and performance. The maintenance of this equipment ensures the correct operation and ongoing reliability.

Signalling maintainers are responsible for maintaining track circuits for safe and reliable operation. They are to work in accordance with the following maintenance requirements and schedules. As with other vital signalling equipment, signalling maintainers should be on the lookout and check for potential track circuit problems whenever the opportunity permits, as when visiting sites or walking through the section.

Maintenance requirements include tasks such as but not limited to:

- Track circuit examination
- Recording of track circuit voltages etc. and settings
- Shunt test
- Polarity test

Signalling maintainers shall make themselves aware of the equipment manuals and specifications and maintenance procedures for each type of track circuit which they will be required to maintain.

Signalling maintainers shall have current competency for the type of track circuit they are required to maintain.

The objective of maintaining track circuits is to find and remove any potential failure conditions and ensure that as far as possible the track circuit will function reliably as per design.

Any conditions likely to cause a reduction in the reliability of the track circuit shall be attended to immediately.

2.1 Track Circuit Examination

The objective of examining track circuits is to find and remove any potential failure conditions and ensure that as far as possible the track circuit will function reliably as per design. Any conditions likely to cause a reduction in the reliability of the track circuit shall be attended to immediately.

This is a detailed inspection of the physical components of the track circuit; the inspection will include but is not limited to:

- Inspection of track leads
- Inspection of signalling and traction bonding
- Inspection of connection points
- Inspection of track/ballast condition
- Inspection of insulated rail joints
- Inspection of other associated hardware (e.g. Compensating capacitors, Westrak diodes, shunts and couplers etc.)
- Inspection of power supply and associated track feed equipment
- Inspection of relay / receiver / other equipment

Please refer to ESW-26-01 for details.

2.2 Track Circuit Test Records (History Cards)

Track circuit test record cards (history cards) shall be kept adjacent to the track circuit equipment and tests shall be made and recorded thereon. This assists in assessing the performance outside the specified values which may lead to failure.

Although preferable to have one card per track circuit located in the track relay location, it is permissible to have a second card in the track feed location and the test readings recorded separately for each end of the track circuit on the respective card.

The track circuit history card provides a past record of the performance of the track circuit. Further to highlighting variations that need to be accounted for, observation and comparison of values recorded provides a way of detecting "trends" in performance, allowing problems to be detected before they cause a failure. Gradual consistent variations (e.g.: adjusting the track feed voltage upward by a small amount every maintenance visit) indicate the deterioration of some component of the track circuit.

The causes of these problems shall be sought out and attended to.

The following shall be treated as separate track circuits and tests and records carried out and kept accordingly:

- pinpoint detectors
- centre fed track circuits
- common transmitter track circuits
- double receiver track circuits
- cut section track circuits
- coded track circuits
- overlay track circuits

Track Circuit History Cards are covered by Work Instruction ESI-07-03.

2.3 Shunt Test

Shunt tests using test resistors may require two people, one to apply the shunt resistor and the other to observe the operation of the relay. Trains shall not be used for shunt tests.

a. Drop Away Shunt Test

The 'drop shunt' resistance is the highest value of resistance which, when placed across the rails, will cause the relay to drop away (i.e. become de-energised with all front contacts open.)

The drop shunt resistance is measured by aid of a variable shunt device (known as a `shunt box').

When taking the `drop away shunt' measurement the leads of the shunt box are connected across the rails at the relay/receiver end of the track, set at a high value (at which the relay is energised), and then the resistance is decreased until the relay drops away; the 'drop shunt' value is then measured.

The drop away shunt test is repeated three times until consistent operation of the relay is observed. This result shall then be recorded on the track circuit history card.

b. Fixed Shunt Test

A `fixed shunt test' is carried out by connecting the specified value fixed shunt across the rails and observing that the track relay drops (de-energises). Shunt boxes are available for this purpose.

These are fitted with leads and a special set of clamps to minimise rail-lead contact resistance.

For a fixed shunt test the fixed shunt resistor is connected across the rails at all extremities of the track circuit (including within crossovers) and at the mid-point of the track circuit. At each point the track relay is observed to drop away.

