MOD UK Railways

Permanent Way Design and Maintenance

Standards

Issue 5

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CONDITIONS OF RELEASE

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ANNEXES

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Preface

The Ministry of Defence (MOD) owns, operates and maintains a number of railway systems at diverse establishments for the movement of material both within establishments and between establishments, UK ports and the Channel Tunnel. In addition the MOD estate includes specialist railway systems for mobile targets.

Operation of railway systems requires that permanent way is constructed and maintained for the safe passage of railway vehicles. Inherent within this requirement are standards of permanent way management, design, construction and maintenance that ensure the safety of all personnel and vehicles encompassed by the operations and maintenance of a railway.

External guidance upon permanent way is concentrated within Network Rail and is much concerned with the high speed running of heavy freight and passenger traffic. MOD railway systems are predominately freight carrying and operated at low traffic speeds.

This document sets the standards for MOD railways and is a manual for the use of MOD staff, military, contractors, consultants, sponsors, and project managers involved in the management, design, construction or maintenance of MOD railways. It has been devised for the use of the Crown and its contractors in the execution of contracts for the Crown. The Crown hereby excludes all liability (other than liability for death or personal injury) whatsoever and howsoever arising (including, but without limitation, negligence on the part of the Crown, its servants or agents) for any loss or damage however caused where the document is used for any other purpose.

Compliance with the contents of this document will not in itself confer immunity from legal obligations.

This document was prepared under the instruction of Defence Infrastructure Organisation, Technical Services, Engineering and Construction. It supersedes previous issues 1-4 of this document and Defence Estates Design and Maintenance Guide 09 Railways.

Enquiries relating to the application and content of this manual should be directed to:

Defence Infrastructure Organisation (Technical Services)

Acknowledgements

The bibliography lists published works used as reference material when writing this document. Much of the content is a rewrite of the former Defence Estates Design and Maintenance Guide 09 Railways, which was further developed through Issues 1-4 of this document written by 170 (Infrastructure Support) Engineer Group Royal Engineers on behalf of MOD DE&S.

The support and subject matter expertise from the Principal Railway Infrastructure Engineer at MOD DIO was instrumental to this publication.

1 The Permanent Way

1.1 INTRODUCTION

This document sets out the standards and practice for permanent way design, construction and maintenance and is applicable to all MOD railway facilities.

This document supersedes Defence Estates (DE) Design and Maintenance Guide 09 Railways, which in turn superseded Property Services Agency (PSA) Technical Instruction CE37: Railways Permanent Way Standards for Design, Construction and Maintenance 1989. It provides current MOD organisational structure within the context of current permanent way national standards, good practice and legislation.

The aim of this document is to give a broad overview of permanent way design, construction and maintenance, and to define the required technical standards. These standards ensure compliance with JSP 790 Defence Rail Regulations, and consequent alignment with the statutory Railways and Other Guided Transport Systems Regulations.

The technical standards apply to all MOD operational railways (those supporting the movement of trains or rail mounted vehicles), including target railways, remotely operated railways, and narrow gauge railways over 350mm gauge.

1.2 FUNCTION OF RAILWAY TRACK

A railway track serves three functions, all of which involve the wheel/rail interface:

- Guide the railway vehicles in the required direction along a prescribed route.
- Distribute the loads and associated stresses from the vehicles into the formation.
- Provide a stable surface that gives smooth and safe running to the vehicles.

1.3 IMPOSED LOADS

1.3.1 Static Live Load

A vehicle load is transmitted through the axle to each wheel, the tyre of which bears on the head of the rail, and the interface pressures are in the order of 3 tonnes/mm². The rail transmits this load to the sleeper to which it is fastened and, as the rail/sleeper bearing area is greater, the pressure is reduced. The load is distributed through the sleeper to the ballast and the ballast further distributes the load so that, at formation level, the pressure is reduced to a value that can be applied to the formation without permanent deformation occurring.

Table 1.1 Typical Static Loads

Item	Load (tonne)
Heavy freight trains – gross	1000 – 2000
Single passenger coach – gross	20 – 50
Single locomotive	60 – 120
Axle loading – locomotives and freight	20 – 25
Axle loading – passenger coaches	10 – 15

1.3.2 Dynamic Loads

A moving vehicle also imposes dynamic loads that are summarised below. The magnitude of dynamic forces increases considerably as train speed increases.

- Vertical vehicle oscillations caused by poor vertical track alignment, especially at dipped rail joints.

- Vertical impact forces at rail joints; severe when joints are dipped or poorly maintained.

- Vertical vehicle oscillations and impact forces caused by vehicle wheel flats and wheel/suspension defects.

- Weight transfer from one wheel to another on an axle when a vehicle speed is greater or less than the design speed of a curve, or when cant deficiency has been allowed.

- Hammer blow caused by the vertical movement of wheel counterweights on the driving wheels of some locomotives.

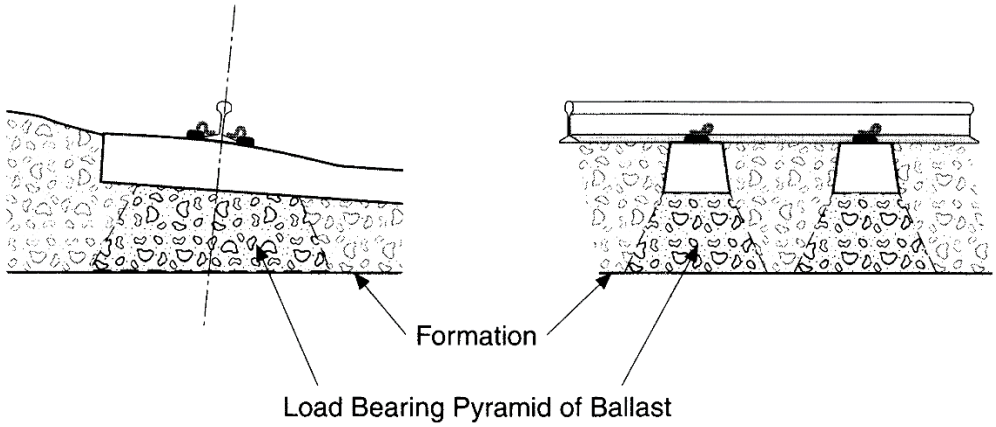
- Nosing – the lateral force exerted when a vehicle changes direction. This can include “hunting” of wheels on straight track.

- Centrifugal actions.

- Lateral forces due to train acceleration and deceleration.

Figure 1.1 Wheel/rail interface

Figure 1.2 Load dispersion to formation



1.3.3 Stresses Induced by Other Factors

Environmental, geophysical and climatic factors can induce both vertical and lateral stresses to the track, either through the ground or in the track materials:

- Lateral and vertical ground movement (heave and subsidence) due to tree roots, ground freezing, changes in ground water content, settlement of fill material, or geological ground movement.

- Temperature differentials and thermal movement causing longitudinal stresses in rails, which may result in vertical and/or lateral stresses.

1.3.4 Other Loading Factors on Supporting Structures

A range of other factors need to be considered when designing or maintaining track supporting structures, including bridges and earthworks. These include, but are not restricted to, the following:

- Wind.

- Temperature differentials and thermal movement.

- Sea water, rivers and water courses; considerations include:

    - Storms.
    - Potential water levels.
    - Water velocity.
    - Tides.
    - Collision impact from water borne debris.
    - Scour or undermining of structures.
    - Collision impact from road traffic.

1.4 TRACK FAILURE MODES

There are several failure modes for the track:

- Geometric – loss of track gauge, out of tolerance cross-levels, twist.

- Distortion or lateral track buckles caused by temperature differentials.

- Collapse or breakage of rails or sleepers due to over-loading, poor condition, flawed materials or damage.

- Subsidence or heave due to ground movements.

- Subsidence or pumping due to ballast failure or formation failure.

- Damage caused by derailments and misuse eg road vehicles and plant.

1.5 LAYOUT OF SIDINGS AND DEPOTS

The various railway elements of sidings and depots are:

1.5.1 Approach Tracks

Approach tracks are minor running lines or lines that connect main running lines to depot facilities. They are commonly of single-track construction and are only provided where the depot facility is not adjacent to the running lines.

1.5.2 Junctions

These allow divergence, convergence or crossing of routes by means of points, turnouts and crossings.

1.5.3 Exchange, Entrance or Reception Sidings

Exchange, entrance or reception sidings are used to facilitate the changeover of main line locomotives and depot locomotives. They may not be provided where there is no train working within a depot. In this case, the rolling stock is shunted into a single siding for loading or off-loading. Where these sidings are provided, they are constructed and maintained to the standard required by the main line railway.

1.5.4 Running Sidings

Running sidings are the principal running tracks within the depot.

1.5.5 Standing or Sorting Sidings

Where standing sidings are provided, rolling stock is stabled whilst awaiting loading or unloading, or awaiting assembly/disassembly into/out of main line trains.

1.5.6 Loading Sidings

Loading sidings are adjacent to the loading and unloading facilities of the depot.

1.5.7 Rail Loops

A large depot may have many rail sidings at isolated locations and may be connected to the exchange sidings by a single line. Greater flexibility in train operating is achieved if the sidings are connected by a loop so that if an incident does occur on one of the lines, traffic is still able to move.

Figure 1.3 Typical simple sidings and depot layout

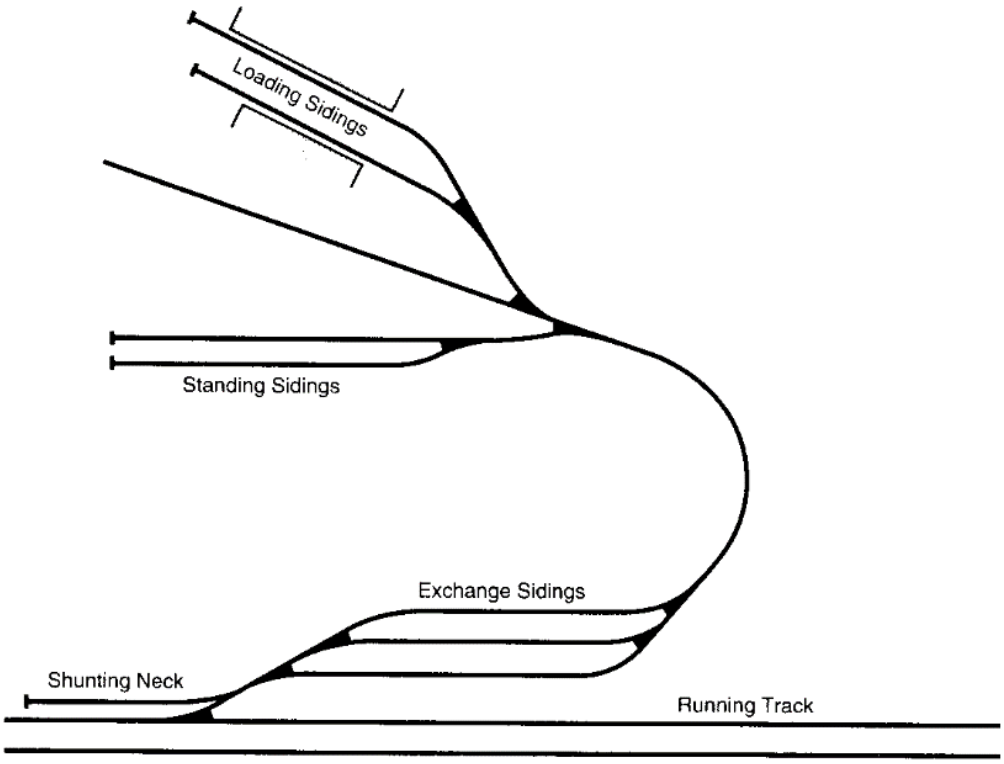
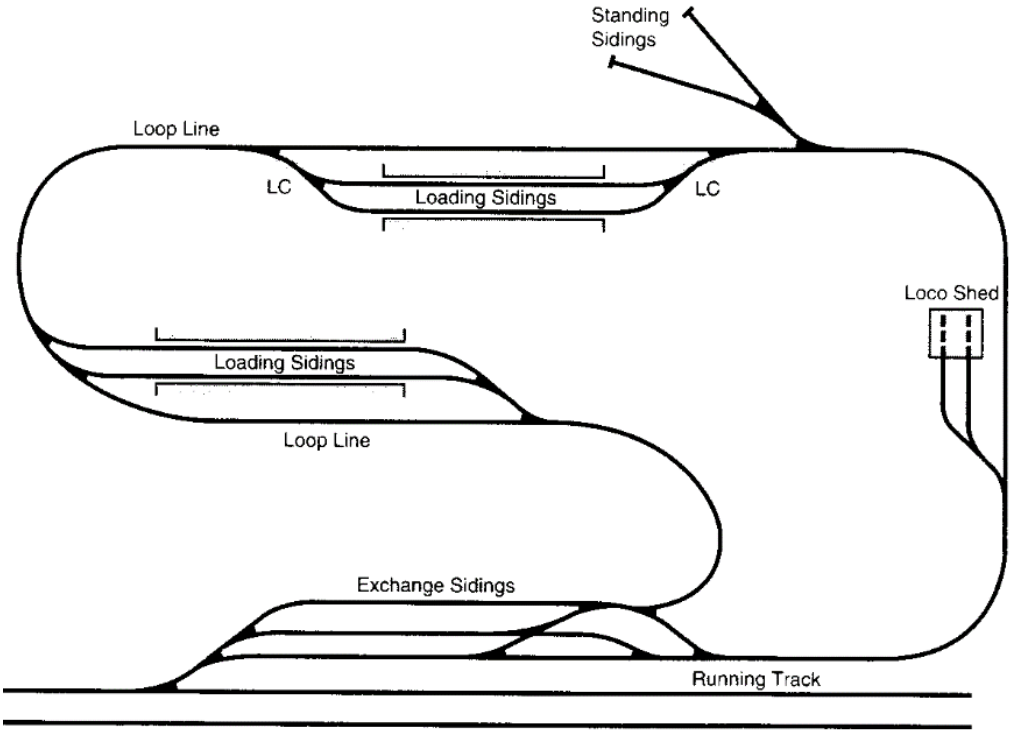


Figure 1.4 Typical depot layout with loop line



1.6 STANDARD AND NARROW GAUGE RAILWAYS

The railway track commonly found in MOD facilities falls into two main types, each specified according to function.

1.6.1 Standard Gauge

Standard gauge track is similar to that found in most British railways and is normally chosen for its ability to support high tonnages, faster speeds and compatibility with the European rail network. Standard gauge has traditionally been 1435mm (4'-8½") and refers to the distance between the inside face (running edge) of each running rail. Some track, mainly continuously welded rail (CWR), from the 1980-99 period, was installed at 1432mm gauge; however standard gauge at 1435mm is the current national network standard gauge. The dimension is fixed and is widened only to facilitate movement of rail vehicles around tight curves.

1.6.2 Narrow Gauge

Narrow gauge track is comprised of lighter components and is therefore likely to be used for transporting lighter, smaller loads using tighter radii within self-contained distribution or target railways. Narrow gauge railways may have a track gauge within the range 600mm to 1000mm. Typical gauges are 600mm, 610mm, 762mm and 1000mm.

2 Elements of Permanent Way

2.1 INTRODUCTION

The principal components of railway track are rails, sleepers, fastenings, ballast and formation. Normal uninterrupted track may be straight or curved and is termed “plain line”. Points or turnouts are used to divert trains between or across tracks and consist of switches and crossings (S&C).

2.2 FORMATION AND DRAINAGE

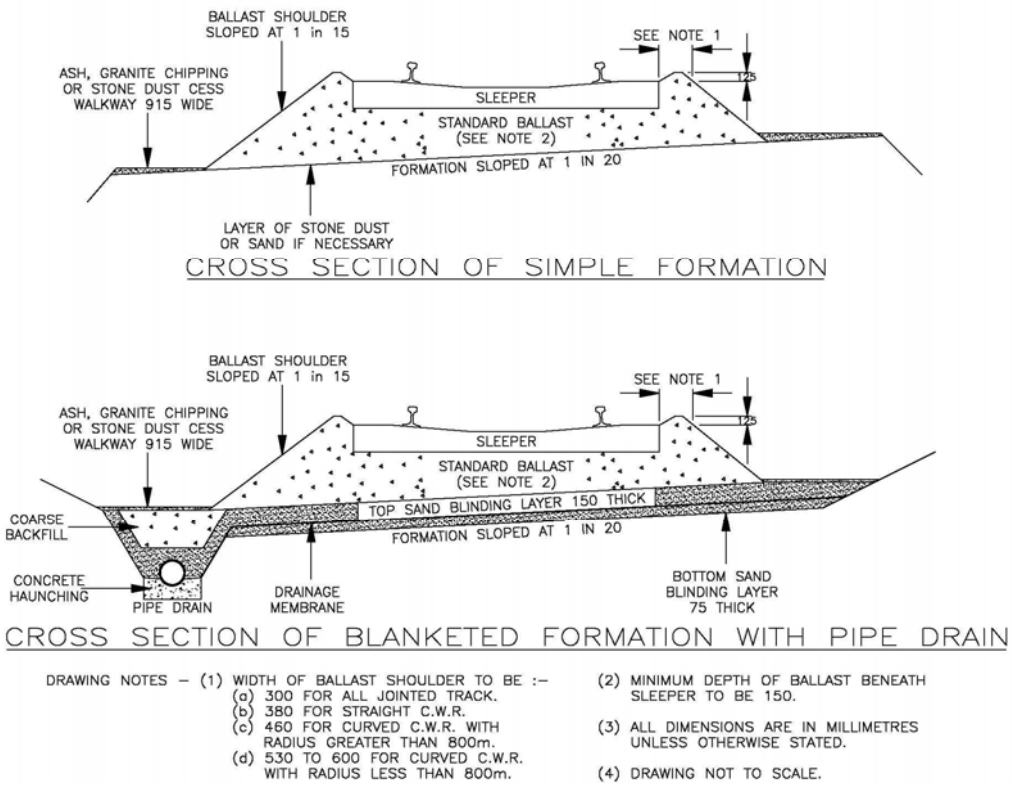
2.2.1 Formation (Subgrade)

The natural or constructed formation has to bear the weight of traffic transmitted via the rails, baseplates, sleepers and ballast. This weight must be distributed sufficiently so that the formation can take the load without significant deformation. It is compacted and finished to levels allowing drainage of water off the formation.

A sand blanket around 50mm thick over the formation is the traditional design, which acts as a cushion on the formation and aids drainage off the formation. The modern form of construction uses a permeable geomembrane in place of the sand blanket to prevent clay and fines pumping upwards and contaminating the ballast.

Where formation material is weak or prone to movement or poor drainage eg clay, a plastic geogrid mesh reinforcement layer is placed below the ballast and on top of the formation membrane.

Figure 2.1 Formation and Drainage



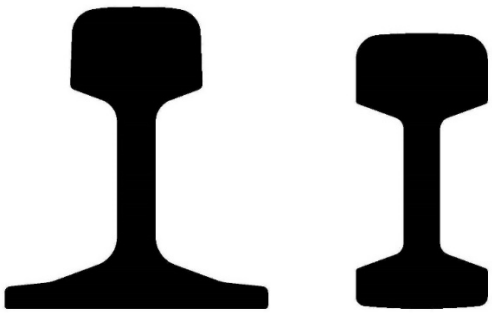
2.2.2 Drainage

Drains are provided to carry away water which has percolated through the ballast and down the cross-fall of the formation to the cesses; otherwise it may soften the haunches of the formation. On embankments this usually presents no problem as the water runs over the edge and down the slope of the bank. In cuttings the water must be collected and carried to a discharge point, usually nearby streams or ditches.

2.3 RAILS

There are two main rail forms: the bull-head section and the flat-bottom section. Each section has in common a 'head' on which the wheel runs, a 'web' and a 'foot'. In the bull-head section the head and the foot are of the same width, but the head is deeper than the foot in order to allow for wear. In the flat-bottom section the head is of similar shape to the head of the bull-head section, but the foot is much wider and is flat on the underside. Modern CEN56 (formerly BS113A or RT113A) flat-bottom rail is now the general standard for MOD railways.

