For queries regarding this document
standards@transport.nsw.gov.au
www.transport.nsw.gov.au

Technical Direction – TD 00055:2024

Issue date: 02 December 2024

Effective date: 02 December 2024

Title: Update to requirements for traction return bonding in axle counter areas – Amendment to SPG 0709 (TS 05168) *Traction Return, Track Circuits and Bonding,* version 2.7

This technical direction is issued by the Asset Management Branch (AMB) as an update to SPG 0709 (TS 05168) *Traction Return, Track Circuits and Bonding*, version 2.7.

1 Background

In the TfNSW heavy rail electrified network, track circuits have traditionally been used for train detection. These circuits use small currents carried by the rails to detect the presence of trains. Due to the safety critical nature of this system, it is vital that both track circuit and traction currents are managed to ensure that the traction currents have a low-resistance path to return to the traction supply system, while preserving the integrity of the track circuits. SPG 0709 (TS 05168) specifies the requirements for designing, installing and maintaining the various bonding systems necessary to ensure the electrical safety and functionality of the TfNSW's heavy rail electrified network.

In recent years, TfNSW has introduced axle counters into specific areas of the network and uses them as the primary method of train detection. Unlike the traditional track circuits, axle counters do not rely on the electrical properties of the rails to detect trains. This simplifies the bonding arrangements, as only traction return currents are required to be managed.

This technical direction provides the mandatory requirements for traction return bonding in axle counter areas, where axle counters are used as the primary method of train detection.

The updates include amendments to the following sections in SPG 0709 (TS 05168):

- 5.1 Substations
- 5.2 Sectioning Huts
- 6.1 Bonding at Points and Crossings
- 6.6 Tie-in Bonding
- 6.6.1 Tie-in Bonding Interval
- 6.6.4 Tie-in Bonding at Axle Counter Track Circuit Interface (new section)
- 6.8 Bonding at Friction Buffer Stops
- 6.9 Tying-in Non-Track Circuited Tracks
- 6.11 Axle Counter Section Interface to Track Circuit Sections (new section)
- 6.11.1 Axle Counter Section Interface to Jointless Track Circuit Sections (new section)
- 6.11.2 Axle Counter Section Interface to Double Rail Jointed Track Circuit Sections (new section)
- 6.11.3 Axle Counter Section Interface to Single Rail Track Circuit Sections (new section)
- 6.12 Bonding Through Sidings (new section)
- 6.13 Guard Rails (new section)
- 6.14 Overhead Wiring Isolation Switch to Rail (new section)
- 7.3 Connection of Electrolysis Bond to Track
- 12 Spark Gap Arrestors.

In this technical direction, areas where axle counters are used as the primary method of train detection are referred to as 'axle counter areas' and the requirements in this technical direction shall apply.

In areas where axle counters are overlaid over track circuits, these are referred to as 'track circuited areas' and the bonding rules for both track circuit and traction return in SPG 0709 (TS 05168) shall apply.

2 Amendments to SPG 0709 (TS 05168)

The following sections in SPG 0709 (TS 05168) are amended as follows:

Section 1.2 Definitions

Add the following at the end of Section 1.2:

OEM original equipment manufacturer

Section 1.3 Referenced Standards

Add the following at the end of Section 1.3:

TS 05333.31 *Signalling Design Principle – ETCS Level 1*

Section 5.1 Substations

Add the following at the end of Section 5.1:

In axle counter areas impedance bonds are not required, which simplifies the traction return bonding arrangement. However, the additional arrangements in the bullet list at the end of this paragraph shall be carried out in order to make the system more fault tolerant. In place of each impedance bond, the following traction return bonding arrangements shall be implemented:

- two cables shall be connected between each rail and the negative busbar
- two cables shall be bonded across the rails as shown in Figure 1.

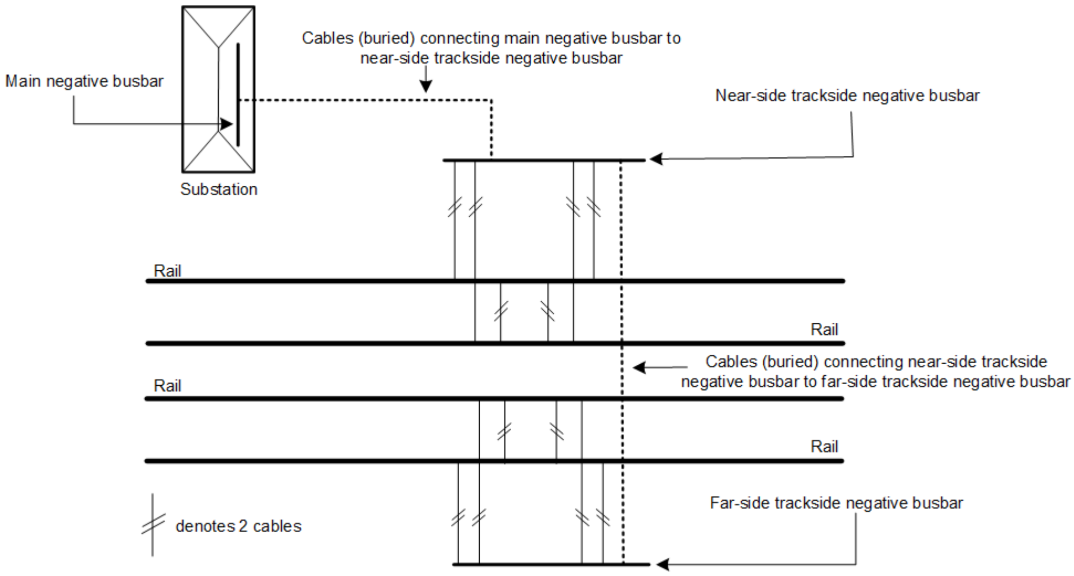

Figure 1 – Traction return connections to negative busbars at a substation

The diverse connection shown in Figure 1 ensures that in the event of a broken rail the current is still evenly distributed across all cables and that there is always a low resistance path for traction return.