The value of the fixed shunt resistor will be the figure shown in Table 1, which is the minimum drop away shunt value for the type of track circuit concerned.

Track Circuit Type	**Fixed Shunt and Minimum Drop Shunt (ohms)**
DC track circuits 4 ohms – DC shelf	0.15 ohms
BT1B	0.25 ohms
QT1	0.25 ohms
DC track circuits 9 ohms	0.5 ohms
Jeumont Schneider impulse track (Double rail) (1xBRTCA2-Rx)	0.25 ohms
Jeumont Schneider impulse track (Double rail) (2xRVT600-Rx)	0.25 ohms
Jeumont Schneider impulse track (Double rail) (1xRVT600-Rx)	0.5 ohms
Jeumont Schneider impulse track (Single rail) (Normal/TV-TH1)	0.5 ohms
Jeumont Schneider impulse track (Single rail) (TV-THD2 or TV-LV)	0.25 ohms
AC track resistor fed – (Single Rail)	0.25 ohms
AC track resistor fed – WBS single rail	0.5 ohms
AC track Resonant impedance bond	0.25 ohms
AC track AAR standards Double rail	0.06 ohms
CSEE jointless track	0.15 ohms
ML jointless track	0.5 ohms (0.15 ohms within loop)
EBI track 200	0.5 ohms (0.15 ohms within loop)
FS2500 jointless track	0.5 ohms (0.15 ohms within loop)
Microtrax	0.25 ohms
PSO 4000	0.2 ohms
PSO III	0.2 ohms
Electro Code 5	0.25 ohms
Electro Code 5 to Electro Code 4 Interface**	0.06 ohms
Electro Code 4**	0.06 ohms

Table 1

** Note: The specified shunt value is based on manufacturer documentation. As the EC4 is a legacy arrangement not intended for new installations, where they are encountered, consideration should also be given to replacement with a current approved train detection system.

c. Train Shunt Check

A functional test of proper operation of a track circuit is the "train shunt check," carried out to ensure that there is effective rail/wheel contact and that a train is effectively detected during its entire passage over the track circuit.

The vehicle used for a train shunt check shall be certified to operate under the signalling system.

A train shunt check is required where there is doubt about the conductivity of the rail contact surfaces. After re-railing procedure ESM-00-12 shall be followed if a valid train shunt check cannot be achieved.

In determining the need for train shunt check requirement for newly installed rail in track circuited areas, consideration should be given to the length and location of newly installed rail, together with the results of rail inspection, rail cleaning and fixed shunt testing. Examples include:

I. Rail replacement not exceeding 13m in length and located more than 15m from a clearance point, track circuit boundary, insulated rail joint or turnout would not normally require a train shunt check provided:
    - A satisfactory fixed shunt test is conducted on the newly installed rail.

II. Rail replacement not exceeding 13m in length and located within 15m of a clearance point, track circuit boundary, insulated rail joint or turnout may be considered without a train shunt check where:
    - The entire length of newly installed rail has been cleaned.
    - Signalling personnel have inspected the newly installed rail to confirm the running surface is free from contamination and a continuous wheel contact band is present.
    - Where practicable, the inspection is undertaken jointly with track & civil representatives, and both disciplines are satisfied with the condition of the rail.
    - A satisfactory fixed shunt test is conducted on the newly installed rail.

III. Rail replacement exceeding 13m in length may be considered without a train shunt check where:
    - The entire length of newly installed rail has been cleaned.
    - Signalling personnel have jointly inspected the entire length of the newly installed rail with track & civil representatives to confirm the running surface is free from contamination and a continuous wheel contact band is present, and both disciplines are satisfied with the condition of the rail.
    - Satisfactory fixed shunt tests are conducted at multiple locations along the newly installed rail, including as a minimum at each end and approximately the centre of each track circuit.

The Signal Maintenance Engineer may determine whether a train shunt check is required based on the risk of ineffective train detection, taking into account site conditions, inspection outcomes, testing results and previous operational experience.