Figure 2.2 Rail types



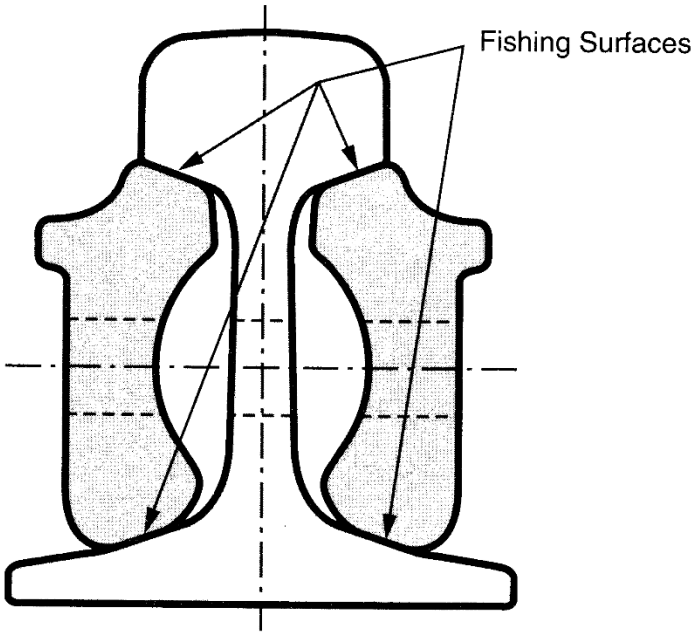
Flat bottom rail Bullhead rail

Plain line rails are normally inclined inwards towards the centre of the track at an inclination of 1 in 20 to the vertical. This is achieved by the seating angle of the baseplate or sleeper bearing area. Some obsolete rail sections and plain line track forms still in use on MOD railways have rails mounted in a vertical plain on appropriate baseplates and sleepers.

2.4 RAIL JOINTS

Rails are joined by means of fishplating or welding. Fishplates are shaped steel plates that are fitted between the underside of the head and the top of the foot of the rails to be joined, and are clamped together by 'fishbolts' passing through holes in the fishplates and the web of the rails. Welding of the rails end to end, to form CWR is predominantly used on main line railways where it offers significant advantages in terms of reduced maintenance, increased line speed and passenger comfort. Therefore the practice of welding rails on MOD Railways is not widespread or economically feasible. However, welded joints are to be found in long running tracks at some MOD facilities, and in hardstandings where their use eliminates the maintenance problem which arises through inaccessible fishplates.

Figure 2.3 Cross Section of Fishplated Joint



2.5 SLEEPERS

Sleepers perform the task of holding the rails the correct distance apart (gauge), and distributing to the ballast the load imposed on the rails by the rolling stock.

As the chief qualities required are a certain amount of flexibility combined with toughness and resistance to shock, wood, pre-stressed concrete and steel are the most common materials from which sleepers are made. Pre-stressed concrete has a longer design life and requires less maintenance than wood sleepers.

The standard concrete sleeper for new installation at MOD depots is F27 type (or equivalent) with Pandrol clip housings.

The standard wood sleeper is 130 x 250 x 2600mm vacuum/pressure treated softwood.

There remain many old and obsolete design reinforced (non-stressed) concrete sleepers in MOD tracks, designed for use with BS75R rails. These are generally adequate with that rail section for light traffic when in good condition, but re-use is not recommended due to heavily corroded through bolt fastenings and loss of grip in concrete recesses for through bolts.

2.6 BASEPLATES FOR FLAT BOTTOM RAIL

Rails are positioned either inclined or vertical on their sectional centre line. The sleepers and baseplates shall determine which position is used. Inclined rails are normal on plain line track on the national network as this gives better structural support to loads and enhances running performance of rolling stock. However significant quantities of track in MOD depots have vertical rail due to economy of components. Most modern concrete sleepers will have inclined rails and wood sleepers with Pandrol type baseplates will have inclined rails. The older BS75R rails on older concrete sleepers, and rails on some wood sleepers with simple pressed steel baseplates will have vertical rails. All switch and crossing rails on MOD tracks normally have vertical rails. There are 2 standard baseplates for new installation at MOD depots: pressed steel baseplates for vertical rail, and Pan 6 cast steel baseplates for

inclined rail. Rails are seated on neoprene rail pads on Pandrol baseplates and when seated without baseplates on modern concrete sleepers, in order to create some resilience and reduce wear on the main components.

2.7 CHAIRS FOR BULL-HEAD RAIL

Bull-head rail is supported in cast iron chairs and secured by a hardwood or spring steel key. A number of different chair patterns are required for turnouts. They are normally fastened to wood sleepers by means of coachscrews or fang bolts which pass through the sleeper.

2.8 FASTENINGS

The method of fastening flat-bottom rail is dependent upon the rail section, the type of sleeper ie timber, concrete or steel, the type of baseplate, and the standard of fastening required.

Dog-spikes, with or without a baseplate, on wood sleepers rely on the spike holding the foot of the rail in both horizontal and vertical position. The spikes are square in section with large heads which overhang the edge of the rail foot. They hold the rail to baseplate and baseplate to sleeper.

Spring spikes, similar to dog-spikes perform a double function, holding the rail to the baseplate and baseplate to the sleeper. Their advantage over the dog-spike is that they have more resilience, providing more grip on the foot of the rail and restricting movement of the rail due to oscillation.

Pandrol clips are the standard fixing for new and refurbished MOD railways. These spring steel clips hold the rail to the baseplate which in turn are screwed to wood sleepers. Pandrol clips are also used on modern style concrete and steel sleepers. They are simple, economic and can be inserted and extracted easily and quickly using simple hand tools. The clips provide good toe pressure and there are several sub-types for different applications.

There are many other variations of spring clip, bolted and hybrid type fastenings. Several of these will be found on MOD railways and whilst many are obsolete designs, if they are fit for purpose and in good condition, may be left in service.

2.9 BALLAST

Ballast is the material placed between the sleepers and the formation. Its functions are to:

- Distribute the live load from the sleepers to the formation without progressive settlement
- Permit rapid drainage of water from the track
- Provide lateral and longitudinal stability to the track
- Contains thermal movement of the track.
- Contains train braking, acceleration and lateral forces.
- Afford a convenient medium for packing the track to maintain longitudinal level, cross level and alignment.
- Provide resilience for the track.

The depth of the ballast provided varies depending on a number of factors, but within limits the deeper the ballast the better, since the greater the depth the less the intensity of pressure on the formation and the less maintenance required. However, there are limits put on ballast depth due to economic constraints.

To assist in the prevention of lateral movement of the track an adequate width of ballast shoulder must be provided, particularly on the outside of curved track and CWR track. Jointed track in yards and sidings usually has ballast shoulders finished level and flush with sleeper tops in order to form convenient shunter's paths.

Crushed hard stone such as granite is the most suitable material but for lower categories of traffic and lighter track crushed limestone may be used. Ash (crushed furnace slag - coal combustion residue) was previously widely used in MOD depots with older BS75R rail track but is no longer used for new or refurbished track.

2.10 SWITCHES AND CROSSINGS

Combinations of switches and crossings are used to provide the necessary train operating movements. They may incorporate standard and special rail sections. The rails are fastened to bearers, which are commonly timber, and increasingly, new designs are using pre-stressed concrete and steel versions. Bearers perform the same function as sleepers in plain track, ie hold the rails to gauge and spread the load from the rails to the formation, but support the greater vertical and lateral forces generated through S&C. There are two main configurations of S&C which are formed from basic standard units.

2.10.1 Turnouts. A turnout is used to divert trains from one track to another. In simple form it consists of a pair of switches and a common crossing together with the necessary closure rails to join the unit together. Turnouts are sometimes referred to as points.

2.10.2 Diamond Crossing. One rail track crossing another at the same grade without a facility to switch from one track to the other is known as a rail/rail grade crossing, flat crossing or diamond crossing. It is a configuration of two common crossings and two obtuse crossings that allow one track to cross another. Diamond crossings are not common and should not be designed into new layouts as they are high maintenance items and incur higher signalling and traffic control risks. If space allows, they can be avoided by the use of back-to-back turnouts as, for example, are found in double-track parallel junctions.

2.10.3 Basic Standard Units

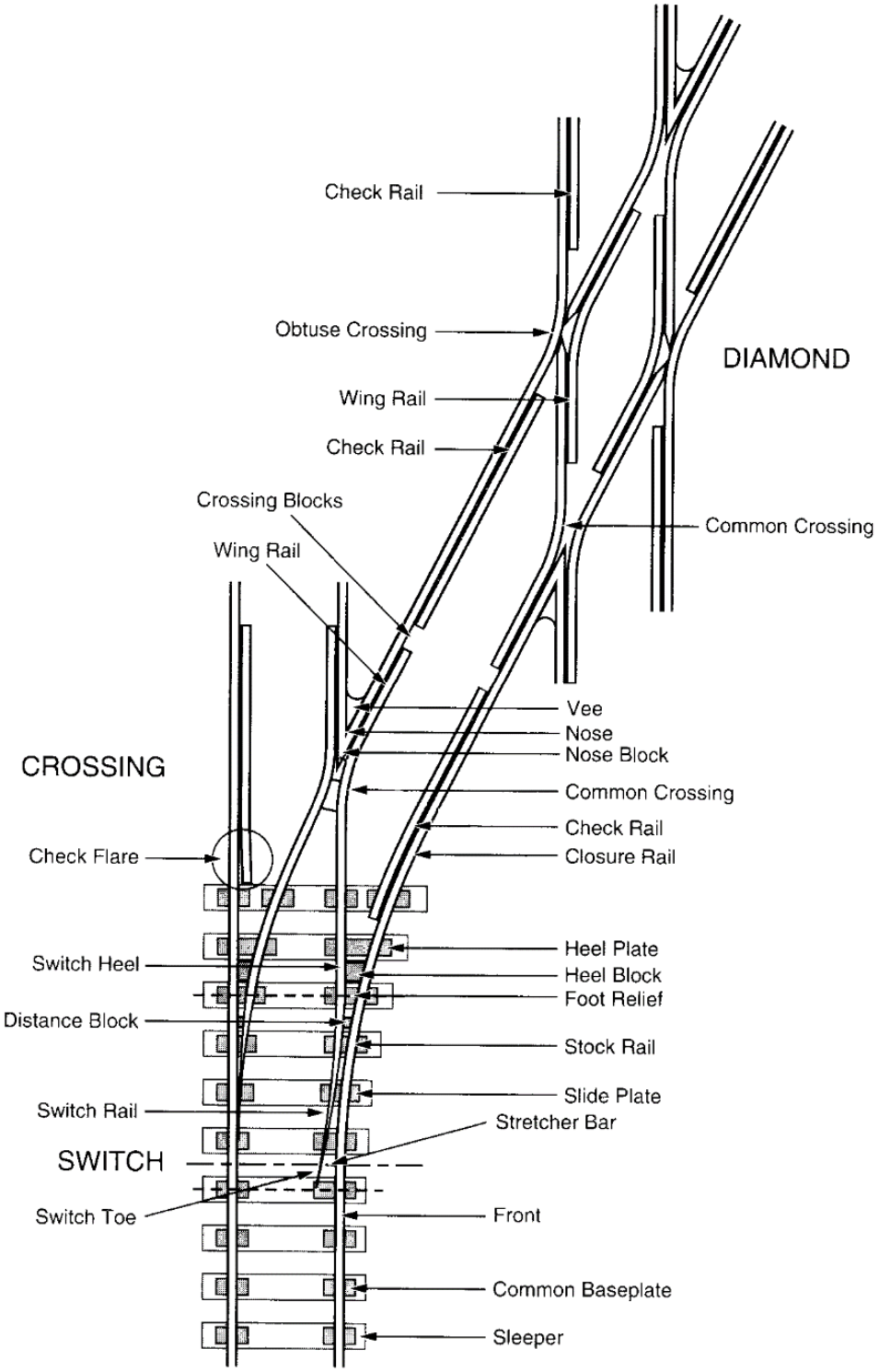
All S&C work is built up from three basic units:

- **Switch**. An apparatus that enables a train to be diverted on to an alternative route by guiding the wheel flange.

- **Common Crossing**. A configuration of two rails converging at an acute angle that allows the flange of a wheel to pass through rails that would otherwise be an obstruction.

- **Obtuse Crossing**. A configuration of two rails converging at an obtuse angle that allows the flange of a wheel to pass through rails that would otherwise be an obstruction.

Figure 2.4 Simple turnout and diamond crossing – plan view



2.10.4 Turnout Identification. Turnouts are identified as either left-hand or right-hand. To identify the type of turnout, the observer should stand at the toe of the points, looking towards the crossing. Having identified the through track, the track that turns away from the through track can be observed and the hand of the track identified.

3 Management of MOD Permanent Way Works

3.1 MOD RAILWAYS

The MOD owns a number of railways on its estate and is therefore legally responsible as the infrastructure owner for the safe management, operation, maintenance and condition of these railways. Whilst maintenance and operation may be contracted out, MOD is the technical authority and retains management and client responsibilities.

Most of the principal railways are inside logistics depots and ports, and are used for transportation of munitions, stores and road/armoured vehicles internally to the depot, and in/out of the depot via the national railway network, connecting to other depots. The size of these railways varies from just a few terminal sidings to small depot networks with circuits, exchange sidings, sorting sidings and running lines. Some of the largest depots have a track mileage up to 20 miles.

Other railways serve target railways, strategic oil depots and static training facilities eg search, explosive ordnance disposal, Special Forces, and loading facilities.

3.2 ORGANISATION AND RESPONSIBILITIES WITHIN MOD

3.2.1 Rail Policy

MOD rail policy is determined by ACDS Log Ops, who sponsor the document JSP 790 Defence Rail Regulations, and coordinate the strategic requirement for railways.

3.2.2 Rail Safety Regulator

DSA ensure rail safety compliance through a system of audits on depot railways.

3.2.3 Rail Operating

The depot railways are generally operated by contractors managed within MOD logistics contracts by Defence Equipment and Support (DE&S). The rail operating contractor appoints a Rail Operating Manager (ROM) to manage routine rail operations and train control at each depot.

3.2.4 National Main Line Services

DE&S manage the MOD contracts for national freight operating companies to provide rolling stock and train services between depots on the national railway network, and track connection agreements with Network Rail.

3.2.5 Rail Infrastructure

Defence Infrastructure Organisation (DIO) is the MOD technical authority and Duty Holder for rail infrastructure. DIO is responsible for the provision, management and maintenance of MOD rail infrastructure. Each railway is declared fit for purpose and safe for the operation of rail traffic in the form of annual certification (licensing). The DIO Principal Railway Engineer (PRE) provides the following services:

- Professional head of rail infrastructure engineering and rail SME.
- Sets and monitors PW standards.
- Provides compliance assurance.
- Conducts annual inspections and certification.
- Licenses the PW as safe and fit-for-purpose for rail operating.
- Rail infrastructure asset manager.
- Maintains the asset database and track layout drawings.
- Produces the requirement for annual rail remedial works.
- Provides advice to DIO and other MOD departments as required.
- Confirms work done by contract for scope, specification, quality and safety.
- Approves track fit for purpose and safe to run trains on completion of works

3.2.6 Target Railways

Target railways are generally operated and maintained by the infrastructure prime contractor.

3.2.7 Military Organisations

Permanent Way (PW) and associated specialist railway infrastructure is within the remit of the Royal Engineers for deployed military operations. The professional expertise is maintained at unit level by Army Reservists embedded in 170 (Infrastructure Support) Engineer Group RE, including:

- 507 STRE(Rly Infra) – sub-unit level team with capability for specialist design, survey, recce, consultancy, advice, works control and supervision.
- Individual specialist officers, professionally qualified with railway expertise, acting as subject matter experts.

3.3 EXTERNAL INTERFACES WITH MOD

3.3.1 Network Rail (NR)

NR is the infrastructure owner and controller of the national railway network and this railway is connected to MOD railways usually at or near depot rail gates. The ownership and track maintenance boundaries are marked by a plate fixed to the top surface of the sleeper. There are often rights of access for each party to gain access for maintenance up to the boundary. Arrangements for track and signalling at connections with the main line, and definitions of boundaries are covered by Siding Connection Agreements with NR.

3.3.2 Train and Freight Operating Companies

Train and freight operating companies with their own locomotives and rolling stock use MOD track to haul trains into depots in order to exchange trains with MOD railway operators.

3.3.3 Office of Rail and Road (ORR)

ORR is the regulatory arm for railways of Department for Transport (DfT). Within ORR, Her Majesty's Railway Inspectorate (HMRI) is the safety directorate, responsible for approvals, inspections, compliance, enforcement and accident investigation.

3.3.4 Railway Accident Investigation Branch (RAIB)

RAIB is a separate branch of DfT. Certain categories of railway accidents involving moving trains are reportable to RAIB. The ROM must be aware of the definitions of reportable accidents and will make the report for relevant accidents. RAIB investigates accidents to determine cause but not blame.

3.4 TRAINING AND COMPETENCE

3.4.1 General

It is important that each person involved with PW, in whatever capacity, receives training appropriate to that person's responsibilities and is certified as competent. Specialist training companies within the wider railway industry offer courses at a range of levels:

- PW appreciation
- Apprentice
- Platelayer/Track Person
- Technician
- Engineer

Courses are available to cover a wide range of related subjects:

- Platelayer skills
- PW equipment operator skills
- Track maintenance
- Track inspection
- Track engineering

3.4.2 On-Track Safety

All staff carrying out work on or near the track require training to ensure their own safety and the safety of rail traffic.

- Personal Track Safety (PTS) is a national railway industry standard requiring a medical examination, 2 day training course, examination and certification. A refresher course is required every 2 years.

- Other simplified courses run by the military, railway operators, or contractors may be acceptable to give basic railway safety whilst walking or working, on or near MOD railways.

3.5 DELIVERY OF WORKS AND MAINTENANCE

3.5.1 System of Maintenance

Planned periodic preventative maintenance to the PW, including routine inspections, is delivered by specialist contract through the DIO prime contractor system. Larger projects are almost always delivered by RPC using the core works process.

Vegetation control to the PW is generally delivered by the grounds maintenance contractor through the DIO prime contractor system.

Annual packages of rail remedial works, and reactive emergency repair works are scoped by the DIO PRE, who generates the requirements based on inspection reports. These are input to the DIO prime contract system for delivery.

Larger projects such as relaying and significant layout changes are progressed through the DIO core works process.

3.5.2 Standards

This document is the standard for all MOD railways.

3.5.3 Contractors

All contractors engaged by the prime contractor or facilities managers must be assessed as suitably qualified and experienced specialist railway contractors in the field of work specific to the requirement. As a minimum they must be fully participating in the national railway industry Link-up approval process, and ISO 9000 series Quality Assurance registered.

3.6 ACCESS TO THE TRACK

Access to the track, commencement of all works, and the safe system of work protecting train movements and protecting staff from movement of trains, must be planned with and authorised by the ROM.

3.6.1 Person in Charge

In any group of staff on the track, a person in charge shall be nominated to be held responsible for individual works or maintenance operations. This person must be suitably fit and competent to carry out the duty. He shall be responsible for setting up a safe system of work and liaising with the ROM.

3.6.2 Safety Briefings

All personnel walking or working on the track must:

- Receive an initial site specific safety briefing from the ROM.
- Receive a task specific safety briefing on their specific work at the start of each different activity or new location, including relevant risk assessments.
- Wear the minimum railway standards PPE plus any additional items detailed in the task risk assessment.

- Know their nominated person in charge.
- Understand the safe system of work.
- Be aware of moving trains on the nearest and adjacent tracks.
- Be vigilant for their own safety. Know their position of safety for passing trains.
- Not leave tools, equipment or obstructions in or close to the track.

3.6.3 Permit to Work

A railway specific permit to work must be issued to contractors carrying out work on or about the railway. All contractors carrying out work require permits to work, which must only be issued by the ROM. The area bounded by the term "on or about the railway" is within a limit of 3m outside of either running edge. A Permit to Work form is at Annex D.

2.6.4 Method Statement and Risk Assessment

For tasks to be carried out on or about the railway (not necessarily for track maintenance) a method statement and risk assessments must be submitted to the MOD prime contractor, DIO PRE or ROM as appropriate, for approval in advance of the work.

3.7 TRACK POSSESSIONS

3.7.1 Requirement for a Track Possession

A track possession is a formal procedure to stop rail traffic over a defined section of track and to hand the track over to a contractor or other staff for the purpose of carrying out works safely. The need for a possession shall be determined by the ROM after considering the type of work to be carried out along with method statement, risk assessment, location, access, traffic, and other factors. Each possession is defined by precise location on the track, and by time limits, and the information is presented on a certificate signed by both the ROM and the person in charge of possession (PICOP) at the start and end of each possession. The possession certificate is at Annex E.