The number and size of cables shall be in accordance with Section 8.1.1.

Traction bonds shall be installed in a manner that allows for mechanised track maintenance (tamping).

In multiple tracks areas, where there are no intermediate substation negative busbars that are connected to the inner roads, the middle tracks shall not be bonded to the outer tracks (daisy chained). Instead separate connections shall be run to the nearest negative busbar to prevent overloading the outer track cables, which would otherwise carry both the inner and outer track traction currents. These separate connections shall be run in an underline crossing. Surface running of the cables under the adjacent track shall not be permitted as shown in Figure 2.

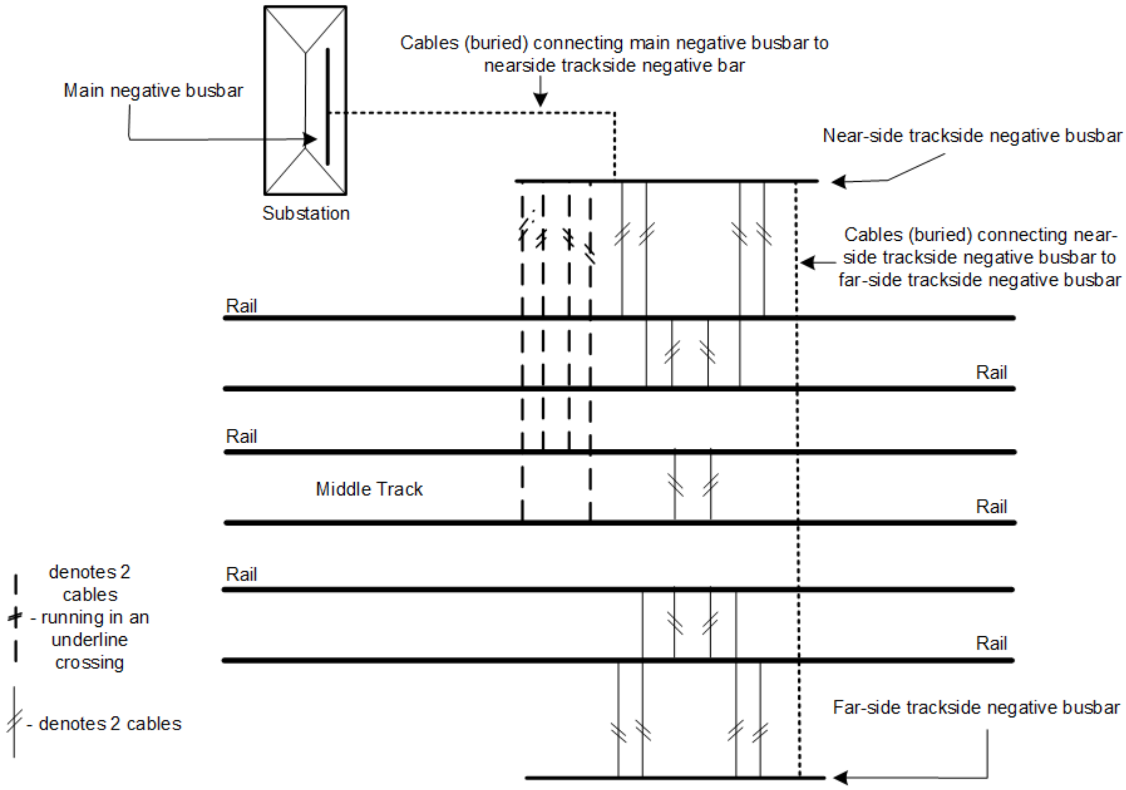

Figure 2 – Traction return connections to negative busbars for multiple track areas at a substation

Section 5.2 Sectioning Huts

Add the following at the end of Section 5.2:

The configuration for connection to the sectioning hut shall be similar to that of the substation in axle counter areas.

The magnitude of traction current at a sectioning hut is lower than at a substation. As a result cable size can be the same as a tie-in.

There shall be no track-to-track tie-in connection at sectioning huts as each track is directly connected to a sectioning hut negative busbar which is already interconnected. Therefore, a surface run tie-in connection is unnecessary as shown in Figure 3.