The check is carried out by monitoring the track relay/receiver input voltage, while a train passes over the whole length of the track circuit and observing that the input voltage does not exceed a maximum 'train shunt' value.

The test point and the maximum value for 'train shunt' for different type of track circuit are given in the table below.

Track Circuit Type	Test Point	Measure Units	Maximum Train Shunt or Open Circuit Feed Value
DC-Shelf	Relay Coil	vDC	<30% of relay Drop Away Voltage
DC-Plug in	R1R2	vDC/I DC	<30% of relay Drop Away Voltage/Current
AC	Control Terminals	VAC	<30% of relay Drop Away Voltage
CSEE	Receiver R1R2	mVAC with filter	<90 mV
ML TI21	Receiver R+R-	mVAC with filter	(mV x GAIN) <100mV
EBI track 200	Receiver TP1 & IP1	mVAC with filter	<50% of threshold current
FS2500	Receiver Monitor	mVAC	<400 mV
J/S	Receiver terminals C+/C1 (RVT-600) 3/C1 (BRT-CA2)	VDC with integrator	<100 Volts

Table 2

Note: This check is best carried out with a Digital Multimeter with an analogue bar display, set to a fixed voltage range (not auto - ranging).

The drop away test value for shelf relays is shown on the manufacturer's or workshop's test label on the relay.

The drop away test value for plug-in relays is shown on the manufacturer's or workshop's test label on the relay for that type of relay and is also shown in the Relays Equipment Manual.

Note: The track circuit shall be disconnected and booked out of use if maximum "train shunt" value is exceeded under train shunt conditions.

Notwithstanding the specified maximum 'train shunt' values, test readings above ten percent of the drop away test value or above one third of the other values specified in the table above, are to be further investigated and immediately reported to the Signal Engineer.

2.4 Polarity Test

Rail voltage polarities shall be checked using a voltmeter (and pulse integrator where applicable) to ensure that there is polarity reversal across all insulated rail joints between adjacent track circuits of the same type, namely 50Hz AC to 50Hz AC, DC to DC, HVI to HVI, Microtrax to Microtrax.

The existence of like polarities on these track circuits is acceptable only at a track feed to track feed interface, or with cut tracks where the track relay directly cuts the adjacent feed.

Polarity reversal does not apply to audio frequency track circuits.

Upon detection of track circuit polarity anomalies, the track connections must not be reversed without the approval of a Signal Engineer.

The Signal Engineer shall be advised of incorrect polarities between track circuits as soon as possible.

The condition of the insulated rail joints shall be checked to ensure they are not liable to breakdown before the situation is corrected to the instructions of the Signal Engineer.

Traction return bonding must also be checked at this time.

The Signal Engineer shall consult with the appropriate Signalling Design representative, as necessary, to determine design solutions.

2.5 Track Circuit Adjustment

On installation, adjust track circuits and complete all entries shown on the track circuit history card.

a. Adjust track circuits with the track bonding (rail bonds, series bonds, parallel bonds, impedance bond side leads) and rail connections in good condition with low resistance.

   Track circuit feed voltages shall not be increased to compensate for open circuit or high resistance bonding - in electrified areas high track feed voltages could increase the probability of circulating currents through traction tie in bonding or earth paths.

b. Track circuit adjustment and drop away shunt tests shall be performed preferably in dry ballast conditions. Track circuits adjusted in wet or poor ballast conditions shall be drop away shunt tested again when the track has dried out, or the ballast conditions improved, to ensure correct shunting.

   - The signalling maintainer is to be kept informed of planned works or activities that could change track or ballast conditions which affects the reliable and safe operation of the track circuit.
   - Should large adjustments or adjustments for unaccountable reason be required, the Signal Engineer shall be contacted promptly for instructions.

c. Whenever the track circuit is readjusted, measure and record all track circuit voltage readings; carry out a fixed shunt test at all extremities and observe the relay pick up and drop away correctly. Also carry out a drop away shunt test at the relay/receiver end.