3.7.2 Responsibilities for Track Possessions

The ROM shall have sole responsibility for issuing the authority for taking a possession; the PICOP shall be the only person authorised to establish the possession and shall be held responsible for handing back the track within the possession to the ROM in a safe condition suitable for use. The PICOP shall be solely responsible for putting down and removing the method of demarcation for the possession and work may only commence after the system of demarcation has been established.

3.7.3 Person In Charge of Possession

When a possession is necessary to undertake work, the nominated PICOP must sign for and be held responsible for taking of the possession and is referred to as the PICOP. That person must be certified as fit and competent for carrying out the task.

3.7.4 Demarcation of Possession Limits

The limits of a possession should be defined and referenced where possible by the turnout identification numbers, block section numbers, shed entrance, level crossing, rail gates or other identifiable fixed positions at either end of a track section. Limiting turnouts where possible shall be clipped and padlocked out of use so as to safely isolate the worksite, with the keys for the padlocks remaining with the PICOP at all times. Possession limits should be indicated on the track by red banner, marker board, and a red flashing light.

3.8 RAIL MOUNTED PLANT AND TROLLEYS

Manually propelled PW trolleys may only be put on the line and used within a track possession.

Rail mounted plant, on-track machines, road/rail vehicles and motorised trolleys may only be used when running as a train (operated and equipped as a train), or within a Track Possession.

4 Health and Safety

4.1 SAFE SYSTEM OF WORK FOR WORKING ON AN OPERATIONAL RAILWAY

The primary safety hazard on the railway is to staff on or about the track being struck by a moving train. There are many other hazards specific to railways and generic to construction and outdoor work. The consequences of any accident on a railway are inherently more severe than in many other situations due to the weights, visibility, directional avoidance constraints and train stopping capability.

A safe system of work must be produced, set up and monitored for every activity on or with the railway. This will be specific to the location, task and prevailing conditions, and will include task specific risk assessments and method statements. The safe system must be briefed to all personnel before moving on to the track, and re-assessed whenever the circumstances or situation changes. Everyone who plans or uses the Safe System of Work must be familiar with the following principles, including those in charge of the work site and those on the track that are directly at risk.

4.1.1 Work on or about the operational railway must be minimised.

All railway lines must be considered operational unless certified as closed (permanently or temporarily).

Work should be done when trains are not running at all, so far as is reasonably practicable, using a Track Possession.

When this is not possible, work should be segregated from trains by providing fencing.

When this is not possible, work may be undertaken in traffic provided that protective systems are in place to give adequate warning of the approach of trains, or adequate separation space from the nearest running line is created.

4.1.2 Only appropriate people must go on or near the track.

A nominated responsible person must be in charge of the safety of each individual or group.

All persons working on or near the line must be signed-in with the railway operator and must have either a track possession or permit to work.

Only those people essential for the planned task must go on or near the track.

They must be medically and physically fit to do so.

They must be assessed as competent to conduct the required tasks and have received appropriate training.

They must hold valid railway safety certification, eg railway industry standard Personal Track Safety (PTS), or other recognised certification such as Defence Rail Environment and Safety Training (DREST).

They must have received a briefing on the safe system of work.

They must wear protective clothing as specified in the task risk assessment, including orange high visibility clothing and safety boots compliant with railway industry standards.

Those responsible for the safety of others should be further trained and carry certificates to demonstrate their competency.

Recording of accidents and near misses is mandatory.

4.1.3 Safety features for workers must be provided.

A safe means of access to the railway should be provided and maintained.

Where people may be on or near a track open to the passage of trains, places of safety should be provided and maintained.

4.1.4 Safety systems to warn of trains.

The use of technology is the preferred approach for warning of trains.

If this is not practical lookouts must be used; these must be clearly identified, have a reliable means of communicating warnings and have no other duties.

The system of work must ensure that sufficient warning time is provided to clear the track of obstructions and move to a place of safety.

On receipt of any warning, personnel must immediately acknowledge the warning, stop work, move themselves and tools to the designated place of safety.

4.2 ELECTRIFIED RAILWAYS

Generally there are no overhead line electrified (OLE) railways on the MOD estate, however there may be close proximity to 25kV OLE equipment at interfaces with the national network. Particular attention must be given to creating the safe system of work in these locations to prevent any access by people or equipment within 3m of the OLE equipment.

Some target railways have an electrified DC ground level third rail for traction current. The safe system of work must cover procedures specific to this environment, including isolations, earthing protection and permits to work.

4.3 SAFETY MANAGEMENT SYSTEM (SMS)

Each contractor, organisation or business working with or on the railway must have a documented SMS that specifically covers working in a railway environment.

4.4 STATUTORY REGULATIONS

The following Statutory Regulations cover the specialist railway aspects applicable to the design, construction and maintenance of permanent way (PW) within MOD establishments.

4.4.1 Health and Safety at Work Act 1974

General responsibilities of employers and employees.

4.4.2 Management of Health and Safety at Work Regulations 1999

These cover the requirement for identification of dangers and hazards, risk assessments, effective planning, organisation, control, monitoring and reviewing preventative and protective measures. This includes provision of health and safety information, and training.

4.4.3 Railways and Transport Safety Act 2003

These place a duty on employers in the rail industry to ensure employees carrying out safety critical work are competent and fit to carry out that work.

4.4.4 Railways and Other Guided Transport Systems Regulations 2006

Places responsibility for the safe operation and maintenance of a railway system on the Duty Holder, implemented through a Safety Management System that demonstrates that risks are appropriately managed.

4.4.5 Construction (Design and Management) Regulations 2015

Places specific duties on clients (project sponsors), designers and contractors to have a coordinated approach to construction works.

4.5 MOD REGULATIONS

The following MOD Regulations are additional to the statutory requirements and cover the specialist railway aspects applicable to the design, construction and maintenance of permanent way within MOD establishments.

4.5.1 JSP 375 Management of Health & Safety in Defence

General MOD requirement.

4.5.2 JSP 790 Defence Rail Regulations

Covers all aspects of railway operations on the MOD estate.

4.5.3 MOD General Railway Rule Book

General rules for staff operating and working on MOD railways. This is published as an Annex to JSP 790.

4.5.4 Local Railway Working Instructions

Additional local standing instructions for specific depots and locations published by the rail operator.

4.5.5 Periodic Operating Notices

Additional local temporary or short notice instructions for specific depots and locations published by the rail operator.

4.6 PERSONAL PROTECTIVE EQUIPMENT

All personnel working on or about the PW must wear high visibility clothing. This must be compliant with the national railway standard in terms of orange colour, reflective stripes, size and displaying sponsor/company name. In addition safety footwear must be worn which shall have a steel toecap and a steel midsole.

Other protective equipment must be worn depending on the task and as determined by the risk assessment. Such items may include: safety helmet, gloves, ear defenders, safety glasses, eye protectors, face shield, face mask, fireproof spats, spark resistant overalls, anti-vibration gloves, knee pads.

4.7 REPORTING OF ACCIDENTS AND DERAILMENTS

Reporting of accidents and derailments must be carried out by the Railway Operating Manager using the railway specific forms in JSP790, and in accordance with the operator's or contractors own SMS, ensuring that copies are also submitted to the relevant Head of Site Establishment, and MOD's prime contractor where applicable.

5 Maintenance – Planning and Inspection

5.1 MAINTENANCE STANDARDS

The standards to which permanent way (PW) is to be maintained must provide for the safe, reliable and efficient operation of rolling stock having regard to overall economy.

Contractors employed for railway works must be specialist railway contractors with proven experience and competence in the field of work, and registered under the railway industry Link-up approval scheme.

Staff with design, planning, supervisory or site roles must be competent in their prescribed duties.

Where standards are not covered in this document then the Network Rail or Railway Safety and Standards Board standards shall be adopted. The standards in this document have precedence.

5.2 CATEGORISATION OF TRACK

The category is determined according to track usage, operational importance, specification and condition. This is to be reviewed on a regular basis to take into account changing trends of traffic flows using the railway. The Railway Operating Manager (ROM) in conjunction with the DIO Principal Railway Engineer (PRE) identifies the category of each track. Table 5.1 gives the categories of use that are to be used and standard descriptions.

Table 5.1 Track categories

Track Category	Description
1	Main strategic route, the loss of which would halt or cause a serious disruption to the running of an Establishment.
2	Secondary strategic route, the loss of which would cause a disruption or inconvenience to the running of an Establishment.
C&M	Care and maintenance only. Not used for routine traffic. Minimum maintenance regime to enable economic reinstatement to higher category if necessary.
Closed	Closed to all rail movements but track left in situ.

5.3 RECORDS

5.3.1 Track Layout Drawings

Depot track layout drawings should be produced in computer aided design (CAD) format showing track categories by colour coding, and should be amended and kept in date when categories or other features change. These drawings should be geographical, scaled and show other relevant infrastructure features to aid location identification. Locations and limits can be defined by features such as turnouts or buffer stops which will enable a section of track to be isolated. Switch and crossing units, level crossings and rail gates should have unique identification numbers.

A schematic style diagram showing track layout and track categories is a useful additional drawing to maintain as this is the preferred format used by the railway operators for train movements. An example drawing is shown at Annex K.

5.3.2 Asset Register and Database

The track layout drawings fulfil the function of asset register. A database of track section lengths and quantities of turnouts and other rail related infrastructure should be maintained.

5.3.3 Inspections, Maintenance, Renewals and Repairs

Records should be maintained of all inspections, maintenance, renewals and repairs.

5.4 FREQUENCY OF INSPECTION AND MAINTENANCE OPERATIONS

Table 5.2 sets out the frequency for inspection and routine planned periodic maintenance operations relevant to the particular categories of use.

Table 5.2 Maintenance Frequencies

Operation	Operation Description	Track Category			
		1	2	C&M	Closed
1	Licensing inspection of rail infra and maintenance regime	Annual	Annual	Annual	Not required
2.1	Inspection – permanent way	6 monthly	6 monthly	6 monthly	Not required
2.2	Inspection – public road level crossings	Annual	Annual	Annual	Not required
2.3	Inspection – bridges	3 yearly	3 yearly	3 yearly	Not required
3	Programmed maintenance	Monthly	3 monthly	Annual	Not required
4	Programmed maintenance	2 yearly	2 yearly	2 yearly	Not required
5	Programmed maintenance	6 monthly	6 monthly	6 monthly	Not required
6	Weedkilling	Twice yearly	Twice yearly	Twice yearly	Not required
7	Vegetation control	Annual	Annual	Annual	Not required
8	Animal control	Twice yearly	Twice yearly	Twice yearly	Not required
9	Level crossing – electrical maintenance	As stated in O&M manual for specific LC	As stated in O&M manual for specific LC	As stated in O&M manual for specific LC	Not required
10	User's functional check	Weekly	Weekly	Monthly	Not required

5.5 ROUTINE MAINTENANCE OPERATIONS

Table 5.3 describes the planned periodic maintenance operations listed in Table 5.2.

Table 5.3 List of Planned Periodic Maintenance Operations

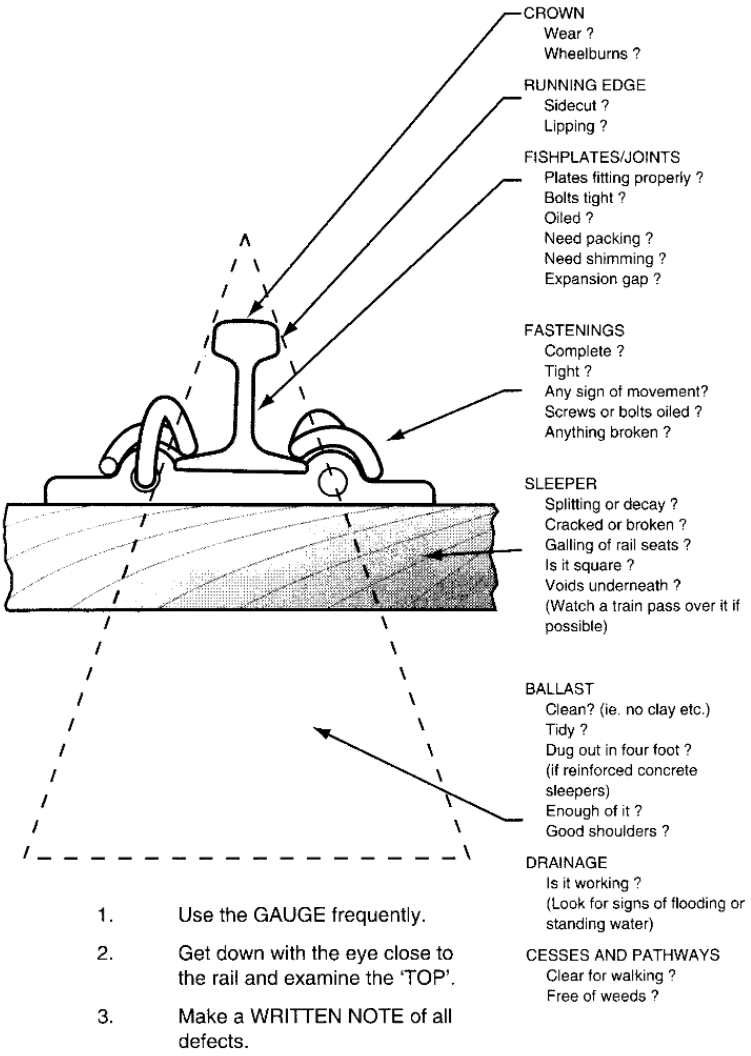
Operation	Description	
1	Rail infra licensing inspection by the DIO Principal Railway Engineer (PRE). Overview of the permanent way, management, maintenance, inspection reports and works arising, to determine fitness for purpose, track safety, track quality, condition, and future minor new works/relaying programme.	
2	(1)	Inspection of the whole of the permanent way including track, cuttings, embankments, formation, drainage, vegetation, bridges, structures, level crossings, signage and all other items necessary to keep the PW in safe running order. Within 5 working days from the completion of inspection submit report of all defects to the DIO PRE. Urgent items found during the inspection are to be reported to the ROM on the day they are discovered. Inspection conducted by a suitably qualified or experienced engineer, clerk of works or inspector within the MOD prime contract.
	(2)	Inspection and risk review of public road level crossings. Conducted by the DIO PRE.
	(3)	Inspection and risk review of bridges. Conducted by the DIO PRE.
3	(1)	Tighten or tension as required spikes, coachscrews, through bolts, keys, clips, rail fastenings and baseplate fixings. Replace any missing items.
	(2)	Tighten as required fishbolts, bolts in turnout assemblies, check rail bolts in plain track, bolts in wheel or buffer stops and all other rail fittings.
	(3)	Top up rail lubricators.
	(4)	Clean out all flangeways in level crossings and paved areas. Clean out space between switchblades and stock-rails, and in/around leverboxes.
	(5)	Clean and oil slide plates with warm weather lubricant or de-icing lubricant, according to season.
	(6)	Oil leverbox mechanisms, including all pivots, moving parts, screw threads, connecting rods and gauge tie bars.
	(7)	Adjust switch blades, stretcher bars, gauge tie bars, connecting rods and leverboxes to ensure correct operation of switches.
	(8)	Adjust and oil lever boxes connecting rods and gauge tie bars.
	(9)	Remove all obstructions, debris and foreign objects from the track, load gauge envelope, cesses and shunter's paths.
	(10)	Remove obstructions to flow of drainage water in culverts, drainage channels and ditches alongside the track.
	(11)	Maintain ballast profile to track edges and flush to top of sleepers, keeping stones clear off sleeper tops and around rail fixings.
	(12)	Maintain sand profile in sand drags.
4	(1)	Take off all fishplates, wire brush and grease plates, rail bearing flanges and bolts, and refix all plates. Not to be carried out at joints on severe curves or other locations where rail alignment might be lost or where plates would be difficult to refit.
	(2)	Inspect plates, particularly stepped and joggled plates, for cracks. Report all defects in rail ends, plates or bolts.
5	(1)	Oil rail gates and crossing gate hinges, catches and locks. (Note: level crossing barriers subject to special maintenance procedures as defined in the manufacturer's maintenance manual).
	(2)	Clean and repair all rail side warning signs including level crossings and fixed stop signs.
6	Spray application of herbicide (weedkiller) to all track surface area and sides out to 2m from rail. Two applications each year, in May and September for best effect. Herbicide to be capable of defeating grass, broad leaf, bramble and woody growth.	
7	Cut back and remove vegetation to retain a clear gauge envelope. Pull out roots of heavy weeds and shrubs in track bed and cess. Strim, cut and flail brambles, trees and vegetation as necessary.	
8	Ensure the permanent way is free of rabbits and other animal burrows, eradicating animals and filling burrows as necessary.	

9	Maintenance of electrical components of level crossings, including supply, circuits, red lamps on gates, floodlights, sirens, wig wag lights, treadle switches and control units, as defined in the manufacturer's maintenance manual.
10	User's basic functional check conducted by rail operating staff or railway qualified person. The user walks the track (or observes from a loco running at caution) and reports obvious and urgent visible faults eg obstructions, subsidence, damage or effects of severe weather. Where possible obstructions are removed "at the time" eg removing a tree branch on the track.

5.6 INSPECTION REPORTS

The inspection of the permanent way must specifically address defects which affect the safe running of the railway and must be conducted by a suitably qualified and experienced PW inspector. Annex B comprises a List of Common Defects which may be found whilst inspecting the permanent way. It should be recognised that this list is not exhaustive. A key element of track inspection is measuring gauge and cross-level to confirm track is within tolerances, and to identify potential derailment risks. The 'pyramid rule' is a simple guide to the identification and prioritisation of track faults, focusing on the path of load transfer through the permanent way.

Figure 5.1 Pyramid Rule



To maintain continuity of reporting the inspector should be afforded access to the previous report. A sample track inspection sheet is included in Annex A of the standard. Access to the preceding report should also avoid duplication and allow for efficient monitoring of work undertaken to remedy defects.

The report should be presented to the DIO PRE, and ROM or sponsoring officer, within 5 working days so as to enable prompt procurement of services to address items that have been reported which affect the safe running order of the railway.

5.7 DEFECT CATEGORIES

Faults and defects identified on inspections are defined and categorised in Table 5.4.

Table 5.4 Defect Categories

Fault Category	Fault Definition
A	An urgent or critical fault with high risk of derailment, damage to rolling stock, injury to people, or safety of the track.
B	A fault with a low risk of derailment, damage, injury or safety, but which will deteriorate further. Fault may be deferred to a period of planned maintenance due to its non-critical nature.
C	A fault that is acceptable without rectification, but which requires observation at subsequent inspections to monitor and detect any further deterioration.

5.8 DEFECTS REPORTED BY INSPECTION

Any urgent, safety critical defects (those which affect safe operation) verbally reported to the ROM must be followed up by written communication, eg email or entry in depot PW faults book, in addition to being included in the inspection report.

All faults and works identified shall be scheduled for action, monitored or accepted as serviceable by the DIO PRE or the designated competent PW engineer.

5.9 ROUTINE REPORTING OF DEFECTS

In addition to planned track inspections, railway operating staff must report any defects as soon as noticed. ROMs should conduct user checks of the track as shown in operation 10 at tables 5.2 and 5.3. Defects must be reported to the ROM and recorded in a dedicated fault book. The ROM shall take appropriate action to protect trains, rectify faults or seek advice from the DIO PRE.

The PW inspector must check the fault book at each rail facility before commencing the monthly programmed maintenance, and arrange to check faults and report accordingly. The ROM should record the actions taken in the fault book.

5.10 CAUSES OF DERAILMENTS

Common causes of derailments are listed in Table 5.5. These should be considered when conducting routine track inspections and may also be used to categorise causes on an inspection following a derailment. Derailments are often caused by a combination of the causes listed in the table.