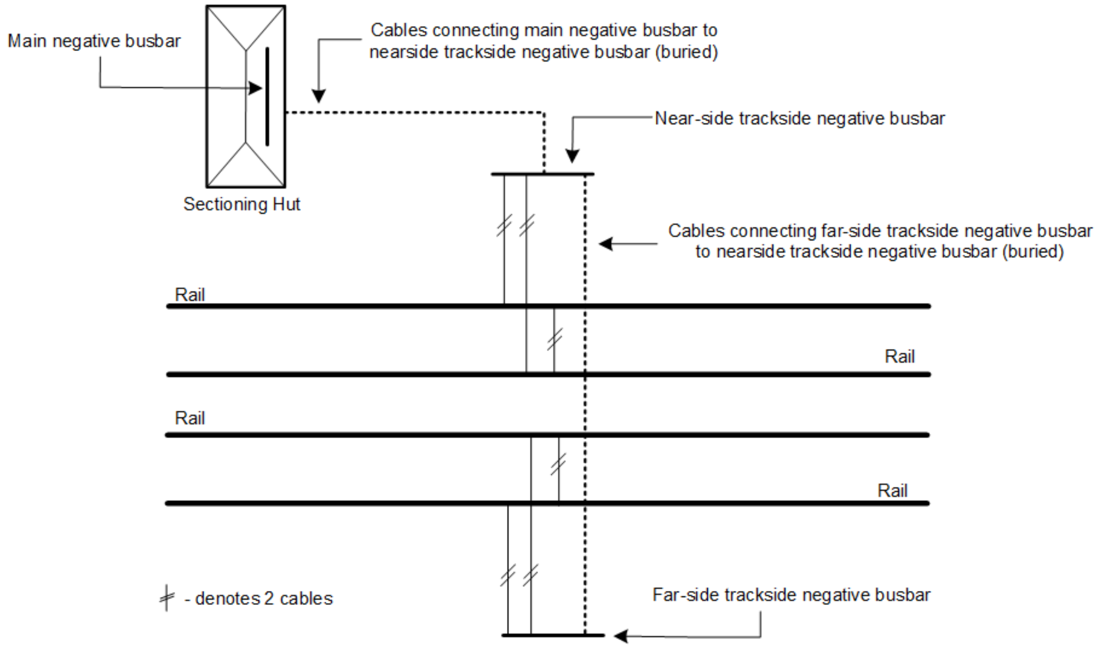

Figure 3 – Traction return connections to negative busbars at a sectioning hut

In multiple tracks areas, where there are no intermediate sectioning hut negative busbars that are connected to the inner roads, the middle tracks shall not be bonded to the outer tracks (daisy chained). Instead separate connections shall be run to the nearest negative busbar to prevent overloading the outer track cables. These separate connections shall be run in an underline crossing. Surface running of the cables under the adjacent track shall not be permitted, as shown in Figure 4.

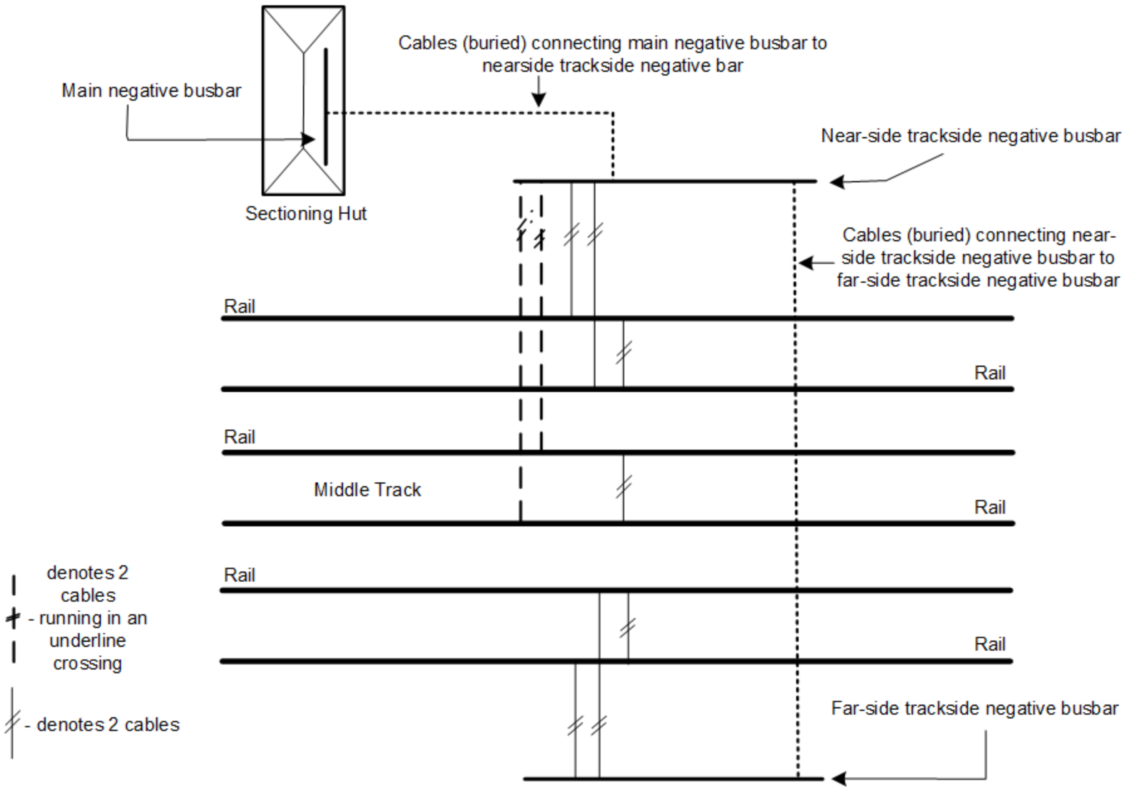

Figure 4 – Traction return connections to negative busbars for multiple track areas at a sectioning hut

Section 6.1 Bonding at Points and Crossings

Add the following at the end of Section 6.1:

Bonding through points is generally not required in axle counter areas. However, bonding shall be provided around any mechanical (bolted) joints in the rail in axle counter areas.

All rails shall carry traction return current to minimise the risk of points magnetisation. As there is no need for insulated rail joints if the points layout is fully welded (continuous switch rails and a cast V crossing) there is no need for any additional bonding.

A typical crossover in an axle counter area showing exothermic welding bonds around the heel joint (for heeled switch rails) and a fabricated (jointed) V crossing is shown in Figure 5.

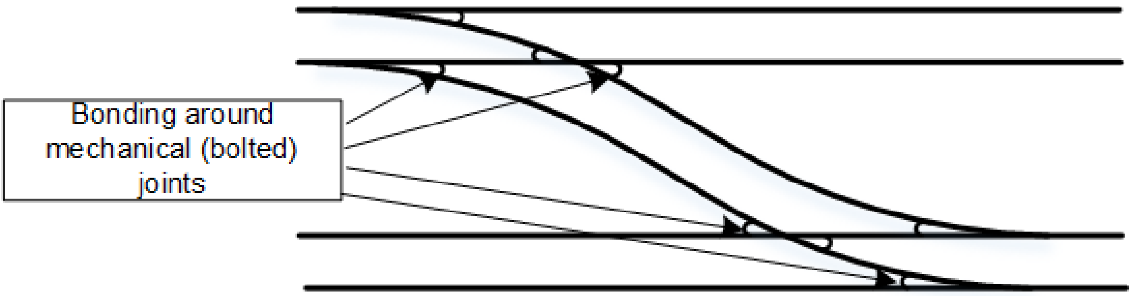

Figure 5 – Typical bonding arrangement through points

Bonding requirements (or the lack thereof) in a crossover where flexible switch rails have been installed and monolithic (single piece) V crossings are used is shown in Figure 6.

