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Steel Sleepers – Usage and Installation Standard

ETC-02-03

Applicability

ARTC Network Wide

SMS

Publication Requirement

Internal / External

Primary Source

NSW Standard TCS 10 v2.1 dated 19/02/2009 (formerly RIC Standard TS 20 540 3 00 v1.1 draft)

Document Status

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1.0	04 May 15	Standards	Stakeholders	Acting GM Technical Standards	OSERC 12/05/2015

Amendment Record

Amendment Version #	Date Reviewed	Clause	Description of Amendment
1.0	04 May 15		First issue of Standard to supersede NSW Standard TCS 10 v2.1. Extended to network wide applicability and supported by new Procedure ETC-02-04. Further updates following original approval resubmitted to OSERC.

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1 Introduction

1.1 Purpose

This standard specifies requirements for the use and installation of steel sleepers. It covers all track classifications and includes both interspersed steel sleepers in timber sleepered track and fully steel sleepered track. It does not specify the criteria on which the choice of sleeper material (timber, steel, or concrete) is made.

1.2 Scope

This standard covers;

1. the selection of approved steel sleeper type to suit different applications.
2. the installation of steel sleepers
3. re-use of damaged sleepers and
4. the maintenance of steel sleeper track.

1.3 Responsibilities

The Manager Standards is responsible for the content of this standard.

The Infrastructure Manager is responsible for the compliance of this standard

The Civil Engineering Representative is responsible for certain decisions as prescribed in this standard.

1.4 Reference Documents

All activities and materials used in the installation of steel sleepers shall conform to relevant ARTC Standards, Procedures, Guidelines, and Work Instructions; Australian Standards; and Codes of Practice including:

AS 1085.17, Railway track materials – Steel sleepers

AS 1085.19, Railway Track Materials – Resilient Fastenings

ARTC Steel Sleeper Specification

ARTC Specification ETA-04-01 Ballast Specification

ARTC Track Geometry Standards and Procedures

ARTC Standard Classification of Lines

ARTC Standards and Procedures for Track Lateral Stability

ARTC Timber Sleeper Maintenance Standard

ARTC Procedure ETC-02-04 Steel Sleepers - Usage and Installation Procedure

ARTC Procedure for Mechanised Track Surfacing

1.5 Definitions

The following terms and acronyms are used within this document:

Term or acronym	Description
May	Activity permitted by this standard (from AS HB 162 – 2002)
Pod	The space under a steel sleeper below the sleeper deck and between the side walls of the sleeper.
PRS	Partial Re-Sleepering
Rail Anchoring	Use of “Fair” type anchors with timber sleepers and resilient rail fastenings with steel and/or timber sleepers to restrain (anchor) the rails from moving longitudinally through the sleepers.
Shall	Mandatory criterion (from Australian Standards Handbook – AS HB 162 – 2002)
Should	Guideline or recommendation (from AS HB 162 – 2002)
TAL	Tonne Axle Load

2 Application Limitations

2.1 General

Steel sleepers are different to timber and concrete sleepers, mainly because they are relatively light in comparison to their rigidity. They rely on the ballast in the sleeper “pod” to provide vertical and lateral support. The service life of steel sleepers is governed by fatigue that is not apparent until the sleeper has started to fail. Fatigue failure involves cracking of the steel sleeper in and around the rail seat. It is important to prevent excessive loads being imposed if the design service life of the steel sleepers is to be achieved.

Steel sleepers are typically installed as Partial Re-Sleepering (PRS) in existing timber track as part of a process that will eventually create fully steel sleepered track. Conversion to fully steel sleepered track may be achieved through successive PRS cycles. Alternatively, in circumstances where it is cost effective to do so, e.g. small radius curves, steel sleepers may be installed on a face.

Steel sleepers are also good conductors of electricity, which can result in problems with signalling. As a result, insulated sleepers are used in track circuited areas. In non-track circuited areas consideration shall be given to future signalling requirements, such as the installation of active level crossing protection. In circuited areas consideration shall be given to hazards that could electrically bridge the gap across the insulators provided between rail and fastenings.

Track functional performance considerations of stability, smooth ride, and electrical insulation have been used to determine the limits to the application of steel sleepers. These functional performance characteristics shall be measured by standard track measures, including track geometry and track stability, for compliance assessment.

2.2 Signalling and Other Electrical Issues

Even with insulators fitted contamination by conducting material around the fastenings or under the rail can cause signalling problems. This includes locations:

- where contaminants regularly invade the track area (coal, minerals, mud, clay, dirt etc)
- locations where the track is continually wet.