Table 5.5 Common Causes of Derailments

Origin	Cause
Operating	Overspeed
	Outside permitted wheelbase, radius, weight, loading limits
	split points by poor operation or lack of observation
	Over running catch points, derailers, buffer stops
	Snatching on curves
	Over loaded or unevenly loaded wagons
	Insecure loads allowing items to fall on track and become obstructions.
	Wagon doors left open
	Rough shunting
	Inappropriate propelling movements
Locos and rolling stock	Faults in axles, wheels, springs
	Worn wheel flanges causing split points
Permanent way	Subsidence due to bad drainage or excessive wheel loads
	Buckling or distortion due to heat or creep
	Sharp change of grade or curvature
	Broken rail or fishplate
	Poor construction or maintenance, eg irregular gauge, cross-levels, super elevation or curvature; loose or inadequate fastenings; decayed sleepers or insufficient structure clearance. The most common results are gauge spreading under load and rapid changes of cross-level forming a 'twist' fault.
	Switches not properly closed or open (switch splitting), due to small obstructions, seizing or lack of adjustment
	Insufficient clearance at the back of switches (preventing them from opening fully).
	Worn through bolts at the heel blocks of switches.
	Badly worn crossings, wing and check rails, or guard rails.
	Obstructions on the track

5.11 TRACK IN CARE AND MAINTENANCE CATEGORY

Where a section of railway track is taken out of use and placed under Care and Maintenance, minimum maintenance should be carried out as listed below in a manner such as to enable the track to be safe for occasional use and to allow resumption of routine traffic with minimal reinstatement works.

- Inspect track annually.
- Basic preventative maintenance sufficient to keep track safe and available for reopening to routine traffic with minimum work.
- Keep ballast and formation surfaces free of weeds.
- Keep drainage ditches and pipes in working order.
- Keep structure gauge free of obstructions.

5.12 REMEDIAL WORKS

Management and implementation of remedial works is an essential part of the maintenance system. An annual package of PW remedial works for each railway facility should be produced as a requirement, covering fault rectification, repairs, replacement of worn components, and track relaying. This may be scheduled by the DIO PRE using data from the various inspection reports and prioritising those works that are essential to maintain the safe condition of the railway. These requirements are suited to an annual package of works at each location to achieve economy of scale, minimise disruption to rail services, and minimise contractor deployment costs.

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6 Maintenance – Standards

6.1 FORMATION, DRAINAGE AND VEGETATION

6.1.1 Formation

The formation must be kept as dry as possible and any spoil above cess level must be trimmed off and removed from site to allow surface water to drain away.

6.1.2 Drainage

The formation and track must be kept free of standing or running water.

Where drainage is poor the formation can "pump" under traffic and cause wet spots.

Drains and catchpits affecting the permanent way drainage must be regularly examined and cleared as necessary to ensure they are kept in good working order. Catchpits must always be fitted with lids or grids as appropriate. They must not be left uncovered, or otherwise be a danger to staff.

Clearing of a blocked drain should be started from the lower or outfall end. Ditches, water channels or pipe drains must be kept clean and free flowing. Any obstruction to the outfall of a drain or water course which is outside MOD property must be reported to the railway operating manager. Any attempts by outside parties to divert water onto MOD property or any interference with the drainage system must be reported to the railway operating manager.

6.1.3 Vegetation

Vegetation control on the track and the track sides is essential for:

- Safety of operating and maintenance staff.
- Free drainage of the ballast, which keeps the formation dry.
- Retention of track stability and track geometry.

The track, including ballast surface, cess, intervals and walkways must be kept free of vegetation growth (weed free). Herbicide weed control spray (continuous drenching spray) should cover all tracks to a width of 2m on each side of each rail (approx 5.4m total width for a single track), all wide track intervals, and unmetalled working areas in yards. Weed spraying is most effective in May/June with a second treatment necessary in September due to restrictions on more powerful chemicals. The treatment should include green leaf and woody herbicide (treatment of brambles) and include a residual chemical to treat new sprouting growth after treatment. The treatment is most effective when applied by a rail mounted or road/rail vehicle.

The structure gauge envelope must be kept clear of vegetation. Lineside vegetation, including trees, hedges, shrubbery, overhanging branches, must be cut back to prevent encroachment of vegetation into the structure gauge envelope. Treatment by rail mounted flailing/cutting machine to all the trackside once every year, after leaf fall and before nesting season, is the most effective method. Ground vegetation and brambles require cutting back or strimming where weed control has been omitted or ineffective.

Additional cutting back of vegetation is required as a safety measure at level crossings to ensure adequate sight lines for road traffic to identify trains approaching the crossing.

6.2 CUTTINGS AND EMBANKMENTS

The examination of cuttings should take place regularly, particularly after severe frost, heavy rainfall or snow thaw, to check whether any material has been loosened or has fallen so as to endanger traffic. Clay cuttings and embankments should be regularly examined for cracks, especially during periods of very dry weather and such cracks must be reported to the railway operating manager who shall arrange for further specialist inspection.

Tracks laid over peat formations often suffer from significant settlement and special inspections and maintenance may be required.

Any signs of slips in cuttings or embankments must be reported to the railway operating manager and any further developments watched carefully.

If a slip has occurred the following should be investigated:

- Cross Levels – one rail may sink or heave relative to the other, leading to twist.
- Alignment - the gradual introduction of "flats" or sharpenings into curves or of misalignments in straight track.
- Interval between tracks – one track moves towards or away from adjacent track.

Leaning fence posts and signal posts, where previously upright, can indicate the presence of slips. A simple method for detecting movement in a slip is to drive a series of pegs at intervals in a straight line across and beyond the extent of the area believed to be affected. Occasional sighting along this line of pegs will disclose whether further movements are occurring, since the pegs move off line at such places.

When a slip occurs, the slip material should not be removed from the toe of the slope, except to the limited extent necessary for the passage of traffic pending the carrying out of full remedial measures, since the weight of material at the toe helps to retard further movement. Slurried ballast from wet spots and other materials must not be piled upon cutting and embankment slopes but spread evenly over a larger area to minimise the risk of triggering bank slips.

Care and attention to trees and shrubs on slopes may be beneficial to the stability of banks.

6.3 BALLAST

Ballast must be clean, well consolidated and correctly profiled to ensure that it functions correctly.

Adequate quantities of ballast should be provided prior to lifting, tamping or lining work and on completion of the work any deficiencies made good. Ballast regulation will normally be carried out manually but on-track ballast regulators are available for major items of work. Stone to be used as a packing material must be the normal ballast specification, as for construction. Where manual packing is to be used, stone chippings may be used. These must be 12-14mm crushed granite chippings, clean and free from dirt.

6.3.1 Ballast Shoulders and Profile

Track must be supported by adequate ballast shoulders, the minimum width of which should be as follows:

- Straight track (CWR and S&C) 380mm
- Curved track of radii greater than 800m (CWR and S&C) 460mm
- Curved track of radii less than 800m (CWR and S&C) 560mm
- Jointed track

In all CWR track including switches and crossings (S&C) the shoulders must be heaped above the top of sleeper level. For jointed track ballast shoulders must be flush to sleeper tops.

The four-foot and six-foot must be fully ballasted, flush to sleeper tops, so that the vertical faces of the sleepers, timbers or bearers are not visible.

On CWR track not more than 6 alternative half cribs or 2 consecutive full cribs within a 9m length may be opened out at the same time.

Particular attention must be paid to the packing of sleepers in the area of the transition from a bridge deck or paved track to ballasted track.

6.3.2 Ballast Deterioration

Deterioration of ballast is brought about by erosion from the movement of sleepers because of the action of trains, the action of tamping machines, contamination from wind blow debris and wagon spillage. The products of deterioration will clog the ballast, reducing the drainage properties, the effectiveness of tamping and support to the sleepers.

Concrete sleepered track, if not well packed with clean ballast, will quickly develop wet spots or ballast contaminated with a ballast/concrete sleeper slurry which in dry weather sets into a hard material. The removal of this material is essential if the stability of the sleepers is to be restored.

6.3.3 Repair of Slurried Track

Wet spots are symptoms of one or more problems which may include: dipped joints, poor quality welds showing dips and humps, ballast and drainage deficiencies, loose or missing fastenings, missing rail pads and rail surface irregularities. It is essential that the reason behind the formation of the wet spot should be remedied before, or at the same time as, the wet spot treatment is undertaken.

A minimum depth of clean ballast must be provided below the bottom of the sleepers and the bottom of the excavation must fall towards the nearest drain or suitable ground. A crossfall of 75mm over the length of a sleeper is required. Work should progress towards the predominant direction of traffic.

6.4 SLEEPERS

6.4.1 Sleeper Types

Wood, pre-stressed concrete or steel sleepers are used but types should not be mixed (interspersed).

Where a change of sleeper type is required, this should only be installed such that there are several continuous panel lengths of track with each sleeper type. Sleeper type changes should not be made within two sleepers of a rail joint.

6.4.2 Voids under Sleepers

It is important to keep the rail bearing portion of each sleeper well packed and free from voids. Voids can be detected by watching the vertical movement of the sleeper under traffic and in the case of wood sleepers by sounding, near the chair or baseplate, with a hammer or accurately measured using void meters. Tell-tale white, rounded pieces of ballast on or at the ends of concrete sleepers, which may also show white dust, will indicate the presence of voids.

6.4.3 Defects

When isolated sleepers become defective and/or decayed they should be removed and replaced with sound serviceable or new sleepers of compatible type. The number to be consecutively removed will generally depend on site conditions, ie obstructions, traffic interruptions, etc, but on CWR track only one sleeper may be removed in a 9m length at any one time.

When screw fastenings have become loose and left untightened or where ferrules have not been replaced when they have become worn or damaged, then the action of passing traffic will cause the chair or baseplate to push the screws outwards thereby elongating the holes in the sleepers. Once started, the to-and-fro motion of the chair or baseplate (shuffling) will abrade the surface of the wood causing an indentation which will retain water and accelerate decay of the sleeper.

Where sleepers have enlarged or elongated baseplate/chair screw holes which are not capable of being treated with maintenance liners but where there are no indications of indentation or adzing, then it is permissible to pull the sleeper through.

In the process of "pulling through" sleepers all the baseplate/chair screws or spikes are withdrawn, the rails and chairs or baseplates eased off the sleepers and the affected sleeper pulled laterally under the track. The rails and chairs or baseplates are then lowered back onto the sleepers and the chairs or baseplates re-fastened, new holes being drilled for the screws or spikes.

The precise distance that the sleeper is to be moved must be determined on site but any new baseplate/chair screw holes must not be closed than 75mm to existing holes under any circumstances.

Where sleepers are pulled through there must be not less than 150mm from the outermost edge of the chair or baseplate to the end of the sleeper. Only in an emergency should this minimum dimension be reduced and a new sleeper installed as soon as possible.

All redundant chair/baseplate screw holes in wood sleepers must be plugged with wood plugs. Softwood sleepers cut on site must have the cut surface(s) treated with creosote and cut ends of hardwood sleepers should be given a coating of an approved switch lubricant.

6.4.4 Inspection of Wood Sleepers

Visual examination, in-situ, of the exposed surfaces of the sleeper in track will not reveal the presence of decay on the underside or within the sleeper. Similarly, severe weathering of the top surface, indicating poor condition, may mask wood which may be quite sound internally.

Examination of sleepers removed from the track can be examined for condition by using a small hammer, the sleeper can be "rung" by striking one face of the sleeper after the sleeper has been stood on edge. A sleeper which is internally sound will produce a distinctive clear note whilst a sleeper which is internally decayed produces a dull tone. Alternatively, by using a hand pick to probe for areas of decay, concentrating on the chair or baseplate seating areas, holes, splits and areas of damage.

A device known as the Sleeper Integrity Tester (SIT) which uses a non-destructive technique based on the simple principle of the wheel tapping hammer has been designed to simplify the assessment of the condition of plain line softwood sleepers. The SIT impacts the sleeper and monitors the response. An analysis technique built into the instrument quickly identifies the overall condition of the sleeper.

6.4.5 Gauge Spread on Wood Sleepered Track

Where gauge spread has taken place then the fitting of gauge ties or tie bars (which must be of the insulated type on track circuited lines) can be undertaken as a temporary measure (up to three months) to return the track to gauge.

Permanent repairs, which may include the installation of replacement sleepers or S&C timbers, attention to fastenings and the fitting of gauge stops, must be put in hand as a matter of urgency.

6.4.6 Inspection of Concrete Sleepers

Visual examinations of concrete sleepers should be made in-situ to determine the presence of transverse and longitudinal cracks in the vicinity of the fastenings, rail seat and in the fourfoot, the latter indicating centre binding. Loose and/or skewed cast-in housings and the breaking up of the ends of the sleepers can also be detected. This method of inspection will not usually reveal the presence of abrasion of the underside (soffit) of the sleepers or the presence of longitudinal horizontal cracks. A more thorough examination of the longitudinal vertical faces of the sleepers can be made if the beds are opened out.

A thorough examination of the undersides of concrete sleepers can be made only if the sleepers are removed from the track. Replacement sleepers must be of the same type. Where soffit abrasion is severe then the lower stressing wires or strands will be visible on the underside of the sleeper for more than 100mm from each end of the sleeper and if this condition exists then the sleepers must be replaced at the earliest opportunity. Similarly, the presence of exposed stressing wires or strands away from the sleeper ends must be taken to indicate that the sleeper will fail at an early date.

6.5 CHAIRS, BASEPLATES AND FASTENINGS

6.5.1 Chairs for Bull-Head Rail

Chairs must be placed firmly to the foot and web of the rail and held in place by a wood or steel key of either the tapered or self-retaining type. Where a tapered key has worn or distorted or the chair jaw has become worn the old key should be driven out, the sleeper and chair held up tight to the rail and the new key driven in with the addition of a maintenance liner if necessary.

Broken chairs, or those incapable of gripping a key and maintenance liner must be replaced. Chairs must not be struck with a hammer because of the possibility of damage to the chair and injury caused by flying splinters of the casting.

6.5.2 Baseplates for Flat Bottom Rail

Flat bottom rail must seat evenly on baseplates with all fastenings correctly tensioned. All broken or defective baseplates must be replaced at the first opportunity with baseplates of compatible types. If there is any doubt about the grip of spike fastenings in the sleepers then maintenance liners should be fitted before the spikes are re-driven and additional spikes can be fitted to holes not in use.

Where attention is given to baseplates and/or fastenings the sleepers must be repacked, the ballast returned to the correct profile and consolidated where necessary. Baseplates must not be struck with a hammer because of the possibility of damage to the baseplate and injury cause by flying splinters of the casting.

The outer shoulder of flat bottom rail baseplates should contact the foot of the rail before fixing to gauge, except at:

- Crossing noses and wing rail fronts, where the rails must contact both baseplate shoulders.

- Crossing V legs, where the crossing legs must be in contact with the baseplate centre section.

6.5.3 Chair/Baseplate Screws

Correct hole sizes must be drilled to suit the coach screw or chair screw specified. All holes must be drilled vertically and centrally with respect to the chair or baseplate holes. Screws must NOT be driven in the timber or sleeper by the use of a keying or sledge hammer. In softwood the screw can be "started" quite easily by hand prior to being screwed down by means of a "T" spanner or impact wrench. For hardwood one light tap only using a keying hammer is all that is required to "start" the screw. Screws must not be tightened so far that the underside of the head makes contact with the upper surface of the chair or baseplate but must just contact the top of the ferrule. Screws must be entered vertically into the pre-drilled holes; care must be taken to ensure that the screw remains vertical as it is screwed home.

Screws which are bent, have damaged threads, show signs of corrosion or have damaged square heads should be scrapped.

Prior to any tamping or lining screws must be checked and tightened.

When screw holes have become enlarged and the timber or sleeper is no longer capable of gripping the screw then either maintenance "M" screws or maintenance liners or coils should be used.

Where gross elongation of the screw holes has been allowed to develop, it is possible that the fitting of the maintenance liners or coils may not be sufficient to restore the grip of the screws. In such cases it will be necessary to either "pull through" the affected timber(s) or sleepers or provide new serviceable timbers.

Screw holes which are not drilled either centrally or vertically with respect to the baseplate or chair holes will result in the screw pulling the chair or baseplate out of position as the screw is tightened down. This will result in variations in track gauge.

For softwood timber two persons using a "T" spanner will exert sufficient torque to tighten screws but the use of an impact wrench is recommended for fitting screws to hardwood timber. In both cases care must be taken to avoid crushing the ferrule.

6.5.4 Ferrules

Ferrules are design to be inserted into the holes in chairs or baseplates such that the top of the ferrule is 6mm above the upper surface of the chair or baseplate.

Ferrules must not be driven fully home into the hole in the casting, unless the ferrules are of the flange type, when the flange must be in contact with the top of the chair or baseplate. Screws must be inserted with care to avoid damage to the ferrules by overtightening. Full contact must be made between the underside of the head of the screw and the ferrule. The screw must not make contact with the chair or the baseplate.

Where ferrules have become distorted or damaged because of incorrect fitting or through the effects of traffic they must be replaced by new ferrules of the correct type. In cases where the ferrule drops into the chair or baseplate without any force being applied to the ferrule, then the chair or baseplate must be renewed. Where ferrules are prone to crushing, nylon "66" ferrules should be used.

6.5.5 Bull-Head Rail Fastenings

Keys must be driven in the direction of traffic, except at joints where the key on each side the joint is driven towards the fishplate. On single lines keys should be driven either in the direction of the main weight of traffic or in the direction in which there is a tendency to creep or, if traffic is equal in both directions and rail creep is not present, in alternate directions on adjacent sleepers. Each key must be tightly driven but not overdriven and all keys found to be loose or out must be re-driven immediately. When keying up, the chair must be held firmly to the foot of the rail to ensure that the rail is properly bearing on the chair seating and firmly against the inner jaw of the chair.

Wood keys are slightly tapered, with distinguishing mark "S" at the thin end, and wood or metal packing liners should be used between the web of the rail and the key when the keys are found to be undersized for tight driving but otherwise sound. Wood keys should be used in tunnels. Stocks of keys, packing or liners should be kept under cover until required.

6.5.6 Flat Bottom Rail Fastenings – Elastic Spikes

Care must be taken that spikes are not over driven. The spikes should be adjusted as required, defective or broken ones being replaced. Where an effective grip or toe load can no longer be maintained then either fitting maintenance liners to the spikes, fitting spikes to previously unused baseplate holes or fitting maintenance spikes as replacements for the original spikes should be undertaken.

New holes for elastic spikes should be drilled 12mm diameter and right through the sleeper taking care not to damage the drill bit. Care must also be taken to avoid any buried cables which may be located under the sleeper.

6.5.7 Flat Bottom Rail Fastenings – Clips

Normally clips shall be inserted using the manufacturers approved technique. Clips should not be driven with a hammer. Any clips which are broken or have become defective should be replaced. Where clips are tensioned by a nut or screw, care must be taken to ensure that they are correctly tensioned. In the case of CWR, care should be taken in hot or cold weather not to release more than eight consecutive pairs of clips on one rail at the same time, except during stressing operations.

From time to time it will be necessary to undertake maintenance of driven, pulled-in or screw-fastened type clips to regain the toe load on the rail foot. Where nylon insulators have been used they shall be replaced to maintain toe load and gauge.

When fastenings become loose, the designed toe load on the rail is not retained, resistance to rail creep in jointed track is reduced and the resistance to track buckling is reduced.

Vertical vibrations can also be set up which will lead to pad wear and vibration of the sleeper against the ballast. This in turn will lead to wet or slurry spots developing.

Worn and cracked pads contribute to loose fastenings, sleeper damage, formation of wet beds and, in some cases, track circuit failures in signalled sections. They should be replaced as soon as possible. Periodic inspections must be made so that defective pads may be replaced before mechanical damage occurs.

6.5.8 Rail Creep

There is a tendency for the rails to move gradually through the fastenings in the direction of predominant traffic. On single and bi-directional lines this movement will be in the direction of the most or heaviest traffic. The phenomenon is known as rail creep and can be influenced by:

- Braking of trains
- Worn or missing fastenings
- Shortage of ballast
- Inadequate packing of the sleepers
- Worn and badly maintained joints
- Gradient
- Corrugations

The first sign of rail creep will be that the expansion gaps close up (tight joints) and these must be corrected at the first opportunity, particularly before the onset of hot weather, to reduce the risk of buckling. All existing fastenings must be examined and re-tensioned or retightened and the packing must be checked to ensure that all sleepers are consolidated.