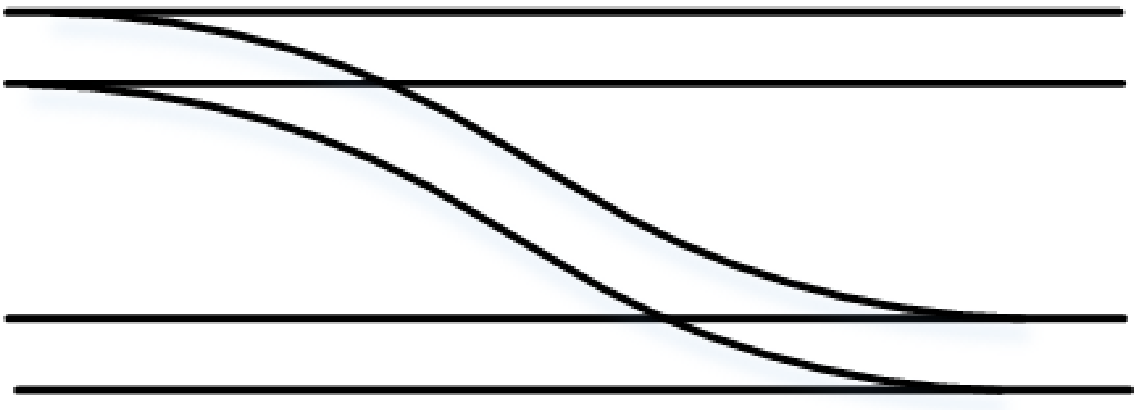

Figure 6 – Arrangement where the switch rail and V crossing are single pieces and electrically continuous

Section 6.6 Tie-in Bonding

Add the following at the end of Section 6.6:

Tie-in connections shall comprise of the daisy chaining of all rails in axle counter areas.

All rails shall be connected by two cables to the adjacent rails as shown in Figure 7.

Figure 7 – Tie-in connection

Section 6.6.1 Tie-in Bonding Interval

Add the following at the end of Section 6.6.1:

Generally, tie-in bonding interval shall be between 500 m and 800 m except in areas where lines are segregated. The maximum interval of tie-ins in areas of segregated track shall be 1600 m.

The project representative shall consult with the electrical supply asset manager, which manages the traction supply, to determine if there are any constraints on the traction supply in the proposed axle counter areas.

If there are constraints on the traction supply, such as a reduced DC feeder circuit breaker setting or high rail to earth voltages, the project representative shall ensure that the tie-ins are installed at 500 m intervals.

If there are no constraints on the traction supply, the project representative shall evaluate both the rating and the condition of the existing bonding. If the bonding is rated for light traction or is in a dilapidated condition requiring renewal, the project representative shall ensure that the tie-in connections are replaced and that the interval between the tie-ins is 500 m. However, tie-in intervals at distances greater than 500 m and less than 800 m (that is, replacement on a like for like basis) shall only be considered if an increase in traction loads is unlikely, which could then result in the need for reducing the intervals between tie-ins.

If the traction bonding is in good condition and there are no issues with the traction supply system in areas where a double rail return already exists (meaning all rails are part of the traction return circuit), the existing interval between tie-ins may remain unchanged provided that the distance between tie-ins is between 500 m and 800 m.

Tie-in intervals in areas with single rail track circuits are set to 300 m to reduce the effect of DC voltages developing across the track circuit relay. In converting a single rail track circuited area over to axle counters, all rails shall form part of the traction return circuit. In locations where axle counters replace single rail track circuits every second tie-in connection may be removed so that the end result is tie-ins at approximately 600 m intervals provided that there are no other issues (traction system limitations or the condition of the existing bonding).

Figure 8 outlines the decision-making process discussed in the preceding paragraphs within Section 6.6.1.