   - In exceptional circumstances, if it is necessary to temporarily readjust a track circuit to compensate excessively wet or poor ballast conditions, an entry to that effect shall be made on the track circuit history card.
   - The Signal Engineer shall be promptly advised and shall suitably record such advice. The suitably accredited signalling maintainer must regularly monitor the track circuit and the track must be readjusted immediately the ballast conditions have improved; the Signal Engineer shall ensure the timely correction of the adjustment.

2.6 Interference/Repairs to Track Circuit Wires

Whenever two or more track circuit wires are disconnected and reconnected or repairs are made to two or more broken wires to or from track circuit equipment, ensure that the track relay has picked up and carry out a fixed shunt check or train shunt check to ensure that it drops away

correctly. Where applicable, carry out a polarity reversal test between the affected track circuit and adjacent track circuits if there is any possibility of the track circuit polarity being altered.

2.7 New or Rusty Rails

After re-railing, where rail surfaces are not clean (bright and shiny) or when the rail surface is rusted after a period of disuse, carry out a train shunt check to ensure that a train is effectively detected over the complete length of the track circuit.

Ensure rail surfaces are clean for sections of track even as short as the wheelbase of a single bogie when that section of track is located within a vehicle wheelbase of an insulated rail joint between adjacent track circuits.

Whenever there is replacement of rails in points or at block joints, or in tuned loops, or where short sections of rail are replaced in the vicinity of the clearance point between converging tracks and near the interface between adjacent track circuits, or where glued insulated joints are installed, then the signalling maintainer is to be in attendance and ensure that the rail surfaces are clean before the track circuit is restored into use.

In certain areas of plain track, the attendance of the signalling maintainer may not be necessary for the replacement of short sections of rails where the requirements of section 1.5 (Guidelines for the use of temporary rail bonds) of ESS-00-01 Re-railing – Precautions to be Taken have been met and with the agreement of the Maintenance Signal Engineer.

In these cases, the civil engineering staff is to grind the surface of the rail to clean off any protective coating, rust or other contamination and provide a shiny metallic surface for good electrical contact with the wheels. Alternatively, restoration of the track circuit is to wait until the passage of trains has cleaned the rail surface to ensure shunting.

2.8 Infrequent Use

Inspections during maintenance visits are to be made of sections of track where rust or other contaminants are likely to accumulate on the rails of track circuited lines e.g. sidings and entry to sidings, refuges, branch lines. Whenever signalling maintainers become aware of rails that are rusty or otherwise contaminated such that the track circuit would not reliably detect the presence of trains, they shall inform the network controller and advise Signal Maintenance Engineer. Under these circumstances, requirements of ESM-07-04 are to be followed.

Any potential risks of motor points operating under a train foul of the turnout due to rusty or contaminated rails, the motor points and respective signal routes can be disconnected and booked out of use in consultation with the signal maintenance engineer and network controller.

Where the rusty rails of a track circuit are on a double ended turnout (crossover) operated from an adjacent ground frame or on a turnout with catch point operated from an adjacent ground frame, then the ground frame release may be left connected.

2.9 Excessive Sanding of the Track by Locomotives

When excessive sanding of tracks occurs in track circuited areas the effective shunting of track circuits could be affected.

Any case of excessive sanding is to be immediately brought to the attention of the Signal Engineer, and the appropriate network controller.

Any instances of trains failing to shunt track circuits, intermittently or otherwise due to sand on the rail head, are to be immediately reported to the Signal Engineer and fully investigated.

2.10 Precaution to be Taken when Inserting Track Circuit Receivers

It is critical that CSEE receivers, especially, be plugged into their correct rack positions. The misallocation of a receiver by one module space can have unsafe consequences, with the permanent energisation of the track relay.

3 Track Circuit Cyclic Maintenance

3.1 Check of Double Rail 50Hz track circuits in electrified areas

Test 50Hz AC double rail track circuits in electrified areas as follows, and record the results on the history card:

The track relay coil voltage should be roughly one volt under normal unoccupied conditions.

The current in each rail at the one location should be equal or within 0.5 amp as measured on an induction meter.

Investigate unbalance (unequal) current readings and advise the Signal Engineer promptly.