Where these conditions exist consideration shall be given to the use of alternatives to steel sleepers.

2.3 Sleeper Support

Because the functionality of steel sleepers is dependent on the restraint of the track ballast in the pod alternatives to steel sleepers shall be considered in situations where this restraint is likely to be compromised by high impact loading and/or pumping track e.g.:

- where the ballast/ formation is poor and where deflection under load is high
- at locations where track dynamic forces are high, such as at dipped joints, dipped welds, wheelburns, corrugations or bridge ends.

2.4 Sleeper Fatigue

The life of the steel sleeper will generally be a function of fatigue effects. Situations causing high levels of fatigue could shorten the life of the sleepers. These could include:

- sleeper support deficiencies
- where there is backcanting in the adjoining timber sleepers (unless this is compensated for by a denser tie pattern of the steel sleepers)
- where there is wide or tight gauge in adjoining timber sleepers that would result in a high level of gauge variation (which in turn induces additional loads in the steel sleepers)
- where the steel sleeper will be required to carry an excessive share of the load due to the poor condition of adjacent timber sleepers.

The fatigue impact of the above situations could cause premature failure of the sleepers, fasteners, or insulators (where fitted).

2.5 Rail Creep

At locations where additional anchoring has previously been fitted the anchor pattern shall be restored in association with any resleepering work (considering a resilient fastened steel sleeper to be equal to a box anchored timber sleeper).

2.6 Environmental Effects

Steel sleepers are subject to corrosion and chemical damage similar to that exhibited by rails. Such damage will be more severe than with rails as sleepers are in more intimate contact with the ballast and subgrade materials. In locations where corrosion/ chemical damage is likely to be a problem alternatives to steel sleepers shall be considered.

Locations include:

- slag ballast
- areas of high salinity (including coastal locations)
- continually wet or moist areas such as some tunnels or some types of level crossings
- areas where corrosive materials invade the track area.

3 Steel Sleeper Types

The sleeper type chosen for installation shall depend on the operational requirement and whether there are track circuits present. The sleeper types and their application are described in Table 1 below.

Table 1: Sleeper Type and application

Steel Sleeper Type	Application[1],[2]
M7.5 non insulated	Where no track circuits are or may be provided.Sleepers are punched for 47 kg/m or 53 kg/m rail.*
M8.5 insulated	Where track circuits are or may be provided. Sleepers are punched for 47 kg/m or 53 kg/m rail.*
M8.5 non insulated	Where no track circuits are or may be provided.Sleepers are punched for 53 kg/m rail only.*
M10.0 insulated	where track circuits are or may be provided. Sleepers are punched for 53 kg/m rail only.*
2nd hand damaged sleepers **	Lightly trafficked lines and sidings **

Note:

1. *Where an increase in TAL is proposed or lines carrying significant 25 TAL, a risk assessment is required to determine the suitability of the sleepers.*
2. *Only on Interstate, Intrastate and light weight lines*

* Hole punching for 47 kg/m rail will accommodate 50 kg/m rail and some 41 kg/m rail sections. Hole punching for 53 kg/m will accommodate 60 kg/m rail.

** Steel sleepers that have been bent or otherwise damaged by derailment or extraction process may be reused on sidings and lightly trafficked mainlines subject to engineering inspection and assessment. They shall not be used on heavily trafficked mainlines. Refer to section 10 for conditions of use.

Only steel sleeper accessories approved in accordance with the requirements of ARTC Procedure EGP-21-01 New Equipment & System Approval shall be used as fastenings and insulators. Alternatively the steel sleeper system, including fastenings, is acceptable if it complies with the product specification. Steel sleepers shall not be used as transoms on bridges.

Special steel sleepers are available for use at joints on lines with 60 lb/yd (30 kg/m) rail. Alternatively, timber sleepers may continue to be used at joints.

Gauge widening for curves less than 200 m radius is not required for steel sleepers.

4 Compatibility with Rail Type

Steel sleepers shall only be used with rail sizes up to and including the size for which they have been designed and tested in accordance with the Steel Sleeper Specification Spacers, or sleepers with additional holes may be used to provide adjustment so that more than one rail size can be accommodated.

Where steel sleepers are to be used for rail sizes less than 47 kg/m, then the sleeper systems to be used shall be adjustable to accommodate future rail upgrading to 53 kg/m (or larger size) unless otherwise approved by a Civil Engineering Representative.

5 Rail Insulation

Where one or more rails are to carry signalling current then both rails shall be insulated. Insulated sleepers shall comply with the applicable insulation requirements. Where any installation of steel sleepers is planned, a determination shall be made as to the probability of any future signalling installation. This is especially the case with major level crossings. Where future signalling is likely, the use of insulated steel sleepers shall be considered.