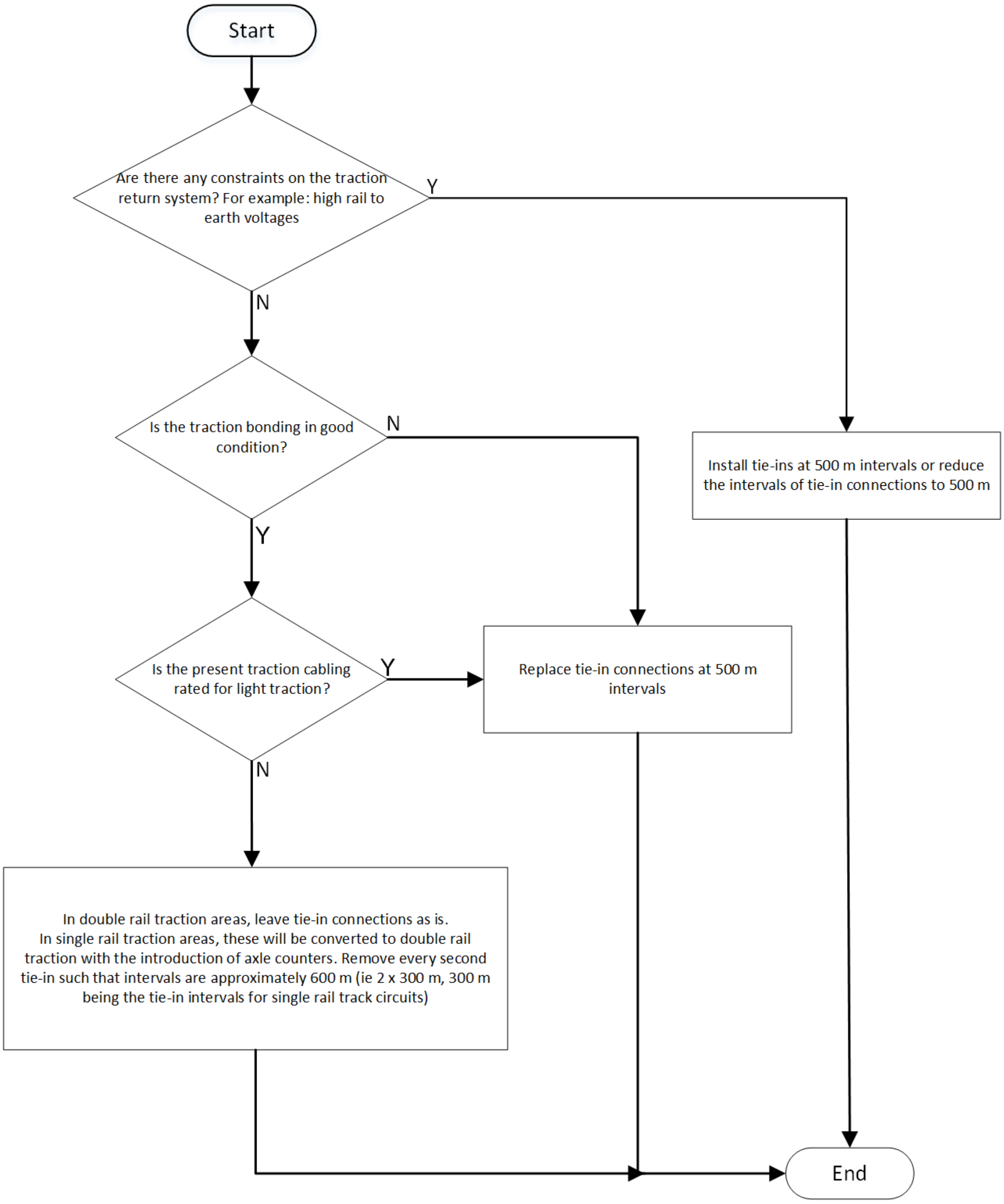

Figure 8 – Assessment flow chart for determining tie-in intervals

Tie-ins shall not be installed at intervals greater than 800 m except in areas where lines are segregated such as in segregated tunnels. In areas where lines are segregated the designer shall ensure the tie-in interval best fits the traction supply requirements, that is, limitations on DC circuit breaker settings and rail to earth voltages. The maximum interval of tie-ins in areas of segregated track is 1600 m.

Following an assessment of the traction return system for the area described in the preceding paragraph, a decision shall be made as to whether to retain the existing intervals of tie-ins or to reduce these to 500 m. If for reasons on site that a tie-in cannot be installed at the defined interval because of an inherent obstruction, for example, a bridge, the interval between tie-in connections shall be no less than 300 m and no greater than 800 m. The intervals between tie-in connections around the obstruction shall be managed in a way that best suits the specific conditions. Generally, this should be achieved by evenly spacing the tie-ins on either side of the obstruction, up to the next tie-in connection that is not affected by the obstruction.

As tie-in connections closer to substations also carry higher currents than those in mid-sections the distance between the first tie-in connections on either side of a substation shall be kept to the correct distance. These distances should not be extended.

The nominated 300 m minimum / 800 m maximum distances while subjective are based on the following:

- The maximum distance of 800 m is based on the minimum distance for tie-ins in track circuited areas where heavy traction loads exist. These could have been closer but for the constraint imposed by the track circuit.
- The minimum distance of 300 m is more subjective but is based on the frequency for tie-in connections for single rail track circuits as shown in Figure 9.

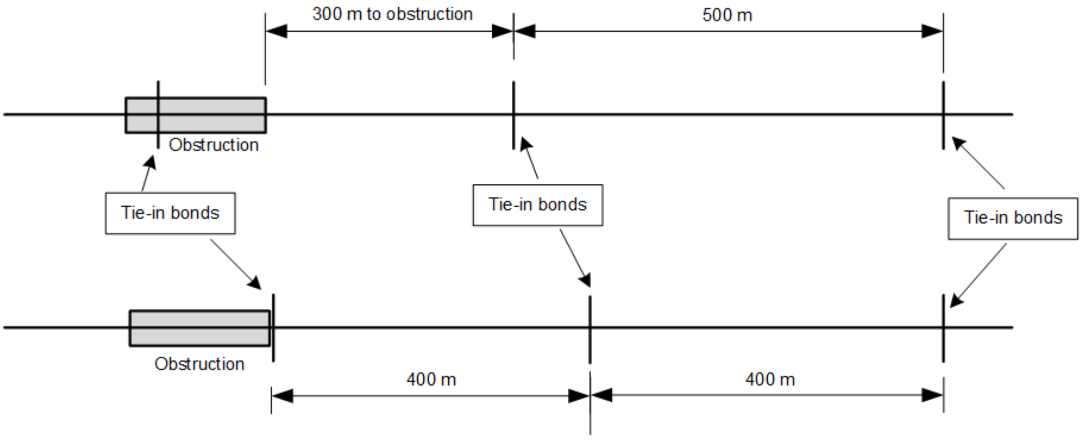

Figure 9 – Managing obstructions for tie-in placement

Section 6.6.3 Track Circuit Integrity Considerations

Add the following new Section 6.6.4 after Section 6.6.3:

Section 6.6.4 Tie-in Bonding at Axle Counter Track Circuit Interfaces

Axle counter bonding rules shall apply to the axle counter section at locations where axle counters interface with track circuits as shown in Figure 10. Track circuit bonding rules shall apply to the track circuit section as shown in Figure 10.