The currents measured in each cable of a side lead pair of cables should be equal, or within 10%. Uneven current sharing indicates a high resistance side lead or connection.

The voltage drop across a side lead connection to the rail should be less than 10 millivolts ac. Investigate changes in values significantly different to previous readings.

3.2 Regular Check of Parallel Bonds

Parallel bonds on track circuits extending over points to a clearance point on another line, shall be inspected on each occasion the set of points or the track circuit is maintained.

Where the track relay is connected such that open circuit or high resistance parallel bonds would fail the track circuit, then the inspections need only be carried out on the normal rostered maintenance visit to the track circuit.

To deter theft of copper traction bonds used for parallel bonding, maintenance staff should consider converting vulnerable bonds to aluminium or encase them in concrete filled surface conduits.

Staff must be vigilant when visiting locations where parallel bonding is provided to ensure bonding has not been damaged / removed by track machines, vandals or copper thieves.

3.3 Traction Bonding

Where a fault condition causes AC track circuit currents to circulate via traction tie-in bonds or earths, etc through other track circuits (or where a fault condition causes AC currents in the DC traction supply) then a potentially unsafe condition can occur if a high resistance track circuit condition arises. All cases of open circuit or high resistance rail bonds, series bonds, impedance bond side leads, and their connections, shall be rectified promptly. Emergency jumper bonds, in good condition and correctly applied, should be utilised as required but replaced by permanent bonds as soon as possible. Any case where AC rail current unbalance is detected shall be immediately reported to the Signal Engineer and the cause found and rectified without delay.

Signalling maintainers must ensure that track circuit bonding is in good condition, that open circuit bonds are immediately replaced, that high resistance connections are immediately rectified, and that deteriorated bonding is programmed for timely renewal. The Signal Engineer shall check that bonding requirements are met.

Note: Tie in bonds and neutral points at sub stations and section huts require special precautions, refer to ESD-07-02 for detail.

3.4 Impedance Bonds - Maintenance

The removable lids of fully enclosed impedance bonds installed in the track below top of sleeper level shall be removed and the bond examined at prescribed intervals.

The set screws securing the yoke to the laminated core and all terminal studs shall be kept tight. The windings shall be examined to ensure that the insulation is not displaced and that the coil leads are not fractured. The bond shall be examined to see that it is clean and dry, and the case is not cracked. When replacing the lids of bonds installed in the four foot it is essential that the sealing of the connection inlets and hemp lid packing or gasket will effectively exclude the entry of water or other foreign matter.

The set screws or bolts securing the lid shall be kept in good order and the wooden packing, where provided, maintained in position.

Siemens DD131 impedance bonds are provided with a dip stick plug to facilitate checking for the accumulation of moisture. In addition to the yearly examination this plug shall be removed frequently and any water detected shall be removed and the necessary attention given to the sealing of the connection inlets and lid gasket.

Jeumont Schneider (High Voltage Impulse) CIT 1400 impedance bonds can suffer from loose back nuts so particular attention should be given to any loose terminations. The construction of this bond brings out each half of the winding externally for traction connections. To prevent a possible cause for unbalanced traction return a good solid connection must be maintained between the two centre copper bars. Inspect this connection to ensure that the two bus bars form a good connection.

Impedance bonds with removable lids installed outside the track on stands and impedance bonds with fixed lids are not required to have the lids removed for examination of the bonds.

On MJS and ABW 1000 amps per rail impedance bonds the condition of the connections is to be examined for looseness or any signs of oxidisation.

On 2000R and 2000RAF Amps per rail impedance bonds there is an additional box mounted on the rear of the bond containing either capacitors or a transformer (2000P). The lid on the box is to be removed and a check made for any loose or imperfect connections.

Signalling maintainers must also ensure that whenever a refurbished impedance bond is being installed, an internal inspection is carried out to ensure that it has suffered no damage or deterioration during transport or storage.

On prescribed inspections of resonated bonds, the capacitor voltage is to be measured and recorded on the respective track circuit history card. Variation in the voltage compared to previous records is to be investigated.