If, after the fastenings and the packing of the track have received attention, rail creep persists one or more of the undernoted remedial actions may need to be undertaken:

- Fit additional fastenings, ie fit spike fastenings in unused baseplate holes.
- Fit replacement fastenings.
- Fit fastening maintenance liners.
- Fit chair screw liners and new ferrules.
- Spot re-sleeper as necessary, especially at joints.
- Square and correctly space all sleepers.
- Pull back rails and correct expansion gaps.
- Fit approved rail anchors.
- Shim to correct dipped joints or undertake rail joint straightening followed by the fitting of new fishplates and fishplate shims and the packing of sleepers.
- Remove corrugations using specialist equipment.
- Ensure that there is adequate, well profiled ballast.

6.5.9 Rail Anchors

Anchors must not be fitted against any joint sleepers nor should they be fitted to one end only of a sleeper. Anchors must always be fitted tight to the vertical face of the sleeper against which they will bear. Where anchors are loose on the rail they should be replaced. Where anchors have been moved along the rail they should be refitted tight to the face of the sleeper and additional anchors fitted.

6.5.10 Rail Creep Correction

Each site must be carefully surveyed noting any additional work required, eg packing hanging sleepers, to enable the task to be accurately planned. Wherever possible the cutting of rails should be avoided and both rails should be adjusted. Special attention must be given to flat bottom track tending to creep towards bullhead track or S&C, level crossings, longitudinal timbers, adjustment switches and other similar locations. New track must be monitored in its first year so that any tendency to creep can be detected and rectified. All adjusting should be undertaken using hydraulic rail adjusters. The use of a hammer and set is prohibited, as is the use of slewing bars, to lever the rails apart.

Rail anchors must be removed prior to adjusting rails and then refitted on completion of the work. Anchors must be relocated as necessary after tamping and sleeper squaring.

6.6 RAILS

6.6.1 Minimum Length of New or Replacement Rails

When new rails are laid in CWR the closure rails must be not less than 4.5m in length and supported by at least six sleepers. If a rail in CWR has a defect which needs to be cut out, the replacement rail must be not less than 4.5m long in straight track or 9m long (and supported on a minimum of 12 sleepers) in transitions and curved track. Where the defect is of a type that may be repeated in the 18.3m length then the whole rail must be cut out.

On any section of CWR where rail has been replaced stress restoration must be carried out in accordance with Network Rail Group Standards.

6.6.2 Depth of New or Replacement Rails

The greatest difference in rail depth between adjacent rails of the same nominal section which can be welded together economically using pre-formed moulds currently available for the alumino-thermic welding process is 9mm.

Where it is necessary to introduce into a track a rail which has a depth more than 9mm different from the existing rail then closures of a depth intermediate between existing and new/replacement rail must be provided.

Where it is required to weld together rails of different sections, ie to produce alumino-thermic welds known as "composite welds", then the maximum difference in relative wear of the two rails is 3mm. For example, CEN56 (BS113A, RT113A or equivalent) worn 5mm can be welded to BS95R BH having a wear range of 2mm to 8mm.

6.6.3 Examination and Testing of Rails

All rails must be visually examined, during the course of track inspections, for cracks and other defects. Rails removed because of defects must be clearly marked with paint to prevent their accidental re-use.

Previously bolted rails which are to be welded together in-situ to form low-cost CWR must be ultrasonically examined not more than 7 days prior to welding so that any rails having serious defects can be changed whilst still within jointed track.

6.6.4 Marking of Defects

All rail defects should be marked in paint in the web of the rail, recorded and kept under special observation.

6.6.5 Broken and Defective Rails

When a broken rail or a defective rail is discovered in the running line, the first and immediate duty is to take the necessary action to protect traffic and to advise the local operating staff. The action to be taken is described in Table 6.1. An example of a broken rail is shown at Figure 6.1. This is typical of cracks radiating from a fishbolt hole, spreading under traffic, and resulting in complete breaks in both the head and foot of the rail.

Table 6.1 Minimum action to be taken on discovery of a broken rail

Type of Break	Block the Line	Impose 5mph ESR	Impose 10mph ESR
	If **all** conditions apply	If **any** conditions apply	If **any** conditions apply
Transverse break through a plain rail or at a weld	1. The break passes through a bolthole. 2. The gap is wider than 50mm and bridging pieces cannot be fitted. 3. The break is more than 50mm out of vertical. 4. The break is at or is within 3m of a joint, weld or S&C rail.	1. The break passes through a bolthole. 2. The gap is up to 50mm wide and bridging pieces cannot be fitted or the gap is between 50mm and 165mm and bridging pieces can be fitted. 3. The break is less than 50mm out of vertical. 4. The break is more than 3m from a joint weld or S&C rail.	1. The break passes through a bolthole. 2. The gap is less than 50mm and emergency clamped fishplates can be fitted. 3. The break is less than 50mm out of vertical. 4. The break is more than 3m from a joint weld or S&C rail.
Any part of the railhead broken away	1. The break passes through a bolthole. 2. If the break is at or is within 3m of a joint, weld or S&C rail. 3. The gap is more than 50mm wide and bridging pieces cannot be fitted. 4. There are any cracks extending into the web.	1. The break does not pass through a bolthole. 2. Less than 50mm of the railhead is missing and bridging pieces cannot be fitted or between 50mm and 165mm of the railhead is missing and bridging pieces can be fitted. 3. The break is more than 3m from a joint weld or S&C rail. 4. There are no cracks extending into the web.	1. The break does not pass through a bolthole. 2. Less than 50mm of the railhead is missing and emergency clamped fishplates can be fitted. 3. The break is more than 3m from a joint weld of S&C rail. 4. There are no cracks extending into the web.
Lower part of the rail broken away	1. The break passes through a bolthole. 2. If the break is at or is within 3m of a joint, weld or S&C rail. 3. More than 50mm of the rail foot on each side of the rails is missing. 4. There are any cracks extending into the web.	1. The break does not pass through a bolthole. 2. Less than 50mm of the rail foot on each side of the rail is missing and emergency clamped fishplates can be fitted. 3. The break is more than 3m from a joint weld or S&C rail. 4. There are no cracks extending into the web.	1. The break does not pass through a bolthole. 2. Less than 50mm of the rail foot on one side of the rail is missing and emergency clamped fishplates can be fitted. 3. The break is more than 3m from a joint weld of S&C rail. 4. There are no cracks extending into the web.
Longitudinal split	1. Any part of the side of the railhead on the running edge side (gauge face) breaks away.	1. Any part of the non-running edge (back edge) of the railhead breaks away.	Not permitted.
Railhead damage	1. The railhead is damaged or distorted either vertically or laterally by more than 25mm as determined by visual examination.	1. The railhead is damaged or distorted either vertically or laterally by between 25mm and 10mm as determined by visual examination.	1. The railhead is damaged or distorted either vertically or laterally no more than 12mm as determined by visual examination.
Switches and crossings	1. It is not possible to fit emergency clamped fishplates; the tail is free to move (ie a switch rail); the break is not supported by the S&C blocks and bolts or MGL pins or it is not possible to provide any other form of support to the rail.	1. It is not possible to fit emergency clamped fishplates but the rail is free to move and it is possible to provide some other form of support to the rail. 2. The break is supported by the S&C blocks and bolts or MGL pins.	1. Emergency clamped fishplates can be fitted to the break and the rail supported by the S&C blocks and bolts or MGL pins.

Notes to Table 6.1:

● Where bridging pieces are used then they should be fitted in pairs, ie one on each rail so as to minimise the risk of introducing a twist fault.

● Bridging pieces must normally be secured by four G clamps, two on each side of the break; however in exceptional circumstances the use of three clamps is permitted. Where it is possible to fit only three G clamps then two must be on the "running-on" side of the break.

● Emergency clamped fishplates must be secure by four G clamps, two on either side of the break.

● Assessment of "out of vertical" should be made over the full rail depth.

● Localised breaking away of lipping on either the running or back edges of a rail is usually insufficient to warrant classification as rail head damage.

● Sleepers and fastenings on either side of the break must be complete.

Figure 6.1 Example of a Broken Rail

6.6.6 Rail Corrugations and Minor Rolling Contact Flaws

During the passage of trains rails tend to develop corrugations on the running surface especially along the wheel/rail contact band. On certain lines the development of corrugations is accompanied by a fattening of the running surface. Corrugations are detectable by increased wheel noise or "roaring". In extreme cases the vibrations induced into the rail will lead to premature failure of pads, insulators, clips and ultimately the cast in housings in concrete sleepers.

Loss of rail head profile is detected by visual observation and profile measurement and by the poor riding of vehicles on track which is otherwise within maintenance tolerances. Minor rolling contact rail flaws, ie small squats, small wheelburns, gauge corner cracking and micro-cracking of the bright running band on the rail head can be removed using rail rectification machines.

Details of corrugations, loss of head profile and minor rolling contact flaws should be assembled as part of the inspection schedule into a programme of work for rail profile rectification.

6.6.7 Sidewear

Sidewear takes place as a result of the wheel flange making contact with the gauge face of the rail. As sidewear increases the railhead is worn to the profile of the wheel flanges. Sidewear may be reduced by the installation of lubricators to the affected running rail.

Sidewear is measured using a recognised sidewear gauge. Rails should be replaced when the sidewear or a combination of sidewear and a reduction in overall height has caused a loss of head area greater than 10%. Rails may be turned or transposed before the following limits are reached:

- 5% loss, in heavily trafficked track.
- 5-7.5% loss, in sidings.
- 5-7.5% loss, in occasionally used track.

The locations of sidewear must be monitored monthly, ensuring that readings are taken at the same point on the curve. This may be carried out by painting the web of the rail with a unique identifier.

Rail lubricators should be considered for curves with a radius of 200m or less. If rail lubricators are installed they should be correctly adjusted so that grease is not allowed to contaminate the running surfaces of the rails.

6.6.8 Rail End Straightening

Rail ends at joints develop a vertical deformation under traffic which is correctable using a hydraulically driven Rail End Straightening (RES) machine.

Rail end straightening must not be carried out when the rail temperature is 0°C or less. When undertaking straightening the following precautions must be taken:

- All joints should be inspected ultrasonically by an approved procedure.
- No insulated joints should be straightened.
- Packing is to be carried out to the four joint sleepers at the time of straightening.
- Where ballast is frozen preventing packing, straightening should not be attempted.
- Any shimming required should be carried out at the time of straightening.
- All fastenings including fishbolts must be tightened.

- Replacement fishplates must be kept at hand in case of failure of the joint plate during the straightening process.

- Rails at each side of a joint should be marked each time it is straightened. (Joints straightened more than three times are suspect)

6.7 FISHPLATED RAIL JOINTS

6.7.1 Joint Sleepers

It is particularly important to keep joint sleepers firmly packed. Sleepers should be kept square and correctly spaced. The rail joint should be central ± 60mm between the joint sleepers, with the correct expansion gap. The sleeper on each side of a fishplated rail joint must be of the same material and compatibility, ie both wood, both concrete of the same design or both steel. Joints with different sleepers on each side are not permitted. The rail to sleeper fastening must be kept tight and the correct gauge maintained.

6.7.2 Fishbolts

Fishbolts must be kept tight but not so tight as to prevent the proper expansion and contraction of the rails in jointed track. Black (non-high tensile steel) fishbolts and high tensile steel (HTS) "V" quality fishbolts fitted with "R" quality steel nuts and insulated and tight joints should be tensioned, using the approved torque spanner, to:

- Black fishbolts 475Nm
- HTS fishbolts 25mm diameter 881Nm
- HTS fishbolts 28.5mm diameter 1017Nm

If black fishbolts or threads are rusty or dirty they must be cleaned and greased before being tightened.

6.7.3 Rail Joint Lubrication

Rail joint lubrication shall be carried out by taking off both fishplates, wire brushing and lubricating plates, rail bearing flanges and bolts, plates shall be turned (except junction) and all plates refixed. Before retightening the bolts any shims must be reset or, if badly worn, replaced with the correct size shim.

6.7.4 Shimming of Joints

Fishplates that are worn so that they do not give adequate support should be either shimmed or renewed. Failure to keep fishplates correctly tightened will lead to accelerated component wear. It is possible to compensate for this wear by the insertion of shims between the upper surface of the fishplates and the underside of railhead.

Determination of the correct shim size should be carried out by the railway engineer. Continuity of materials should be maintained on both sides of the joint. Following the fitting of shims it is important to check that wear has not been overcompensated. In addition two sleepers either side of the joint must be repacked.

6.7.5 Special Fishplates

A special junction dropped forged fishplate (joggled and/or stepped) must be used to join rails of different sections, eg flat bottom rails to bullhead rails, to ensure continuity of running edge and rail top.

6.7.6 Emergency Clamped Fishplates

These are temporary plates used to effect an emergency repair to a broken rail or defective joint. They should be secured with 4 G-clamps and every effort must be made to carry out a permanent repair as soon as possible.

6.8 SWITCH AND CROSSING – BOLTS AND FASTENINGS

Lock nuts or other locking devices should be used wherever possible. Nuts for bolts with spring clips in flat bottom rail inclined design switches and crossings must be tightened with a box spanner. Where high tensile steel (HT) bolts are used the correct torque must be applied with a torque spanner.

All horizontal bolts must be oiled or greased before being tightened, all blocks firmly gripped and the rails correctly seated in the chairs before they are finally screwed or bolted down on the timbers.

New bolts must be used as replacements in S&C except as a very short term measure when new bolts are not available.

When serviceable S&C is recovered for re-use then the existing bolts may remain in-situ but any which require replacement must be replaced with new items before installation.

Any bolts which have been packed out with washers or packing pieces must be replaced with new items. No more than two washers should be used under any one nut.

6.9 SWITCH AND CROSSING – TIMBERS AND BEARERS

6.9.1 Types

Hardwood timbers, treated softwood timbers and concrete bearers are used with switches and crossings. Hardwood timbers are the MOD standard for new installations, spot replacements and relaying.

6.9.2 Indentation

Indentation of S&C timbers can occur, especially in vertical design layouts on sharp curves, where the outside rails of both the main line and the turnout are subjected to high lateral loading. In such cases the outer ends of the baseplates are being driven into the timbers and galling of the baseplate, clip shoulder and rail foot may be present with resultant gauge widening.

6.9.3 Gauge Spread

Fitting of gauge stops to timbers at the outer face of high rail chairs or baseplates and/or to the outer face of low rail chairs or baseplates when the timbers are new will greatly assist in preventing gauge spread. It is necessary to treat all timbers likely to be affected by gauge spread in a layout otherwise any benefits will soon be lost.

Fitting gauge stops to timbers after they have been in the track for some time is of doubtful value since the chair/baseplate screw holes are already worn and, whilst there will be some short term benefit, overloading of the gauge stop screws will soon occur.

If the fitting of gauge stops has not been done or has failed then the most satisfactory solutions are either to pull the affected timbers through to provide a new bearing area for the whole length of the baseplate, or to replace the timbers.

The fitting of gauge ties or tie bars can be undertaken as a temporary measure (up to three months) to return the track to gauge.

6.10 SWITCH AND CROSSING – FOULING POINT

Fouling points must be marked by white or yellow paint on the sleeper ends or on marker plinths in the interval.

Figure 6.2 Fouling point marker

6.11 SWITCHES

6.11.1 Switch Wear

Switches should be checked for switch and stock rail wear during the course of normal inspections.

6.11.2 Slide Plates

The rail seating on slide baseplates must be kept clean and lubricated regularly.

The indentation of a slide baseplate in the seating under the switch rail shall require renewal of the baseplate.

6.11.3 Flangeway Clearances

The space between switch rail and stock rail must always be kept clear of obstructions and a minimum flangeway clearance of 50mm must be maintained. The minimum clearance between the stock rail and switch rail at the toes of the switches should be 102-120mm.

6.11.4 Gauge Measurement

Gauge at the switch should be checked at each inspection 100mm in front of the switch toes and at all drive points and fixed heel blocks.

6.11.5 Bolts in Switches

The stock rail bolts must be kept tight and the exposed thread periodically greased. Where black bolts exist they should be tightened to 475Nm using a torque spanner. High tensile bolts must be tightened to 881Nm using a torque spanner.

6.11.6 Stretcher Bars

Failure of one or more stretcher bars will result in an incorrect flangeway gap, leading to (in the worst case) derailment. Any cracked, broken or bent stretcher bars should be replaced as soon as possible. In the interim the turnout must be removed from use.

6.11.7 Hand Lever Operated Switches

All hand lever operated switches must open and close to correct positions with equal pull in both directions. If this is not the case it may be as a result of one or more of the following:

- Incorrectly adjusted switch lever.
- Weakened or broken spring.
- Connecting rod incorrectly adjusted.
- Connecting rod not at right angles to the track.
- Damaged switch rail.
- Poor installation.

6.11.8 Switch Toes

Switch toes, other than in single or double slips and switch diamonds must always be kept square to each other.

6.12 COMMON CROSSINGS

6.12.1 Track Gauge at Crossings

The crossing bolts should always be kept tight and the exposed threads greased. For inclined standard gauge crossings the gauge should be 1435mm with a flangeway gap of 44mm. For vertical standard gauge crossings the gauge should be 1432mm with a flangeway gap of 41mm.

6.12.2 Flangeways

The distance between the inside edge of a standard check rail and the running edge of the opposite rail must be maintained at 1391mm. The maximum permitted wear on check rails and wing rails is 3mm. Flangeways should be kept clear of dirt and other obstructions.

6.12.3 Check Rails

The position of the crossing nose should be checked to ascertain that the nose is covered by a check rail.

6.12.4 Defective Crossings and their Replacement

When a broken crossing is found it should be replaced as quickly as possible and in the meantime consideration given to rerouting of traffic or temporary substitution of a plain rail to maintain through running only and the switches clipped out of use.

6.13 TRACK ALIGNMENT, LEVEL AND GAUGE

6.13.1 Geometrical Track Tolerances

- Gauge, plain line: +20mm/-20mm.
- Gauge, S&C: +10mm/-5mm.
- Cross level (cant): +20mm/-20mm permissible variation from design.
- Twist: 15mm maximum rate of change of cross level on a 3m length, (cant gradient 1 in 200).

6.13.2 Maintenance of Gauge

Gauge is measured between the running edges of the rails 14mm below the crown of the rail (when new).

Gauge irregularities give rise to sidewear of the rail and could lead to derailment. In checking gauge particular attention should be given to any visible movement of baseplates or chairs on the surface of the sleeper, or any worn fastenings. To avoid gauge irregularities any change of component should be compatible with those remaining.

Correction of gauge in concrete sleepered track may be carried out by sleeper replacement, provision of new clip insulators or gluing in clip housings. The actual correction method will depend on the type of failure and sleeper type.

Correction of gauge in wood sleepered track may be carried out by moving the sleeper perpendicular to the track and refastening the baseplates or chairs.

A temporary measure to hold gauge or prevent gauge spread is to fit gauge ties or tie-bars.

6.13.3 Twist

Twist is defined as a track condition where there is a difference in cross levels over a short distance which induces one or more wheels of a vehicle to lose contact with the running surface of the rail. Twist is a significant derailment risk.

Twist may be detected by measuring the cant or cross levels every 3m. The difference in adjacent readings will give the twist value. A twist fault for standard gauge track is a twist gradient of 1 in 200 or steeper (15mm difference over 3m length).

6.13.4 Lifting and Packing

Lifting and packing of the track should be carried out after first ensuring that all fastenings are correctly tensioned, rails are seated and defective components replaced. Adequate ballast should be provided and the profiles made good upon completion of the work.

Where lifting and packing work is to be carried out during normal running only the obstructionless type of jack shall be used. Jacks shall be used in an upright position and must never be used under a rail joint.

Lifting should always be carried out towards on-coming traffic except on single lines when it should be carried out in the direction of the rising gradient.

Where tracks are subject to subsidence or other major earthworks are required, remedial work should be designed.

Whenever lifting or packing is carried out the track must be checked for alignment and corrected as necessary.

Voids under sleepers should be identified during track inspections. Where identified they should receive a high priority for correction.

Sleepers must only be packed under the rail bearing area, not at their centres. This is particularly important for the old pattern c1940 Ministry of Supply concrete sleepers used with BS75R rails. These will break their backs in service if centre packed.

6.13.5 Slewing and Lining of Track

Unless realignment work is of a very minor, local nature a realignment scheme should be designed. The realignment scheme will normally be prepared using the Hallade method. The alignment scheme must be set out on site using brightly painted pegs of a single colour set clear of any walking routes or work site.