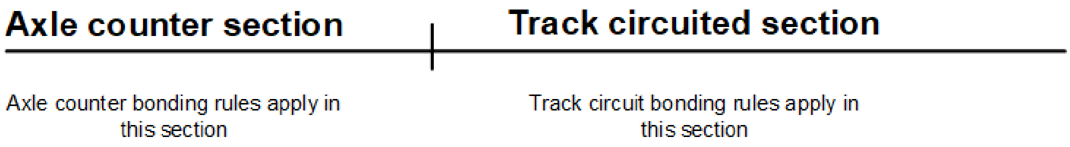

Figure 10 – Tie-in arrangement at an axle counter – track circuit interface

The designer shall take into account any alternative paths in the axle counter section in track circuit bonding design.

Section 6.8 Bonding at Friction Buffer Stops

Add the following at the end of Section 6.8:

The insulated rail joint is not required in axle counter areas. However end of siding bonding shall be provided.

The bonding shall be installed directly in front of the friction buffer stop. This ensures that if the buffer stop is struck, the friction shoes do not damage the rail connections as the buffer stop slides back along the rail as shown in Figure 11.

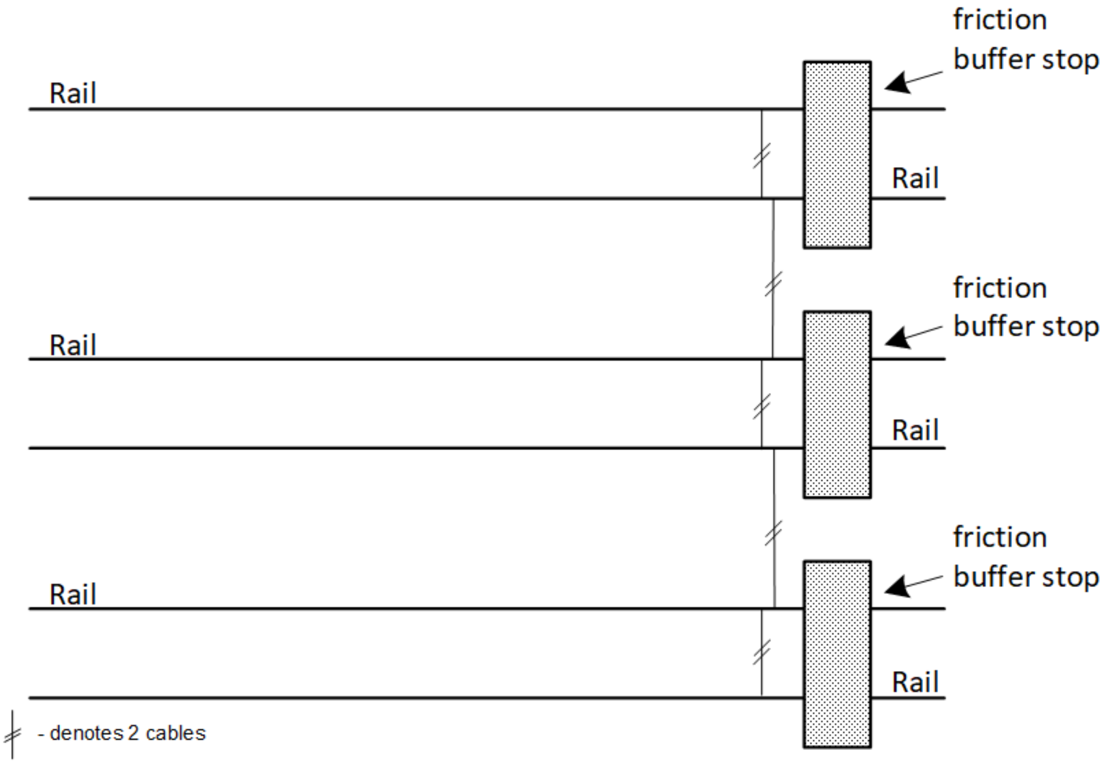

Figure 11 – Tie-in bonding arrangement at friction buffer stops

Section 6.9 Tying-in Non-Track Circuited Tracks

Add the following at the end of Section 6.9:

The requirements in Section 6.9 shall apply in axle counter areas.

Section 6.10 Installation of Tie-in and Cross-Bond Cables

Add the following new Section 6.11 to 6.14 after Section 6.10:

Section 6.11 Axle Counter Section Interface to Track Circuit Sections

Where an axle counter section interfaces with either a single or double rail jointed track circuit, all requirements outlined in Section 6.11 shall apply. This includes double rail track circuits with or without impedance bonds, or of the audio frequency jointless types.

Section 6.11.1 Axle Counter Section Interface to Jointless Track Circuit Sections

Figure 12 shows a traction interface between an axle counter section and a jointless track circuit section. The length of the tuned loop is determined by the type of track circuit with typical lengths being 19 m, 20 m or 23 m.