3.5 Rostered Maintenance Visits – Level 1

Specific attention and visual inspection shall be given, and necessary action taken on the following items:

a. Connections to the rails and the condition of cables for:
   - track circuit leads
   - series and parallel bonds
   - mechanical fishplate bonds

- mixed gauge bonds (no greater than 75 metres apart)
- spark gaps
- electrolysis bonds.
- impedance bond side leads
- traction tie-in leads
- emergency jumper bonds

The voltage drop across impedance bond side lead connections to the bond and to the rail shall be checked to be low resistance, i.e. less than 10 millivolts.

b. Connections to air-cored inductors, tuning units, compensating capacitors and their connections.

c. Cable fasteners to rails and sleepers (including clip/cleating arrangements on concrete sleepers).

d. Insulated rail joints:

- deterioration
- rail burning / burring over
- steel scale
- clear of ballast and metallic items
- shelling
- loose metal identification plate (glued insulated joint)

e. Point rodding, signal wires and debris such as spent drink cans coming into contact with rails and crossing noses.

f. Electric traction bonds or other cables being installed clear of, and insulated from, rails to which they are not bonded.

g. Rusty rails, sand or other contamination which could affect train shunts (on the contact surface of the rail).

h. Rail fasteners or Pandrol clips (blue) clear of fishplate bolts at insulated joints, and clip and chair insulation pads on concrete-sleepered track. Rail fasteners and rail bonds clear of steel structure on bridges.

i. General condition of ballast.

j. Lightning protection equipment.

k. The d.c. voltage drop across all stanchion spark gaps shall be tested to ensure that they are open circuit. A voltage reading over three volts would indicate a satisfactory open circuit spark gap.

l. Relay track coil voltage on 50Hz A.C Double Rail track circuits

Relay track coil voltage on 50Hz A.C Single Rail track circuits

Relay track coil voltage on D.C. track circuits

Receiver Input voltage on joint less and impulse type track circuits

(Record the voltage at the track receiver/relay and check against the last recorded value).

m. Rail current balance for 50Hz track circuits in electric traction areas.

n. Track relay pick up and drop away operation where practical, when the track circuit is shunted by a train.

o. On D.C. track circuits, battery condition and battery voltage and electrolyte level. Record all readings and compare with track circuit battery record card and battery life expectancy.

If the reading shows a variation from the last recorded value which is large enough that it cannot be accounted for by normal variations in ballast conditions, then further investigation and tests shall be carried out. Severe degradation of performance of the track circuit outside normal behaviour or known symptoms of failure must be reported to the Signal Engineer who shall arrange investigation.

In the case of double rail 50Hz AC track circuits, the current balance shall be determined by measuring the signalling current in both rails, at both the feed and relay ends of the track, using an Induction meter. This test is not highly accurate, due to variations induced by traction current harmonics; the test does give a convenient indication of unbalance in the rail currents, and any difference greater than 0.5 amps may be considered significant.

While there should not be stray 50Hz currents emanating from balanced double rail track circuits this is not the case with single rail 50Hz track circuits, where close tie in bonding between the traction rails of parallel tracks provides an alternate low resistance path for stray 50Hz track circuit currents. It may not then be unusual to measure unbalanced 50Hz currents in single rail track circuits.

Measuring rail current balance using a meter that is not 50Hz frequency selective may not be an accurate indicator because of traction harmonics flowing in the traction rail. Differences between the rail currents measured on an induction meter of greater than 1.25 amps on single rail 50Hz track circuits should be further investigated by checking other track circuits in the vicinity.

In addition to the inspection and tests which are carried out on a normally rostered maintenance visit (see paragraph 2.1, the following tests shall be carried out at prescribed intervals as per TMP.

a. Check rail voltage polarities using a voltmeter to ensure that there is the required polarity reversal across all insulated rail joints between adjacent track circuits at all extremities. Ensure the checks are carried out while relevant power supply locations are operating on the ‘Normal’ supply. Advise any discrepancies to the Signal Engineer.

b. Open and examine impedance bonds installed in the four foot with part below top of sleeper level.