For existing signalled level crossings where the track speed is likely to be increased the additional length of track that could be signalled shall also be insulated. The track to be insulated shall cover the distance a train would travel at the maximum permissible speed (including future speed increases) for 30 seconds.

Note: Replacement lock-in shoulders are available to convert standard non-insulated steel sleepers to insulated sleepers, without the need to replace the whole sleeper. However, it is preferable to install standard insulated steel sleepers in the first place if it is likely that track circuits will be required in the future.

6 Ballast Grading

Ballast grading for steel sleepers interspersed with timber sleepers shall be in accordance with ARTC Engineering Standard Ballast Specification.

7 Rail Anchors

Steel sleepers are attached to the rail with resilient fasteners that provide resistance to rail creep. Steel sleeper resilient fasteners typically provide at least equivalent creep resistance to fair type anchors. Fair type anchors shall be replaced against timber sleepers after PRS to restore the pre-existing anchor pattern or, a minimum of one in three sleepers anchored (including both fair type anchors and resilient fasteners) whichever is greater.

8 Sleeper Pattern

Recommended minimum sleeper patterns are given in Table 1. Denser sleeper patterns should be used to address sleeper fatigue and fastening failure issues.

Table 2 Minimum Tie Patterns

Route Class/ Condition of Adjoining Timber	Curvature		
	< 400 m Radius	<600m radius	>600 m radius & tangent track
Heavily trafficked lines	* 1 in 4	1 in 4	1 in 4, may be extended to 1 in 6 if sleeper condition permits.
Lightly trafficked lines	1 in 4	1 in 6	1 in 6

Note: A variation in the sleeper placement of one sleeper is still considered to be to pattern as long as the pattern is generally maintained (e.g. 1 in 4 would allow occasional 1:3 or 1:5)

* Steel sleepers not recommended. Concrete sleepers preferred as they provide better lateral stability. If steel sleepers are used a denser sleeper pattern shall be considered.

Steel sleepers may be used under joints where bar type fishplates are used, however the practice is not recommended.

The clumping of steel sleepers is generally not an immediate safety issue however should be avoided where feasible as the clumping of sleepers whether they are timber, steel or concrete results in variability in track modulus which over time can induce faster rates of degradation to the track asset. The requirement in this case is that the ARTC geometry standards are applied.

Where face renewal is normal practice at special locations such as level crossings, track reconditioning, pipe installations, turnout removal etc., it is not considered to be clumping.

When undertaking PRS, adjoining sleepers shall provide vertical support so that newly installed steel sleepers are not subject to excessive vertical loads or high levels of deflection.

Centre-binding in adjoining sleepers shall be corrected with resurfacing.

Where there is back canting or the condition of surrounding timber sleepers is poor, a closer tie pattern should be considered.

9 Sleeper Support after Installation

Steel sleeper installation and track resurfacing shall be performed in accordance with relevant ARTC procedures.

It is a requirement that during the resleepering process the track shall be mechanically packed to ensure effective support.

The objective of the track resurfacing stage of the steel sleeper installation process is to apply the design track geometry, to fill the steel sleeper pod with ballast, to pack ballast under remaining timber sleepers, and to regulate ballast to the required profile.

During tamping:

- The centre, middle section of all steel sleepers must be tamped in addition to the rail seat areas to fill the entire area under the sleeper with ballast. Centre tamping prevents ballast migration away from the rail seat areas.

- Final track alignment changes should be made before making the last surfacing pass and lift.

Following resurfacing:

- A minimum of 10% of the resurfaced steel sleepers shall be inspected.
- Where ballast inspection holes are provided, the height of the ballast in the sleeper pods shall be such that the gap between the underside of the sleeper deck and the ballast in the sleeper pod shall be ≤ 25mm. The ARTC representative for the works should agree on a plan to remedy any pod depths greater than 25mm. Pod depths more that 50mm shall be immediately rectified or protected.
- The ballast within the sleeper shall be tight
- Deflection of steel and timber sleepers under normal traffic loadings should be consistent and no more than 5mm
- There should be no cyclic top or line in evidence.