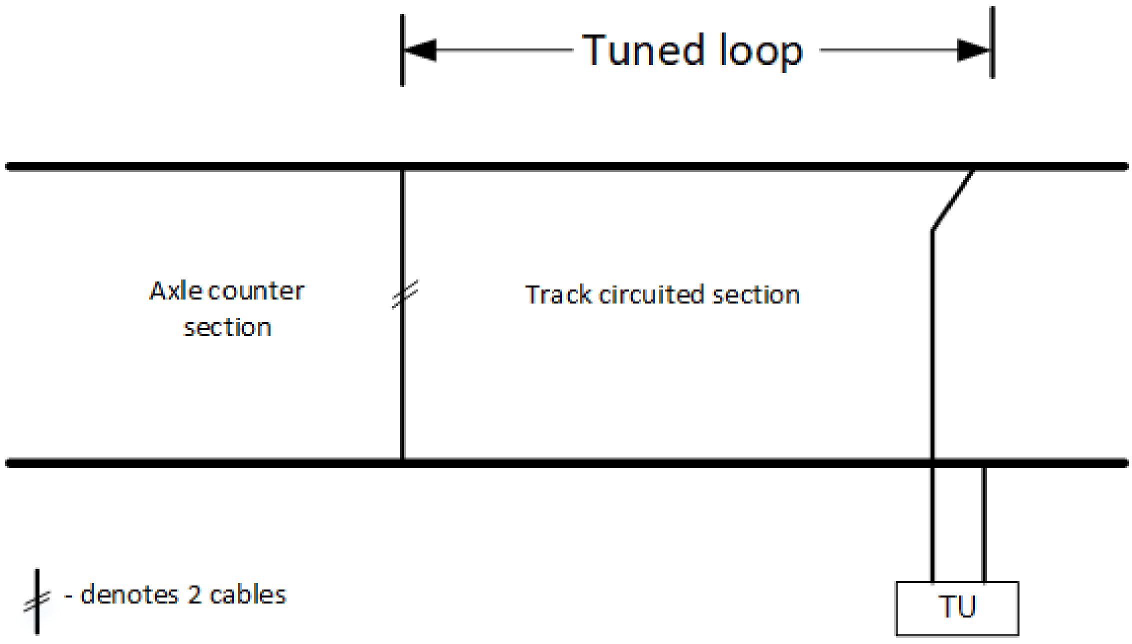

Figure 12 – Axle counter to jointless track circuit bonding arrangement

The short circuit bond performs two functions:

- emulation of the low impedance of the adjacent tuning unit
- provision of a current path for the sharing of traction currents in the event of a broken rail.

The short circuit bonds shall be rated to carry at least 50% of the total expected traction current in the event of a broken rail.

Section 6.11.2 Axle Counter Section Interface to Double Rail Jointed Track Circuit Sections

There shall be a bifurcated style connection from the four way impedance bond to the axle counter section, with a short circuit provided across the rails. The benefit of this is that, in the event of a broken rail, traction currents are evenly distributed in the cabling as shown in Figure 13.

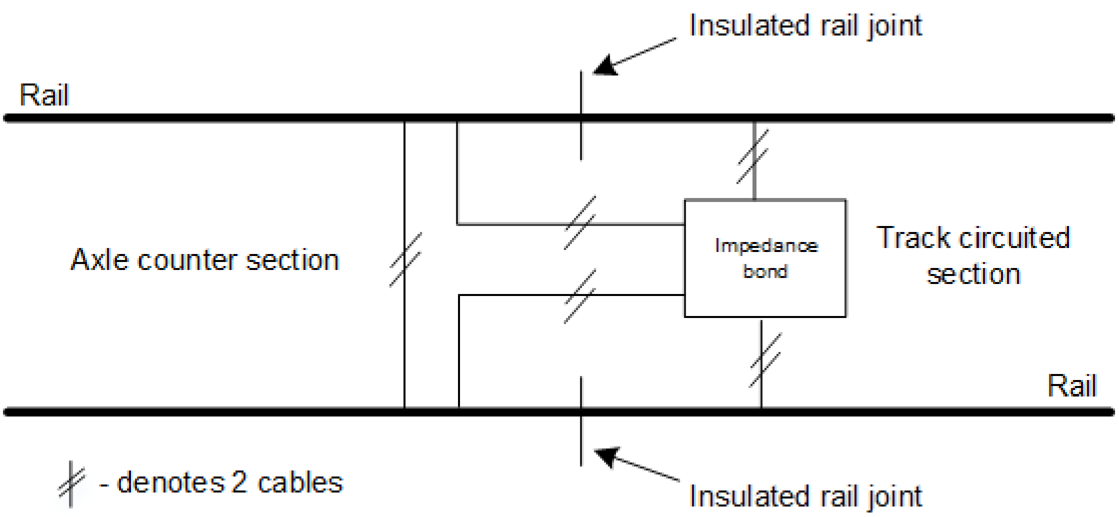

Figure 13 – Bonding arrangement at the interface between an axle counter and a double rail jointed track circuit

Section 6.11.3 Axle Counter Section Interface to Single Rail Track Circuit Sections

Four bonds shall be provided at the axle counter single rail track circuit interface to ensure that in the event of a broken rail full load traction currents can flow through these bonds as shown in Figure 14.

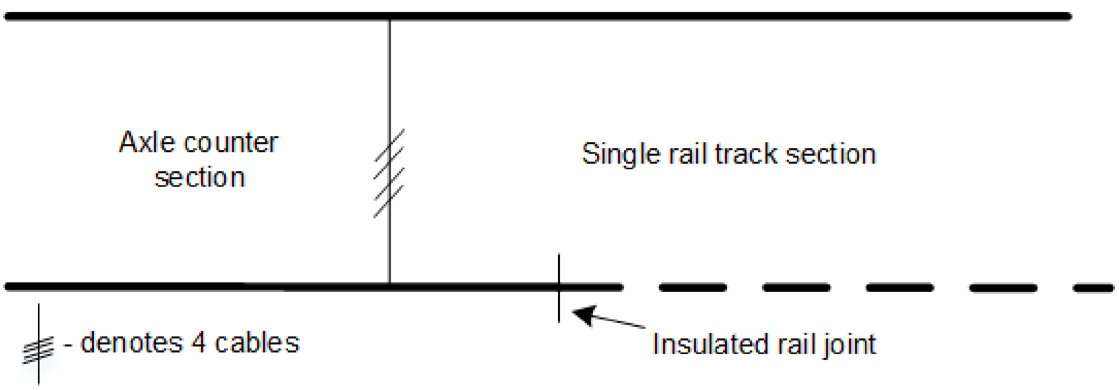

Figure 14 – Bonding arrangement at the axle counter single rail track circuit interface

Section 6.12 Bonding Through Sidings

There is a funnelling of return currents into the neck of the sidings at sidings where multiple roads exist and where electric trains are stabled. This may lead to issues with points magnetism given the cumulative traction load. A tie-in shall be placed at a point where the sidings converge or diverge connecting back to the main line with the aim of providing an additional path for currents away from the neck of the sidings as shown in Figure 15.