When adjusting tracks at platforms or loading bays arrangements must be made for the adjustment of any structure that may be required.

After any realignment work steps should be taken to re-profile ballast particularly at sleeper ends. In addition all voids should be filled with ballast and properly compacted.

If CWR is to be realigned then the track affected must be restressed.

6.14 EFFECTS OF HOT WEATHER

Late spring or early summer are the most vulnerable periods for track buckling. During these times there may be cool nights followed by hot days giving rise to an extreme range of temperature. In general certain locations are more susceptible to buckling than others and these should be monitored at the appropriate time.

- Wind sheltered north/south cuttings.
- Sites of embankment slips.
- Areas of recently disturbed ballast.
- Wet spots.
- Ash ballasted track.
- Where ballasting of sleeper ends is inadequate.

6.14.1 Preventative Work

Track inspections should recognise those lengths of track where there is potential for buckle and should recommend those works required to mitigate the threat. Where works are recommended they should be carried out before periods of hot weather.

6.14.2 Remedial Work

If a buckle occurs the severity should be assessed and if necessary the track closed until remedial work can be carried out. Emergency remedial work may consist of:

- Slewing the track
- Cutting rails
- Adjusting rails

6.14.3 CWR

Extra vigilance is required when rail temperatures reach the stress free rail temperature of 27ºC in CWR. Buckles may be triggered by rail traffic. Temporary speed restrictions (TSR) or temporary closure to traffic may be required.

6.15 EFFECTS OF COLD WEATHER

Typical permanent way problems associated with cold weather are fishbolt failures, joints pulling apart and frost heave. Switches may be blocked, seized or split by snow and ice.

Work that affects the stability of the track should not be carried out at temperatures below minus 7°C.

6.16 MAINTENANCE TASKS

Basic level track maintenance tasks for track staff or contractors are listed at Annex C. These are designed to be managed by local facility managers and railway operating managers.

6.17 MAINTENANCE BY ON-TRACK PLANT

Modern methods of maintenance make extensive use of on-track plant and road/rail machines, which greatly increases productivity and efficiency for long lengths of track or repetitive tasks. Specialist railway engineer advice must be obtained when planning this type of work.

6.17.1 On-Track Plant

There is a whole range of machines from large scale track relaying trains down to spot sleeper changing machines. Commonly used machines are:

- Tamper – for lifting track to levels and packing ballast.
- Liner – for slewing track to a design alignment. This function is often combined with the tamper.
- Ballast regulator – for distributing and shaping ballast profile along the track.
- Dynamic track stabiliser – for consolidating newly placed bottom ballast prior to a final tamp to level.

Figure 6.3 Main line tamping machine

6.17.2 Road/Rail Machines

There is a large range of machines including tampers, excavators, dozers, elevating platforms, load carriers, personnel carriers, and specialist function machines.

Figure 6.4 Road/Rail tamping machine

Figure 6.5 Road/Rail Unimog load carrier with crane arm

Figure 6.6 Road/Rail Landrover weedkilling sprayer

6.18 OBSOLETE TRACK FORMS

A variety of obsolete track forms remain in use to limited extent on MOD railways. These are generally adequate for light and/or infrequent traffic, and should be renewed to current standards when their condition deteriorates beyond acceptable.

Table 6.2 Obsolete Rail Types

Rail Form	Rail Type
Flat bottom	BS110A
Flat bottom	BR109
Flat bottom	BR98
Flat bottom	BS75R
Bull head	BS95RBH

In addition to obsolete rail forms there also remain some obsolete types of concrete sleeper, including types for more modern BS113A rail.

In the past, ash (crushed furnace slag) has been used for ballast due to its low cost and availability. However, it is not suited to modern track specification with higher loads and lower maintenance requirements.

6.18.1 BS75R Type Rail

This rail was commonly used from the 1940s and is usually vertical, supported on former Ministry of Supply concrete sleepers with clips and screwed stud fixings, or wood sleepers with pressed steel baseplates, AS screws and Pandrol PR401 clips. Older pattern dog spikes and associated base plates have now largely been removed. Standard rail and panel length for BS75R rail is 10.973m (traditionally 36ft).

A feature of this track that is still visible at some sites, where installed on Ministry of Supply concrete sleepers, is the area kept clear of ballast in beds 50mm deep below sleeper bottom to a width of 225mm either side of the track centre line. This was designed to prevent centre packing, and support of sleepers in the centre, and hence prevent these sleepers from breaking their backs under load.

Figure 6.7 Plain line track – obsolete BS75R rail on concrete sleepers

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7 Installation and Design Standards

7.1 GENERAL

The designer and installer must ensure that the relevant standards are used and that the specification for the works is of no lesser standard than indicated in the subsequent paragraphs. The specifications in this section apply to standard gauge railways, although many apply with suitable interpretation to narrow gauge railways. Well defined differences for narrow gauge railways are set out at the end of this section.

Some common standards have been adopted as the preferred type of track and components, based on proven efficiency, economy, whole life costs, minimum maintenance requirement, and minimising work routines, skills, specialist tools, etc.

7.2 PROCUREMENT

There are several large specialist permanent way construction and maintenance contractors whose principal workload centres on the national railway network. There are also several smaller specialist contractors focusing on industrial and freight yard railways. The latter are usually more economic for the type and size of work on MOD railways, however the larger contractors may be better suited to large scale track renewal or construction projects.

The procurement of permanent way contractors must follow MOD guidelines. However, it is important that contractors are selected to tender based upon their expertise in permanent way and their previous record with either the MOD or other organisations. Contactors should be national railway industry “Link-up” approved for the relevant type of work.

Whilst most construction and maintenance works will be procured on a plant, labour and materials basis there may be some benefits in the advance procurement of materials to obviate long lead times for some specialist materials.

It is recommended that every opportunity is taken to package fault rectification and minor new works into more substantial size contracts, in order to gain from economy of scale. Notwithstanding the above, it is important that the most appropriate method is adopted for the procurement of works and to this end the DIO Principal Railway Engineer (PRE) should advise.

No permanent way work should be let without the preparation of suitable contract documentation. This documentation will vary in content depending on the type of work to be carried out.

Any proposed work carried out on the track must first be advised to the Railway Operating Manager (ROM) who may seek advice from DIO PRE.

7.3 SUPERVISION

Any work carried out on the railway track shall be supervised by a competent person.

The completion of any work carried out on the track, no matter how minor, must be authorised as safe by a competent person. This person will normally be the DIO PRE or ROM.

7.4 PLANT AND EQUIPMENT

No matter what plant and equipment is used to construct and maintain the track, users must be trained and certified as competent in its use. Larger items such as road/rail mounted machines can be hired complete with properly trained operatives. The national railway industry has a system of certification and recording for skills known as “Sentinel”. Typical plant used in the construction and maintenance of railway track is listed at Table 7.1.

Table 7.1 Plant and Equipment for Permanent Way

Plant/Equipment	Examples
Trains	Flat wagon, open wagon, ballast hopper: hauled by locomotive.
On-Track Plant	Tamper, liner, rail crane, ballast regulator, rail car & trailers.
Road/Rail Plant	Unimog, access hoist/work platform, personnel carrier, flailing machine, excavator, dumper, ballast brush, ballast packer, materials carriers.
Specialist Powered Machinery	Rail grinder, muscleman, impact wrench, trolley mounted torque wrench, abrasive disc cutter, broach hole cutter, sleeper drill, CWR stressing jacks, thermit welding sets.
Manual and Mechanical Tools	Track jack, ironman, shovel, ballast fork, slewing bar, keying hammer, T key, sleeper tongs, rail tongs, rail turning bar, spanners, pan puller, pan setter.

7.4.1 Access to the Work Site

Plant and vehicles (wheeled and tracked) must not normally be moved on, along, or across the track. Where the situation makes this the only means of access, then the track and trackbed should be protected as appropriate with wood sleepers or rafts.

7.4.2 Rail Mounted Plant and Vehicles

Rail mounted plant and vehicles eg PW trolleys and road/rail machines, must only be used within a track possession.

7.5 SERVICEABLE GRADE USED MATERIALS

It is common practice to cascade down worn track materials for re-use as serviceable grade materials, particularly in low speed/low traffic tracks where a decreased rate of wear may be expected. Accordingly, railways within MOD establishments are ideally suited to second-hand materials.

There are limits to acceptable wear and damage to rails, sleepers, baseplates, etc, that are acceptable for reuse. Guidance concerning acceptable levels of wear is given in Chapter 6 Maintenance – Standards.

Where second-hand materials are procured they may only be used if accompanied by appropriate certification.

Designs should accommodate second-hand serviceable items wherever possible, consistent with the requirement to obtain the best value for money, and consideration of whole life costs, for the MOD.

7.6 PLAIN LINE

The normal standard for new or replacement plain line is inclined CEN56 (BS113A, RT113A, or equivalent) rail with F27 or F40 type pre-stressed concrete sleepers in hard stone ballast (preferably granite), with Pandrol e1809 clips. Creosote treated softwood sleepers with Pandrol baseplates may also be used according to conditions. As an economy and where existing track is to be matched, rails can be vertical and used with pressed steel baseplates, Pandrol PR401 clips and wood sleepers. Pressed steel baseplates should be fixed to sleepers by galvanised AS type short pattern 140mm screws. Standard rail and panel length is 18.282m (traditionally 60ft).

Figure 7.1 Plain line track – BS113A rail on concrete sleepers

7.7 CURVES

7.7.1 Gauge Widening

On curves of radius less than 200m gauge widening will be necessary to ease the movement of the vehicle round the curve. Gauge widened curves are to be constructed with the rail on baseplates supported by wood sleepers. The amounts of gauge widening prescribed are shown in Table 7.2.

Table 7.2 Gauge widening for new design

Curve Radius (m)	Gauge Widening (mm)	Flangeway (mm)
200-140	6	50
140-110	12	57
Below 110	19	63

Gauge widening is to be achieved by moving the inner or lower rail of the curve, building up the gauge widening at the rate of 3-4mm per sleeper to the maximum required at the start of the curve.

Gauge widening is not to be employed through switch and crossing work.

7.7.2 Sleepers in Curves

Track generally laid with concrete sleepers should have wood sleepers in curves less than 150m radius.

Concrete sleepers for CEN56 (BS113A or equivalent) rail using Pandrol type clips, can accept limited gauge widening by the use of special Pandrol shoulder inserts.

7.7.3 Continuous Check Rails

On all running lines where the radius is less than 120m a check rail is essential on the inside running rail of the curve. Track carrying passenger trains must have check rails fitted to curves of less than 200m radius. The check rail must be continued for at least 10m beyond the limit of the curve being protected, and must not finish closer than 5m from a running rail joint. Check rails are not required in sidings.

7.8 FORMATION

No ballast shall be spread upon the subgrade until the latter has been prepared in accordance with the approved design.

The subgrade shall be profiled in accordance with the typical track cross sections shown in Chapter 2 Figure 2.1.

Where new tracks are to be laid on a site which has previously been used to support track work, any spent or fouled ballast or other material shall be excavated and removed from site before spreading any new ballast or blanketing material.

7.8.1 Granular Blanketing for Track

Granular (sand) blanketing material is used to form a capping layer over the underlying sub-grade, and to form a drainage layer for the overlying ballast.

Granular blanketing shall be laid and spread upon the graded sub-grade by means which do not disturb the surface of the sub-grade. Pneumatic wheeled vehicles shall not run over the surface of the sub-grade during placing of blanketing.

Granular blanketing shall be laid, spread and compacted in layers not exceeding 150mm thick. Each layer shall be compacted evenly by the use of approved plate compactors. The final layer shall be regulated to a tolerance of +0 to -15mm of a datum line parallel to the specified finished levels.

7.8.2 Geotextiles

A geotextile membrane shall be laid over the formation and blanketing in accordance with the manufacturer's instructions and every precaution shall be taken to prevent the puncturing of the material by ballast. In particular, care shall be taken to ensure that geotextiles are laid correct side upwards.

7.8.3 Geogrid Mesh Reinforcement

A plastic geogrid mesh reinforcement layer is placed below the ballast and on top of the formation, when required, to provide improved support characteristics from the ballast. Where both geogrid and geomembrane are used, the membrane is placed first directly on to the formation so that the geogrid can interlock directly against the ballast.

Figure 7.2 Geogrid over geotextile underlying new bottom ballast

7.9 TRACK BALLAST

The minimum ballast depth (below bottom of sleeper) to be provided is 150mm, and ideally 200mm. However the actual depth will be dependent on the line speed, tonnage, rolling stock type and formation type.

Ballast for new works and maintenance must be crushed hard stone to withstand abrasion, attrition, crushing and impact. The MOD standard is granite ballast but hard limestone may be used where existing ballast is limestone. Stone ballast is a nominal single size or narrow grading, following national railway industry standards at 65-50mm size for main lines where maintenance is by on-line tamping equipment, and 50-35mm size (if available) for tracks subject to manual maintenance.

7.9.1 Laying and Consolidation of Track Ballast

Bottom ballast shall be laid and spread upon the graded surface of the sub-grade or blanketing layer by means which do not disturb the surface. Only pneumatic wheeled vehicles with low ground pressure, or tracked vehicles shall be permitted to run over the graded surface after the initial layer of track ballast has been spread. No vehicle shall be permitted to run over the blanketing or subgrade until the initial track ballast layer has been provided.

Track ballast shall be laid, spread and compacted in layers not exceeding 150mm thick up to 25mm below bottom of sleeper level. Each layer shall be spread to an even thickness, within a tolerance of ± 25mm of a datum line parallel to the specified finished levels. Each layer when spread to within the above tolerances shall be compacted evenly with two passes of an 8/10tonne static smooth roller or equivalent. The final layer shall be regulated to a tolerance after compaction within +0 to -15mm of a datum line parallel to the specified finished levels.

7.10 SLEEPERS

7.10.1 Spacing

The recommended spacings between the centres of sleepers for CWR and jointed track using CEN56 (BS113A, RT113A, or equivalent) rail, and supporting 25tonne axle loading are:

- Straight and curves >600m radius - 700mm (26/standard 18.288m length)
- Curved track <600m radius - 650mm (28/standard 18.288m length)

At sites with known formation difficulties additional sleepers down to 650mm spacing may be used.

The recommended spacings between centres of sleepers for BS75R rail are:

- 17tonne axle loading - 800mm (14/standard 10.972m length)
- 20tonne axle loading - 700mm (16/standard 10.972m length)
- 22.5tonne axle loading - 600mm (18/standard 10.972m length)

Sleeper spacing at the 2 sleepers enclosing a rail joint should be closed up to 600mm where fastenings and fishplates allow, to provide increased support to the rail at the joint.

When replacing or installing additional sleepers in existing sleepered track, compatible types must be used, preferably of the same design.

7.10.2 Wood Sleepers

Wood sleepers shall be Douglas Fir, Baltic Redwood, Scots Fir or similar. They must be seasoned and impregnated with preservative (creosote or equivalent substitute). If the sleeper is machined in any way after receipt, the exposed area shall be treated with the same preservative to prevent the onset of decay in this area.

Sleepers shall be free from decay, heart (pith), unsound knots and live borers. They shall also be free from shakes, splits, hollow knots, compression failures or other defects which would render it unsuitable for use as a sleeper.

Sleeper size shall be 250mm x 130mm x 2600mm. The maximum variation in thickness (excluding wane) between the thinnest and the thickest points on a sleeper shall not exceed 12mm. Maximum dimension tolerance when supplied shall be:

Width	+12mm/ -0mm
Thickness	+11mm/ -0mm
Length	+12mm/ -0mm

The suppliers mark shall be impressed on the sleepers before delivery. Sleepers without the suppliers mark shall not be accepted. All sleepers shall be marked and certified to be from a Forest Stewardship Council (FSC) source.

Sleepers shall be installed heart side downwards.

Table 7.3 Deviations from straightness limits

Aspect	Limit
Spring (Curvature in the plane of its wide face)	A string, stretched from the mid-point on one end to the midpoint of the other end of the sleeper on the wide face, shall be wholly within that sleeper.
Cup (Curvature across the width)	A straight edge laid across the wide face of the sleeper shall not be more than 6mm from the deepest part of the cup.
Twist (Spiral distortion)	A string stretched diagonally on either wide face shall not be more than 6mm from any point on that face.
Bow (Curvature in the direction of its length)	A string, stretched between the midpoint of one end of the sleeper and the mid-point of the other end on the edge (narrow face) should not deviate from the centre line of this face by more than 9mm.

Sleepers containing included phloem which runs from one end of the sleeper to the other, and is less than 30° to the vertical shall be rejected. Sleepers containing included phloem through part of the sleeper and inclined at an angle of more than 30° may be accepted. The aggregate length of the longest splits at each end of the sleeper shall not exceed 150mm. Any single split whose length exceeds 75mm shall be adequately clamped with galvanised steel anti-splitting plates of an approved type.

Creosote use is planned to be discontinued by UK law circa 2018. At this time new developments in recycled plastic sleepers, or hardwood (untreated) sleepers are to be adopted as the standard for spot replacement of rotten wood sleepers in the track. Spot replacement of wood sleepers by steel or concrete sleepers is not normally acceptable.

7.10.3 Concrete Sleepers

Concrete sleepers must be of pre-stressed concrete and shall be capable of carrying 25tonne axle loads. They shall be purchased from approved suppliers who shall provide certification as to their design loading. The MOD standard for concrete sleepers that fulfil these criteria are types F40 or F27 with Pandrol clip housings.

7.10.4 Steel Sleepers

Steel sleepers are available to a number of different patterns. Modern designs are rolled steel section with ends pressed to form “spade ends” that provide lateral stability in the ballast. These sleepers rely on ballast being well packed in the “hollow” underside.

Steel sleepers can be supplied fitted for conventional Pandrol clips or fast clip fixings. It is essential that steel sleepers are packed when installed or moved by stone blowing or modern tamping machinery to insert ballast completely into the sleeper.

7.11 RAILS

The selection of a suitable section of rail depends upon the usage and envisaged annual tonnage a track will have to carry. For new works and extensions CEN56 (BS113A, RT113A, or equivalent) rail is the MOD common standard.

On sites where there is sufficient length of continuous relaying or new works, Continuous Welded Rail (CWR) may be used. Rails for use in continuously welded track shall contain no holes within the usable length. The minimum length of rail to be used shall be 4.5m.

For locations where rails shall be drilled for fishplates the minimum length of rail to be used shall be 4.5m on straight and 9m on curves.

7.11.1 Supply and Use of Rails

Rails are generally supplied from the manufacturer in 18.282m (traditionally 60ft) lengths, although shorter lengths, drilled both ends, are available for use on the inner rail of curved, jointed track. All fishbolt holes will have been cold expanded.

When shorter lengths are required the rails must be ordered undrilled or "drilled one end" and cut to the required length and drilled in the depot or on site.

To minimise unnecessary waste of rail, short closure rails should not be cut from 18.3m rails; the appropriate standard short rail closest to the length of the required closure should be selected for the purpose.

Rails drilled for fishbolt holes must not be manipulated by means of a slewing bar or other device inserted into the bolt holes. Only the correct rail turning bar, rail handling beam or rail tongs must be used.

7.11.2 Storage of Rails

Rails are to be stored on a smooth, level area with a firm base. Concrete hardstanding is ideal but well compacted earth is acceptable. Supports or dunnage should be provided at the rail ends and at regular intervals along the length of the rail. Flat bottom rails must be stacked “right way up” ie on their base and rail flanges must not overlap. As assembly of a stockpile proceeds the essential features are:

- Use rails of the same length. If this is not possible then the shorter rails must be laid nearer to the top.
- Keep the ends of rails of the same length vertically above one another.
- Do not cross layers without specific advice.
- Dunnage or spacers to be used between layers, in identical positions along the rail length, so the dunnage is in good vertical alignment.
- Successive rail layers should be of the same or decreasing width.

7.11.3 Loading and Unloading of Rails

Correct tools and lifting appliances must be used, and rails must be lifted using a spreader beam to avoid imparting excessive stress in the rail. When rails are being unloaded, the utmost care must be taken to ensure that they are not damaged, particularly at the rail ends and that damage is not caused to anything in the vicinity, eg sleepers and signal equipment and cables. Cables and other equipment must be protected to prevent rails resting directly upon them.