In addition to the above, the following inspections and tests shall be carried out at prescribed intervals as per TMP.

i. Measure all voltage readings indicated on track circuit history cards according to the methods prescribed for the type of track circuit under test and fill the results out on a new line on the card and compare with previous results.

ii. Carry out a fixed shunt test, with the appropriate resistance value for the type of track circuit concerned, see Table 1 at all extremities of the track circuit including in points turnouts and crossovers and especially where connected by parallel bonding. Record details on the history card.

If the track fails to shunt at the minimum drop shunt value specified for that type of track circuit, then a drop away shunt test shall be conducted and the Signal Engineer shall be informed immediately. The track circuit shall not be left operating in an unsafe condition.

iii. In the case of compensated track circuits, record the rail-rail voltage at each capacitor connection for comparison with previous results.

iv. Remove the track feed fuse and observe the track relay de-energise properly and check the track relay/receiver input voltage measures near zero and does not exceed the maximum O/C Feed values specified in the Table 2.

Notwithstanding the specified maximum "O/C Feed" value, test readings above ten percent of the D.A. test value or above one third of the other values specified in the Table 2 are to be further investigated and immediately reported to the Signal Engineer.

On D.C. track circuits, open circuiting of the track feed is important in determining whether there is any galvanic action (battery effect) between the rails or residual magnetism in the relay. All cases where a D.C. track relay does not de-energise normally with the track feed disconnected shall be promptly reported to the Signal Engineer.

On AC vane relays supply to the local coil will also need to be opened.

v. On audio frequency track circuits, the transmitter for the track adjacent to the receiver will also have to have the supply fuse removed unless a frequency selective voltmeter is used.

If the track circuit readings show variations from the last recorded values which are large enough that they cannot be accounted for by normal variations in ballast condition, then further investigation shall be carried out. Severe degradation of performance of the track circuit outside normal behaviour or known symptoms of failure shall be reported to the Signal Engineer for investigation.

3.6 Other Circumstances Requiring Testing

The inspections and tests required on maintenance visits shall also be carried out whenever there are changes which could affect the adjustment or polarity of the track circuits, including:

a. when the track circuit is newly installed

b. in the case of 50Hz AC track circuits and DC track circuits with shelf relays, when a relay change has been carried out. Carry out a fixed shunt check at the relay and measure the relay voltage before and during the fixed shunt check. Compare the values with previous values, the track relay workshop test values, and the normally required values. Assess the need for readjustment.

c. after any of the following equipment items forming part of the track circuit has been changed, e.g.: transformer, resistor, impedance bond, capacitor, transmitter, receiver, tuning unit, matching unit, shielding unit. Carry out a fixed shunt check at the relay end and measure the relay/receiver voltage before and during the fixed shunt check. Compare the values with the previous values, the track relay workshop test values and the normally expected values. Assess the need for readjustment.

d. after track work such as re-laying, re-railing, or ballast works which can affect the adjustment of the track circuit. Signal maintenance staff can determine whether the adjustment required depending on the type of work. If required, carry out a fixed shunt check at the relay end and measure the relay/receiver voltage before and during the fixed shunt check. Compare the values with the previous values, the track relay workshop test values and the normally required values. Assess the need for readjustment

e. when track circuit readjustment is required proceed as stipulated in Paragraph 1.5. When a track circuit is readjusted a drop away shunt test is also required as well as a fixed shunt test at all extremities.

f. as required, when investigating “fault not replicated” failures, etc.

g. whenever both track circuit feed wires and relay wires are disconnected and reconnected, carry out polarity tests between adjacent track circuits requiring polarity reversal.

h. whenever track circuit feed wires or relay wires have been reconnected, or a 50Hz track feed transformer has been changed, the track relay must be observed to pick up correctly to ensure that there has been no change to the circuit polarity.

i. whenever the polarity of power supply transformers or wiring feeding the track circuits is subject to change, carry out polarity tests between adjacent track circuits requiring polarity reversal which are fed from different power supplies.

j. when a reported incident has occurred in which the signalling arrangements are being questioned, under the direction of the investigating Signal Engineer.