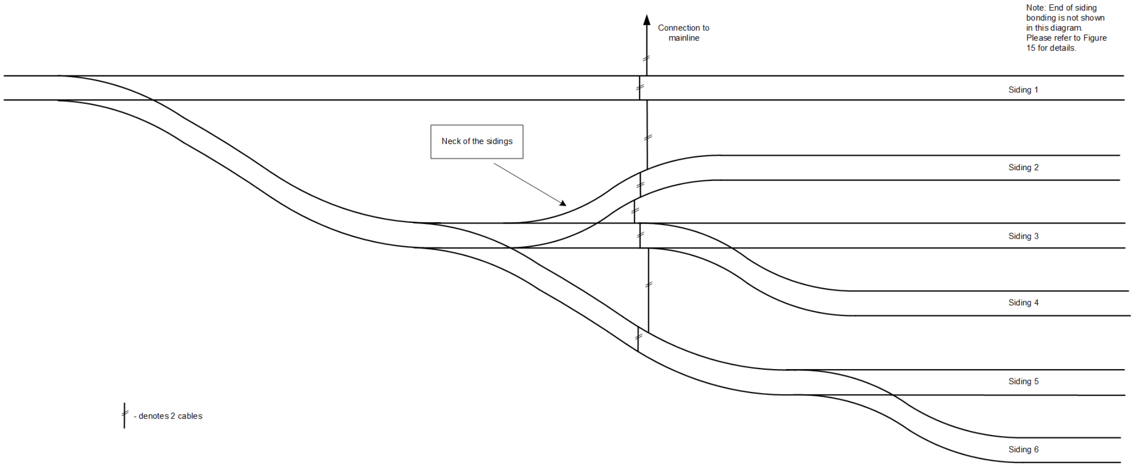

Figure 15 – Bonding arrangement at siding entrance

In all electrified sidings, including the extremities of electrified roads inside fleet maintenance facilities, the end of the sidings shall be tied together and tied in across to the main line in accordance with Section 6.9 as shown in Figure 16.

Figure 16 – Bonding arrangement at end of siding

Section 6.13 Guard Rails

The requirements of axle counter original equipment manufacturer for each wheel sensor type shall be considered with respect to the clearances from other wheel sensors, guard rails and other infrastructure.

In axle counter areas generally there is no requirement to have insulated joints in the guard rails. However, where there are balises within the vicinity of the guard rails, insulation joints shall be installed as per balise requirements. Refer to TS 05333.31 for more details about balises within axle counter areas.

Section 6.14 Overhead Wiring Isolation Switch to Rail

The function of an overhead wiring isolation switch is to provide a connection between the isolated section of the overhead wiring and the rail, allowing safe access to the catenary system.

At any location where an overhead wiring isolation switch is to be installed, all rails shall be connected.

The rail connections of OHW isolation switches shall be connected to the nearest rail. Additionally, the connection shall not be located closer than 500 mm to the wheel sensor or as per OEM requirements as shown in Figure 17.

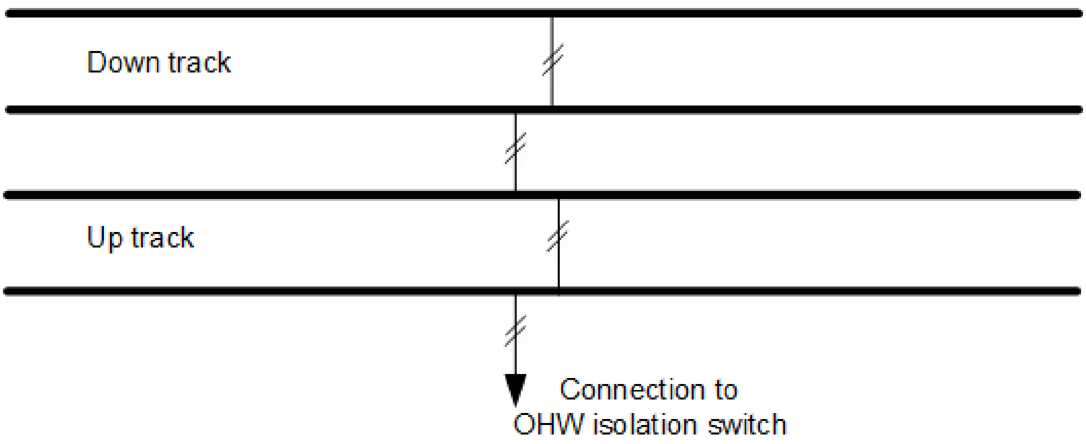

Figure 17 – Arrangement for traction bonding at OHW to rail isolating switches

The connection methodology (the style of the connection) shall be as per a tie-in arrangement. It shall also be considered in the overall tie-in connection scheme.

Section 7.3 Connection of Electrolysis Bond to Track

Add the following at the end of Section 7.3:

There is no longer the need for a signalling neutral point in axle counter areas as all rails carry traction return current. Electrolysis bonds shall be connected to the closest rail maintaining a minimum distance of 500 mm from the wheel sensor or as per OEM requirements.

Section 12 Spark Gap Arrestors

Add the following at the end of Section 12:

Any new spark gap connections shall be to the closest rail. Any new spark gap connections shall not be closer than 500 mm to a wheel sensor or as per OEM requirements.

The spark gap connections may remain in their current position when a track circuited section of line is being converted to axle counters on the basis that all rails will form part of the traction return network.

Mark 2 rail spark gap (such as 'Ferraz' or a similar product) connection to rail shall be treated the same as a spark gap connection, that is to the nearest rail.

Authorisation:

Approved by	Director Signals and Control Systems Engineering Asset Management Planning, Integration and Passenger