Where it is necessary to unload rails in the "fourfoot" of a line open to traffic then the rails must be positioned so that the maximum height of the rail above the plane of the running surfaces of the running rails is not greater than 25mm. This dimension is the maximum permitted irrespective of the need to insert packing pieces to lift the materials clear.

7.11.4 Installation of New or Replacement Rails

When new or replacement rails are laid into existing jointed track, the old rails, where practicable, should be cut back to take the full length of the new rails. Site closure rails in jointed track must not be less than 9m in length between fishplated joints and must be supported by at least 12 sleepers. The minimum length of rail between a weld and a fishplated joint is 4.5m.

7.11.5 Use of Worn Rail

The permissible wear of used rails expressed as a percentage reduction from new in overall height or width of head or width of foot of rail, is as follows:

- Limit at which rail in place must be renewed 10%
- Limit for reuse of worn rail, in heavily trafficked depot track 5%
- Limit for reuse of worn rail, in sidings 9%
- Limit for reuse of worn rail, in occasionally used running lines 9%

Wear is measured by a special calliper gauge.

Careful visual inspection of rails will reveal obvious defects such as severe corrosion, buckling and cracks which would make the rail unsatisfactory. Where corrosion is limited to the fishing surfaces but the rail is otherwise sound, it may be possible to salvage the rail by cutting off the ends. The same remedy may be applied to rail with battered ends or cracked fishbolt holes. Wheel burns indicate locations where repeated wheel slips have occurred and are a possible source of rail fracture.

Burred and chipped rail edges, and head side wear are undesirable, but re-use of the rail may be feasible, if one edge is still sound, by reversal or transposing rails in the track. Where it is not practicable to examine every length of rail for which re-use is anticipated, a judgement has to be made based on an assessment of the visual and physical conditions of representative samples.

The head of a rail is subject to most wear but the sides and the foot may also wear to varying degrees. The overall height and width of the head are the most critical dimensions and they should be checked with a straight edge and steel rule or with callipers. Web thickness cannot be checked easily as it consists of a curved surface in most rail sections, but it is not subject to wear, except at fishplates, and the extent of any corrosion can be checked by striking with a hammer.

7.11.6 Twist Rails

Twist rails are closure rails that have a designed twist at a predetermined position. They are used to connect vertical design S&C or vertical plain line to inclined design track where the rails are set at an inclination of 1 in 20 towards the centre line of the track. Failure to provide twist rails will result in misaligned running edges. The twists in the rail must be located opposite each other and not closer than 1420mm to the nearest joint in the rail.

7.11.7 Closure Rails

When butting up new track to existing track, the final rail or rails shall be accurately measured and cut to match the length of the gap. Site closure rails in jointed and continuously welded track must not be less than 4.5m in length on the straight and 9m on curves.

7.11.8 Cutting of Rails

All rails must be cut by abrasive disc saw or reciprocating saw. Any flame cut rails shall be rejected and not form part of any track.

7.11.9 Cutting of Rails by Reciprocating Saw

Rails to be cut by means of a reciprocating saw must be firmly supported so that there is no tendency for the rail to move during the cutting operation. The rail to be cut must be accurately measured and marked and the saw carefully aligned to the cutting mark. All sawcut ends should be cut square, ie at right angles to the longitudinal axis of the rail and the cut must be vertical.

The saw must not be forced through the cut but be allowed to cut at its designed speed. As the saw blade approaches the tip of the rail foot it is essential to check that the weight of the length of rail being cut off does not cause the rail end to sag, twist or trap the saw blade. Rail offcuts must not be left on site but collected up for scrap.

7.11.10 Cutting of Rails by Disc Cutter

Rails to be cut by means of a rail mounted abrasive saw or disc cutter must be supported as noted in the previous section, the rail carefully measured and marked and the disc cutter support arm positioned relative to the cutting mark by means of the distance gauge. The abrasive wheel must be carefully checked before use and if any doubts exist about its suitability for cutting steel, its general condition or its safe operating speed, then it must be replaced by a new wheel of the correct type.

An abrasive saw must not be forced through the cut but be allowed to cut at its designed speed. It may be necessary to partially cut the rail from one side, reverse the machine on the support arm and cut the remainder of the rail from the other side, depending upon the type of abrasive saw in use and the diameter of the wheel.

Figure 7.3 Cutting rails by disc cutter

7.12 CONTINUOUSLY WELDED RAIL

Where the use of CWR can be financially justified this is to be installed and maintained to the relevant Network Rail Group Standards. CWR must be installed stressed to the equivalent stress free temperature of 27°C.

7.12.1 Welds

CWR rails are welded end to end to form one continuous rail. The joints are made by either flash butt welding (at the factory or in situ), or by alumino-thermic welds on site. Rails in-situ are stressed by tensor jacks to the “equivalent stress free temperature” before welding. Welding is a specialist activity requiring high quality control.

Figure 7.4 Alumino-thermic welded joint

7.12.2 Adjustment Switches

An adjustment switch allows longitudinal movement of rail as a result of thermal movement in the last 100m of CWR track, or at discontinuities such as long underbridges or S&C.

Figure 7.5 Typical adjustment switch plan view

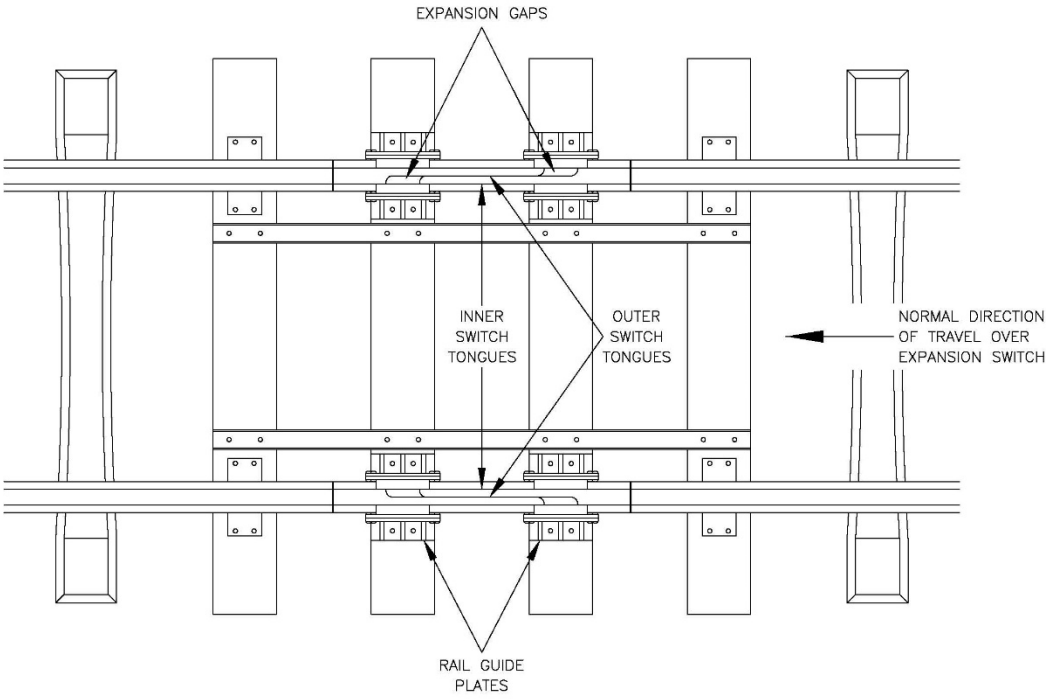


Figure 7.6 Typical adjustment switch in track

The setting of the standard adjustment switch according to ambient rail temperature is shown in Table 7.4.

Table 7.4 Adjustment switch settings

Rail Temperature	Overlap of Switch Rails	Gap Opening
-4 to +2°C	635mm	125mm
2 to 7°C	641mm	119mm
7 to 13°C	648mm	112mm
13 to 18°C	654mm	106mm
18 to 27°C	660mm	100mm

Timber spacing straps located in the fourfoot must be fastened to the timber by means of coach screws.

7.13 FISHPLATED JOINTS

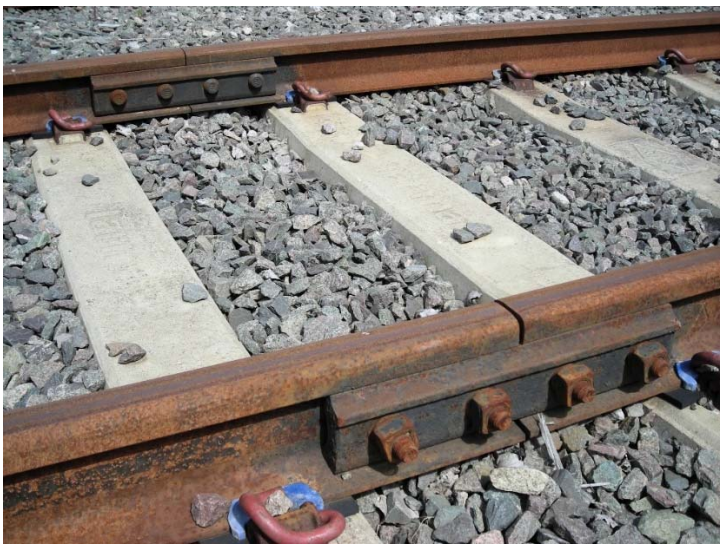
In jointed track the running rails shall be connected end to end by fish plates requiring not less than four fishbolts and nuts for each pair of plates. Both fishplates and bolts shall be installed lubricated. Fish plates shall be forged and not machined or otherwise fabricated.

Rail joints shall be square across gauge on straight track but may be allowed to stagger by up to 60mm on curved track. Appropriate short rails shall be provided on the inside rail of curved track to maintain the rail joints within this limit. Curves of radii tighter than 200m may be laid with joints staggered at half panel lengths to reduce the “kink” effect at joints, a closure rail being inserted in the inner rail at the ends of the curve.

The running table of new rails at joints shall not be stepped or present angular discontinuity in any plane.

Joints between worn or different section rails shall be made with junction fishplates selected to minimise any step and shall, if necessary, incorporate approved shims to eliminate angular discontinuity in the horizontal plane. The requirement for and thickness of any shims to be fitted shall be determined from a 1.0 metre long straight edge and shim gauges. Shims shall eliminate dips without causing joints to hog.

Figure 7.7 Fishplated joint



7.13.1 Position of Joints

Care should be taken to ensure that the appropriate length rails are used to obtain joints squarely opposite each other, but in any event joints should not be more than 6mm out of square.

7.13.2 Joints in Used Rails

Each jointed rail end must not have more than two fishbolt holes, except where six-hole fishplates are in use. Plain line running rails with more holes than standard within fishplate limits should be replaced at the first opportunity. Bond wire holes in new rails must be outside fishplate limits. Where it is proposed to use the alumino-thermic process to weld together rails previously drilled for fishplates, then the rail ends must be prepared so as to ensure a minimum distance of 30mm from the prepared rail end to the nearest part of the first bolt hole. The minimum dimension of 30mm rail end to nearest part of the first bolt applies equally to fishbolt holes and bond wire holes. The nearest edge of bond attachments and bond attachment scars must not be closer than 100mm from the end of the rail to be welded.

All bolt holes which have not been cold expanded and which are at rail ends which are to be alumino-thermic welded must be ultrasonically tested within two months prior to welding.

7.13.3 Expansion Gaps

Expansion gaps for 18.3m (60') and 36.6m (120') rails must be provided and maintained in accordance with Table 7.5. Expansion gaps for 11m and 36m rails are the same as for 18.3m rails due to the tolerances between the fishplate holes and the fishbolts.

Table 7.5 Rail joint expansion gaps

Rail Temperature	Nature of Weather	Expansion Gap 18 and 36 m Rails
Below 10°C	Cold	10mm
10°C and below 24°C	Cold to warm	6mm
24°C and below 38°C	Warm to hot	3mm
38°C and over	Very hot	Nil

7.13.4 Bolt Holes

Fishbolt holes must be carefully set out and accurately drilled to the precise dimensions, to prevent overstressing rail ends, fishplates or fishbolts. Bolt hole dimensions are shown in Table 7.6:

Table 7.6 Rail drilling

Hole Position	Rail Section				
	BH BS95R	**FB BS75R**	**FB BS110A BS113A**	**FB BR98**	**FB BR109**
End of rail to centre of first hole (mm)	60.3	47.6	60.0	60.3	60.3
Centre of first and second holes (mm)	114.3	101.6	127.0	127.0	127.0
Diameter of drill (mm)	30.0	30.0	30.0	30.0	30.0
Finished diameter of holes (after cold expanding) (mm)	30.7	30.7	30.7	30.7	30.7
Diameter of bolts (mm)	23.8	25.4	25.4	25.4	25.4
Diameter of bolts for insulated and tight joints (mm)	25.4	28.6	28.6	25.4	25.4
Height of hole centres from underside of rail	64.3 (mid-web)	54.0	65.0	59.5	65.0

Note to Table 7.6: With the bolts located centrally in the rail and fishplate holes, the dimensions shown in the above table give a 6mm gap between the rail ends. Where a tight joint is required (ie no expansion gap) special tight joint (TJ) fishplates must be used.

7.13.5 Drilling of Fishbolt Holes

All rails which are to be drilled must be firmly supported so that there is no tendency for the rail to tip or vibrate off its support when the drilling machine is working. When drilling for fishbolt holes the machine must be accurately positioned relative to the rail end using the distance gauge provided. The drilled hole must be at right angles to the longitudinal axis of the rail, and the correct height from and at right angles to the vertical axis of the rail. The preferred machine to form holes is the rail mounted broach cutter, which has now largely replaced the old HSS twist bit drilling machine. The holes should be cold expanded after drilling.

7.13.6 Cold Expanding of Bolt Holes

All rail end bolt holes in pearlitic rail steels used in jointed track should be cold expanded using special equipment. All rails drilled at the rail manufacturer’s premises or supplied by S&C manufacturers are delivered with the fishbolt holes cold expanded and retreatment must not be undertaken. Manufacturers cold expand all fishbolt holes in both plain rail and S&C but the rails are not specially marked.

Cold expanded bolt holes can be identified (once fishplates and bolts have been removed or before they are fitted) by the presence of a slight nib at either 9 o'clock position. The "nib" is caused by the rail steel being squeezed into the small gap or split in the mandrel sleeve. Mandrel sleeves must not be left in the boltholes. A detailed record of all fishbolt holes treated must be maintained.

7.13.7 Joints on Underbridges and Level Crossings

It is undesirable for fishplated joints to be located on underbridges or in level crossings due to increased dynamic stress transmitted to the infrastructure. If, however, rail joints are unavoidable, eg on long viaducts, consideration must be given to the welding up of fishplated joints, without increasing the length of the rails between fishplated joints to more than 36.6m. Joints in level crossings are difficult to maintain due to restricted access.

7.13.8 Adjustment Switches at Long Underbridges

Where adjustment switches are provided at the ends of underbridges longer than 30m, particular attention needs to be given to their maintenance owing to the movements of the bridge deck that can take place.

Bolted or welded joints in the ballasted track at each end of an underbridge carrying non-ballasted track must not be located within 4.5m of the point of transition from one trackform to another.

7.13.9 Assembly of Joints

All fishplates, bolts and fishing surfaces at the rail ends must be lubricated before any rail joint is assembled. Fishbolts should normally be fitted with the nuts on the outside of the track.

7.14 BASEPLATES AND FASTENINGS

7.14.1 Baseplates

Baseplates for wood sleepers shall be manufactured from spheroidal graphite cast iron, or an approved rolled steel section, or pressed steel plate. Baseplates shall be designed to suit the rail fastening system.

7.14.2 Fastenings

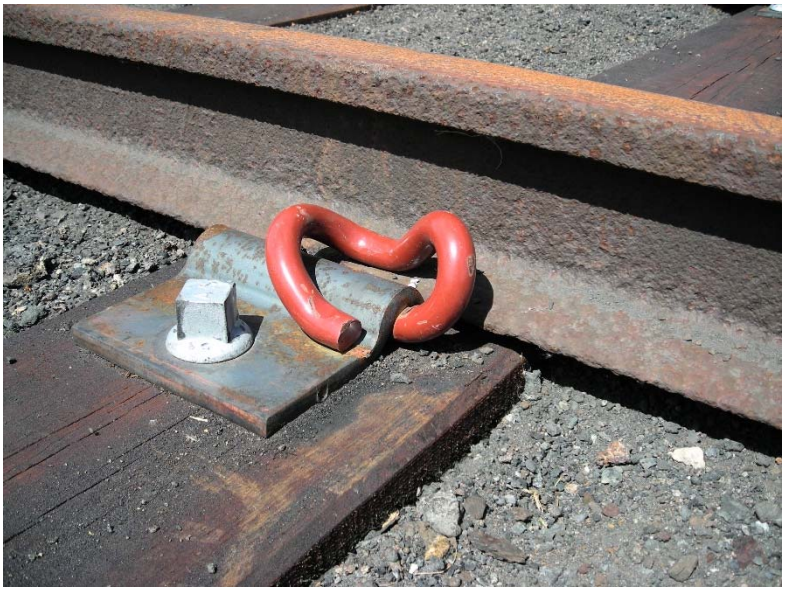
Rail fastenings shall be of the spring clip type selected to provide the appropriate toe load to suit the axle load, type of rail, type of rail support and environmental conditions. Pandrol clips are the MOD standard.

Table 7.7 Pandrol clip applications

Pandrol Clip Type	Application
PR401	Pressed steel baseplates and Pan 6 baseplates.
PR402	As above but left hand for fitting where fishplates restrict access.
E1809	Modern style concrete sleepers with Pandrol housings.
E1810	As above but left hand for fitting where fishplates restrict access.

Figure 7.8 Pandrol clip e1809 with BS113A rail on concrete sleepers

Figure 7.9 Pandrol clip PR401A with BS75R rail on wood sleepers



7.15 SWITCHES AND CROSSINGS

The switch and crossing units suitable for use on MOD standard gauge railways are vertical S&C circular curve turnouts in the range between AV7-DV10¾. These are currently in use on the majority of standard gauge railways within the UK. A typical turnout arrangement is shown in Figure 7.10 and a table of the leading dimensions is shown in Table 7.8. Standard format left hand or right hand turnouts must be adopted for simplicity. Similar flexure and contra-flexure turnouts should not be designed into new layouts where possible. Hand lever operation without point locking is the normal standard in yards and sidings.