10 Criteria for reuse of damaged steel sleepers

Steel sleepers that are damaged by derailment or extraction may be reused in lightly trafficked lines and sidings under the following conditions:

- Damaged sleepers selected for repressing shall be closely examined and not exhibit any cracking, splitting, sharp edges or any other defects around the lock-in shoulder holes.
- Damaged sleepers selected for repressing shall be measured for deformation at the edge of the lock-in shoulder hole. Deformation is not to exceed 10 mm from the upper plane surface level.
- Damaged sleepers selected for repressing shall be inspected for cracking or fatigue indications in other areas of the section, evidence of bending and distortion, corrosion, pitting and other loss of section.
- Repressed steel sleepers shall exhibit round lock-in shoulder holes.
- Repressed steel sleepers shall have a flat rail seat area with a rail cant of 1:20. Care shall be taken not to introduce a convex surface into the top of the sleeper.
- Repressed steel sleepers shall hold the correct track gauge within allowable limits when installed.
- Care should be taken when repressing the steel sleeper not to introduce any gouging to the underside flange to web radius.
- No localised heat is to be used during repair.
- Repressed steel sleepers shall be stamped with a permanent ‘R’ alongside the manufacturers stamp for identification purposes. This stamp location shall not be within the area of the rail seat or the lock-in shoulder hole.
- When installed, the steel sleepers are to be adequately packed with ballast.
- The frequency of consecutive repressed damaged steel sleepers should be no more than 1:2.
- The repressed steel sleepers shall only be located on sidings, on tangent track or curved track with a minimum radius of 1000 m.

11 Lateral Stability

The track lateral stability shall be managed in accordance with the ARTC track lateral stability standards.

The ballast profile for steel sleepers should meet the minimum applicable ballast standards.

It is acknowledged that currently there maybe locations such as narrow embankments where the standard width of ballast profile cannot be feasibly installed or maintained. These locations are considered as part of the inspection regime including the annual track stability analysis which has provisions for reduced profiles and additionally mandates specific responses.

Dynamic stabilisation will provide better initial lateral (as well as vertical) stability, if timber sleeper condition permits its use, by accelerating compaction and reducing subsequent settlement of the ballast. It may also reduce the period of any temporary speed restriction.

For curves less than 400 m radius consideration shall be given to additional measures to enhance stability and reduce the likelihood and extent of curve pull-ins. Such measures could include shoulder ballast compaction and increasing shoulder width.

It should be noted that curve pull-in is more likely if resleepering is carried out in the colder months.

Lateral stability is also reduced at the interface between 100% steel sleepers and timber sleepers or a timber/steel mix, or between steel sleepers and concrete sleepers. This is because of the track stiffness interface and because of the potential for rail bunching. In consequence such interfaces should be avoided within curves and transitions.

12 Maintenance and Inspection

During scheduled track inspections defects will be recorded and reported on the inspection/defect report form

An appropriate priority and response shall be determined in accordance with the Asset Maintenance Works Management Procedure. The appropriate priority shall be determined by an assessment of risk based on, but not limited to:

- visual inspection of pod ballast deficiency
- other adjacent deficient steel sleeper pods
- timber sleeper condition and pattern (where existing)
- track geometry
- track stability assessment factors
- seasonal factors
- traffic usage (gross tonnes, axle loads)
- passenger train use
- track line speed
- track curvature.

A temporary speed restriction shall be considered as a component of any maintenance response to a reported defect.

This assessment should also ensure compliance with the following track standards:

- The limits for acceptable track geometry and the default responses are contained in The ARTC track geometry standards and procedures
- The assessment of lateral track stability and intervention limits are contained in Track Stability Standards).
- The condition of remaining timber sleepers after steel PRS shall comply with Timber Sleeper Maintenance Standards

Where corrective actions are required, they shall be taken as directed in clause 9.

13 Documentation Requirements

The following information shall be recorded as part of the installation process for steel sleeper PRS or face steel installation projects:

- location of sleepered sections
- date of installation
- type of steel sleepers used including fittings used to adjust for different rail sizes and whether insulated or non-insulated
- the PRS sleeper pattern used and the sleeper pattern resulting
- track measurements as required by ARTC procedure for Mechanised Track Surfacing
- any non-conformances
- any defects identified requiring corrective action.

14 Guidelines for Civil Engineering Representative

Civil Engineering Representatives may approve variations from recommended practices, to the extent of their authority, but not mandatory requirements. The requirements contained in this Standard and accompanying Procedure ETC-02-04 provide for steel sleepers to achieve their design life. In approving variations due recognition should be taken of:

- future PRS requirements and the sleeper strategy for the line
- the effect of proposed re-sleepering on track stability and the potential to create misalignment hazards
- the projected operational loading on the track
- safety and reliability
- the effect on future asset maintenance and asset viability (including the fatigue life of the sleepers).

The basis for such decisions shall be recorded and details filed and referenced.