Figure 7.10 Typical turnout arrangement

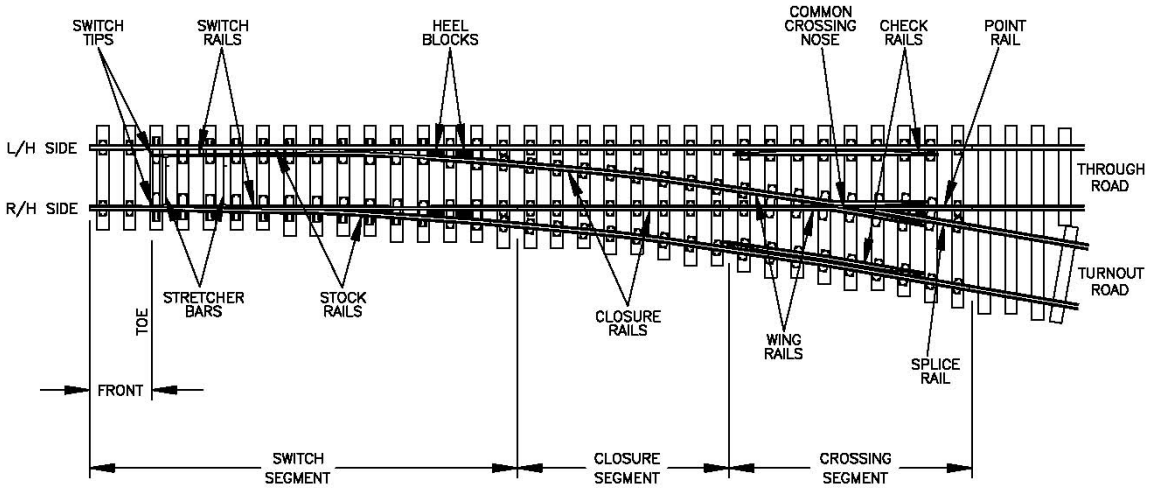


Figure 7.11 Similar flexure turnout

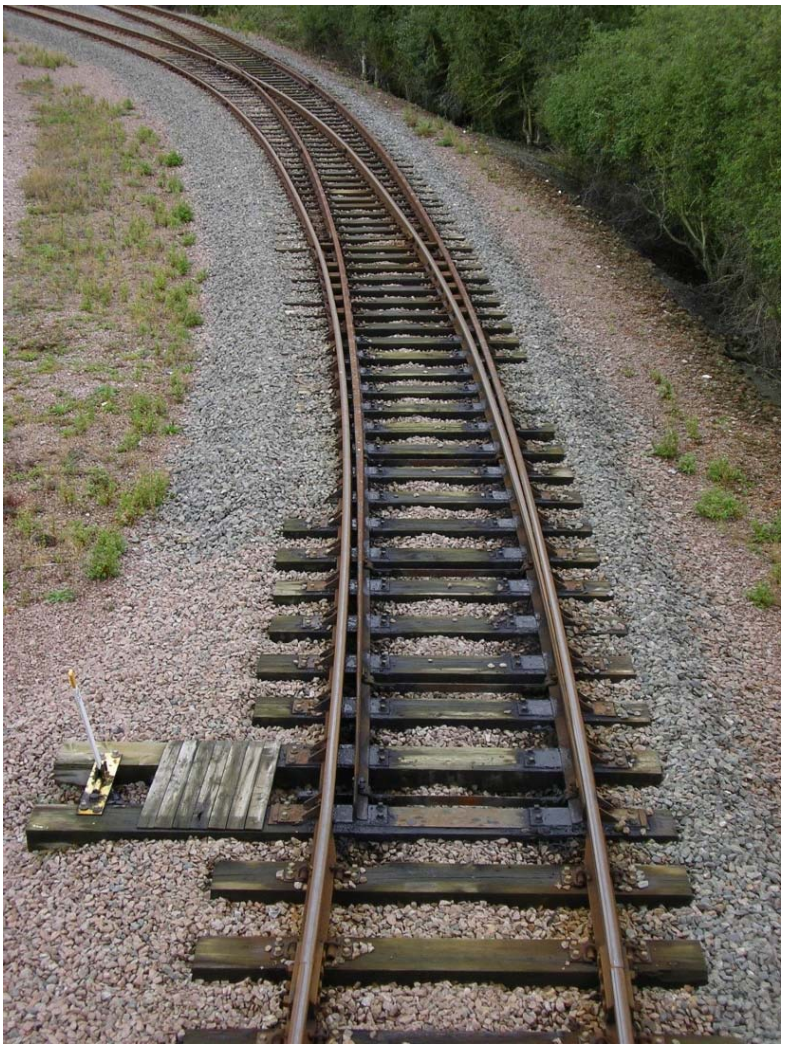


Table 7.8 CEN56 (113A) vertical S&C - circular curve turnouts – leads/radii

Switch	Crossing	Lead Toe to Nose	Planning Radius	Switch Radius	Turnout Radius	Toe Heel	Heel Offset
AV	1 in 7	18617	196750	141052	141052	7317	279
BV	1 in 8	21465	230725	184012	184012	8737	289
CV	1 in 9·25	25025	287251	245767	245767	11920	373
DV	1 in 10·75	29346	367038	331687	331687	12440	298

Notes to table:

- All dimensions in millimetres.
- Gauge is 1435mm.
- All switches to be provided with 3070mm fronts.
- Leads are given from toes of switches to nose of common crossing.
- All leads shown are natural angle turnouts.

7.15.1 Standard for New Work and Existing Turnouts

For track with standard CEN56 (BS113A, RT113A, or equivalent) type rail, BV8 is the desirable minimum length turnout for MOD railways and is adopted as a common standard for rolling stock compatible geometry and line speed. The BV8 turnout has vertical rail, 1435mm gauge, B switches and 1 in 8 crossing angle. The switches should include a sole plate and simple type, single throw lever box. The turnout should be mounted on Jarrah (or equivalent) hardwood bearers of 300 x 130mm section and have Pandrol baseplates, or fabricates steel baseplates, with Pandrol PR401 clips.

Figure 7.12 Switch element within a turnout

7.15.2 Switch – Operation

Most MOD railways have simple non-locking switches, manually operated by a single throw lever box moving the switches by a connecting rod. These are usually adequate in yard and sidings situations with a permanent speed restriction of 5mph. There is an increased risk of switch gapping and switch movement, which is a cause for derailments in facing movements, but normal working practice is for shunters to carefully set switch direction and observe that switches are fully closed/open and secure before allowing the train to move over across. Switches should be secured in the required direction by clamps if additional security of switches is required.

The practice of train operators “trailing through points” without setting the direction for trailing movements is strictly prohibited. This practice causes unnecessary wear to switch rails, components and wheel flanges, and weakens the spring in the leverbox. These defects ultimately lead to derailments. This type of lever box is not designed for this operation, and correctly specified spring points should be fitted if there are operational reasons for “trailing through”.

7.15.3 Switch – Rail Profile

The vertical chamfered switch profile should be used; this provides additional thickness to the switch rail and also continuity for wheels travelling from the stock rail to the switch rail. This is the most widely adopted profile and is the standard profile of full depth switch in the UK.

7.15.4 Switch – Replacement

Changing of one rail in a half set of switches is not permitted except in an emergency. Only complete half sets should be changed to ensure that the switch rail fits correctly to the stock rail.

Where a new half set of switches is being installed all slide baseplate bolts must be slackened before the switches are fixed to the timbers. Once the switches are set to correct line and level the slide baseplate bolts should be tightened to the correct torque and timbers packed.

7.15.5 Common Crossings

Crossings may be of a built-up bolted (fully fabricated), semi-welded (part fabricated) or cast types, and may be in inclined or vertical design.

Standard vertical built up crossings are to be used comprising a point rail, a splice rail, and two wings. These should be prefabricated as a unit using high tensile “Huck” type swaged collar pins. Bolted splice joints have insufficient strength to retain joint tightness over a prolonged period in service. Cast crossings give a longer design life and less maintenance but have a higher supply cost.

Table 7.9 provides the leading dimensions of the common crossings associated with the specified CEN56 (BS113A, RT113A, or equivalent) rail circular curve turnouts.

Table 7.9 Common crossing dimensions

Crossing Angle	Nose to IP (mm)	Wing Rail Fronts (mm)	V Rail (mm)	Wing rail (mm)
1 in 7	112	3070	5450	5720
1 in 8	128	3070	5590	5720
1 in 9·25	148	3070	4110	5720
1 in 10·75	172	3070	4880	5720

Figure 7.13 Common crossing element within a turnout

7.15.6 Check Rails

Check rails are to be provided opposite all fixed common crossings, and form part of the construction of any obtuse crossing proposed. The check rail must control the path of the wheel set so that it is not possible for the wheel moving across the gap in the throat of the crossing, to strike the nose of the point rail. The ends of check rails are to be painted white or yellow as a trip hazard warning.

7.15.7 Flangeway Width

The standard flangeway width in vertical switch and crossing work is 41mm. The critical dimension to be maintained is the distance between the running edge on the crossing side, and the working face of the opposite check rail (check gauge). This dimension must be maintained as nearly as possible at 1392mm.

Flangeways of similar widths are to be provided between the V rails and wing rails of common crossings, and between the wing and point rails of obtuse crossings.

7.15.8 Bearers

The MOD standard for bearers is Jarrah hardwood or similar equivalent to national rail industry standards (supplied from a certified renewable source) of 300mm x 130mm nominal section, in lengths varying in 150mm steps from 2450mm to 6350mm, and then in 300 mm steps up to 10250mm. Modern pre-stressed concrete bearers are steadily replacing timber bearers in main lines, but hardwood timber bearers remains the MOD standard for cost and durability reasons. Hardwood timbers are the MOD standard for new installations, relaying, and spot replacement of softwood timbers.

7.15.9 Bearers – Timbering for Switches

Switch timbers are generally positioned at 710mm centres throughout except at the rail joints. On the stock rail fronts, the spacing is 640mm, and at the heel joints it is 660mm. The centreline of the timber supporting the switch toe is 90mm towards the crossing. The timbers are to be positioned at right angles to the main line - eg for a right hand turnout the timbers are at right angles to the left hand track when looking toward the crossing.

7.15.10 Bearers – Timbering for Crossings

Timbers of common crossings are to be placed at right angles to the main line to avoid problems when tamping the alignment. It is essential that the longer baseplates should sit on the timber without overhanging the edge. If this is likely to occur the bearer must be rotated so that it lies closer to the theoretical optimum position, which is at right angles to the axis of symmetry of the crossing.

On crossover roads, through timbers are used throughout the crossing portion (5900mm long with a standard six-foot of 1970mm).

Separate timbers are to be used where tracks opening out exceed 900mm between running edges. This figure has to be increased to 1200mm when concrete sleepers support the separate tracks.

7.16 NARROW GAUGE RAILWAYS

7.16.1 Ballast

Ballast for narrow gauge railways is usually a smaller nominal size between 50-35mm and 35-25mm.

7.16.2 Sleepers

Steel or wood sleepers of various sizes, depending on the weight of the rail and the gauge, are used in narrow gauge work including turnouts. Steel sleepers in particular may be found in many sections; usually they are an inverted U shape with plain or spade ends, the latter providing increased lateral resistance to movement in the ballast. Plain ended steel sleepers have proved to have insufficient lateral resistance in MOD installations.

Table 7.10 Typical steel and wood sleeper dimensions

Rail Section	Gauge (mm)	Wood (mm)	Steel (mm)
BS35M or similar	600/610/762	1220 x 150 x 100	1220 x 102 x 51
BS45 or BS50 or similar	762/1000	1520 x 230 x 100	1520 x 102 x 51

7.16.3 Rail

Only flat-bottomed rail is recommended for narrow gauge railway work. On future narrow gauge track construction projects the BS 35M section of rail should be preferred. In the past 25R, 30R and 35R BS rail sections have been frequently used. Their use should continue when extending or relaying existing track layouts to maintain continuity, when the rail is readily available. The standard rail sections and sleeper spacing used with various axle loadings are as shown in Table 7.11. For new works it is recommended that a rail weight of 35 lb/yard minimum is used.

Table 7.11 Rail loading capacities

Rail Section	Gauge (mm)	Max Axle Loading (Tonne)	Sleeper Spacing (mm)
BS35M or similar	610/762	5.5	750
BS45 or similar	762	8.5	750
BS50 or similar	762	10.0	750

7.16.4 Fastenings

On wood sleepers, the preferred standard for fixing rails is Pandrol clips on pressed steel baseplates, secured to the sleepers with galvanised coach screws. However for new construction the selection of fastening should be made on a balanced judgment taking into account system characteristics and economy of use. On steel sleepers Pandrol type spring clips used with a hook-on, welded on or punched out shoulder are preferred. In hardstandings, the rail may be fixed to a concrete base by means of rail clips and bolts or cast into the slab.

7.16.5 Switch and Crossing Work

Switch and crossing work is to be produced by manufacturers to the angle desired. The angle of the turnout will be governed by the minimum radius which can be traversed by the rolling stock. Where space permits, radii greater than the minimum should be provided.

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8 Alignment Design – Standard Gauge Railways

8.1 DESIGN STANDARD

8.1.1 Purpose

This Standard provides guidance to which all alignments for the MOD standard gauge (1432mm & 1435mm) track must conform. Notwithstanding the contents of this Standard designers must be proactive, considering all the issues that may affect their design.

The contents of this section do not absolve the designer from discharging his professional duties.

8.1.2 Application

The maximum design speed to be adopted for MOD standard gauge railways plain line shall be 15mph unless agreed otherwise with the Railway Operator. Lower design speeds may be adopted for certain sections where rolling stock characteristics will limit achievable speed or where operational constraints limit the speed. Higher speeds may be designed in for target railways.

The maximum design speed for all switches and crossings (S&C) shall be 5mph due to the risk of derailment at simple, hand operated, non-locked switches.

Where possible alignments shall be straight line and constant grade.

Designs shall be prepared using desirable values. If it is found in certain locations that the use of desirable values has unacceptable cost implications, values between desirable and absolute may be adopted, although the absolute values may not be exceeded.

8.1.3 Symbols

The following symbols have been used in this document:

R	=	Horizontal curve radius (m)
V_m	=	Maximum speed (km/h)
V_e	=	Equilibrium speed (km/h)
E	=	Applied cant (mm)
D	=	Deficiency of cant (mm)
g	=	Acceleration due to gravity (m/s²)
s	=	Distance between contact points of wheels on rails (mm)
$\frac{dE}{dt}$	=	Rate of change of cant (mm/s)
$\frac{dD}{dt}$	=	Rate of change of deficiency (mm/s)
$1 \text{ in } N$	=	Cant gradient
L	=	Length of transition (m)
G	=	Limiting gradient on straight track (%)
G_c	=	Limiting gradient on curved track (%)
A_v	=	Vertical acceleration (m/s²)

R_v = Vertical curve radius (m)
C_h = Chord length (m)
E = Change in cant over a transition
D = Change in deficiency over a transition

8.2 HORIZONTAL ALIGNMENT

8.2.1 Circular Curves

The relationship between cant, deficiency, radius and maximum speed is defined by the equation

$$E = 11{\cdot}82 \frac{V_m^{\,2}}{R}$$

The relationship between cant, deficiency, radius and equilibrium speed (ie when D=0) is defined by the equation

$$E = 11{\cdot}82 \frac{V_e^{\,2}}{R}$$

Cant is only to be applied to running lines, not sidings.

Table 8.1 Cant limits

Limits	Desirable (mm)	Absolute (mm)
Cant	100	150
Deficiency	100	100

Usually the cant to be applied will be given by the lesser of:

$E = \frac{2}{3}(E+D)$ or $E = 100mm$

This recognises that some deficiency is beneficial, to assist the steering of the bogies and yet prevent slow running traffic from experiencing excess cant. However, in some circumstances the cant will have to represent a smaller than ideal proportion of the total cant plus deficiency - for example in the case of some reverse curves or in the vicinity of S&C.

8.2.2 Minimum Radius - Speed Related

The minimum permitted horizontal radius for a given speed can be calculated using the limits defined above.

For example, minimum radius for 40km/h:

$$150 + 100 = E + D = \frac{11{\cdot}82 \times 40 \times 40}{R}$$

ie $$R = \frac{11{\cdot}82 \times 40 \times 40}{150 + 100} = 75m$$

8.2.3 Minimum Radius - Rolling Stock Related

The desirable minimum radius for new designs is 200m, with 150m as an absolute minimum. Existing track desirable minimum radius is 150m with an absolute minimum radius of 75m permitted if operating restrictions are accepted but only with written agreement of the Railway Operator. This figure has been derived from the requirements of modern long wheelbase wagons.

8.2.4 Radii through Platforms and in Tunnels

Where possible platforms should be located on a straight length of track. If this is not possible they should be located on a curve with as large a radius as possible. This is to ensure that acceptable stepping/gap distances are maintained.

8.2.5 Length of Straight or Circular Curve between Transitions

It is undesirable to have very short lengths of straight or circular curve between transitions as vehicles do not have enough time to stabilise between leaving one transition and entering another. A direct reverse is preferable to a very short element. The minimum length of element should allow a vehicle 2 seconds before reaching the next transition, at the maximum speed being considered for the line.

A useful rule of thumb is:

$$\textit{minimum element} = \tfrac{1}{2}V_m \textit{ metres}$$

8.2.6 Transition Curves

The form of transition curve to be used is a section of clothoid spiral. For the purpose of manual calculations a very close approximation to the curve can be obtained by using a cubic parabola.

The relationship between transition length, maximum speed, cant or deficiency and rate of change of cant or deficiency is defined by the equations:

$$\frac{dE}{dt} = \frac{\Delta E V_m}{3 \cdot 6L}$$

$$\frac{dD}{dt} = \frac{\Delta D V_m}{3 \cdot 6L}$$

Where ΔE and ΔD are the change in Cant or Deficiency over the length of transition.

Rate of change of cant and deficiency limits in plain line are given in Table 8.2.

Table 8.2 Rate of change limits

Limits	Desirable	Absolute
Rate of Change of Cant	35mm/s	55mm/s
Cant gradient no flatter than	1 in 1500 or steeper than 1 in 600	1 in 1500 or steeper than 1 in 400
Rate of Change of Deficiency	35mm/s	55mm/s

If cant gradient = 1 in N, the rate of change of cant is given by

$$\frac{dE}{dt} = \frac{100V_m}{3{\cdot}6N}$$

Cant gradients flatter than 1 in 1500 are unacceptable, as they are difficult to apply and maintain.

8.2.7 Lengths of Transitions

The required transition length for a given speed can be calculated using the equations above.

If cant is applied in accordance with the above, cant will always exceed deficiency, and therefore transition lengths will always be governed by a consideration of rate of change of cant rather than rate of change of deficiency. However, where the applied cant is restricted for any reason (eg in the vicinity of S&C), the rate of change of deficiency may govern.

It is necessary to choose a rate of change within the limits given and to decide on the cants to be applied to the circular curves, before a transition length can be arrived at.

Taking into account the requirement to maintain the geometry of the transition the minimum practical length for a transition should be 15m. Where the calculated length of transition equates to a length of below 15m an instantaneous transition may be assumed. For calculation purposes when checking the rates of change a transition length of 11·25m may be assumed. This figure is derived from the shortest distance between bogie centres on UK freight wagons.

Application of superelevation on virtual transitions is to take place ⅔ on the straight and ⅓ on the curve.

8.2.8 Transitions between Reverse Curves

The term "reverse curve" is used to denote the situation where a curve of one hand is followed by another of the opposite hand, with either no intervening length of straight, or a length of straight which is less than the distance between the axles or bogies of a given vehicle.

To prevent buffer locking a length of straight or transition curve must be provided between reverse curves equal to at least the length of the longest wagon used, eg freight wagon 11·25m, container flat 13·5m, MOD Warwell 14·3m.

The transitions between reverse curves must be designed with the same rates of change on both sides of the reverse, to give a constant rate of change of curvature and, within the limits of rounding, cant and deficiency through the transition. To obtain this condition the equilibrium speeds for the curves either side of the reverse must be equal. If one of the curves is designed to the limits, this may only be achieved by accepting "unnecessary" deficiency on the other curve.

8.3 VERTICAL ALIGNMENT

8.3.1 Ruling Gradients

The ruling or maximum gradients on running lines are a function of the tractive and braking effort available from the locomotive and the weight of the train being drawn. Starting effort, curves and turnouts will reduce the power available for motion on inclines. The Railway Operator should be consulted to ascertain the capabilities of the locomotives and hence to determine the ruling gradient. Table 8.3 provides a series of values applicable to the main line network.

Table 8.3 Limiting gradient values

Gradient Value	Application
0% (level)	Acceptable anywhere, but see paragraph **Gradients in Tunnels** for tunnels where 1 in 200 minimum gradient is required.
0.20% (1 in 500)	Maximum gradient to be used in platforms and siding layouts.
0.20% to 1.50% (1 in 500 to 1 in 66)	May be applied anywhere subject to above provisions. As gradients become steeper train performance can be affected and hence steeper vertical alignments should only be adopted where construction economies can be achieved by so doing.
2.50% (1 in 40)	Absolute maximum gradient.

8.3.2 Intersection Between Gradients

At a vertical intersection point when the change in gradient is less than 0·15% it may be assumed that a vertical curve is not required and the gradient may be allowed to change instantaneously.

8.3.3 Compensation of Gradient on Horizontally Curved Track

The gradients quoted in the paragraph above refer to straight track. If a gradient is on a horizontal curve, it must be further limited to compensate for the additional resistance due to curvature. In practice, the compensation need only be applied when the horizontal curve radius is small, say 500m or less.

An estimate of the limiting gradient on curved track can be obtained from:

$$G_c = G - \frac{70}{R}$$

8.3.4 Gradients in Tunnels

Tunnels should have gradients of no flatter than 0·5% (1 in 200), to facilitate free drainage. If the geology or other factors make this difficult to achieve, flatter gradients may be used, down to a limit of 0·2% (1 in 500). Every effort should be made to avoid locating a sump or low point in the vertical alignment in a tunnel.

8.3.5 Limiting Gradients through Platforms and Loading Bays

The HMRI's Railway Safety Principles and Guidance require a gradient not steeper than 0·2% (1 in 500) through a station, where there is a likelihood that trains will be terminated, turned back, have portions attached or detached, have crews changed or stand without brakes applied.

If it does not prove possible to limit the gradient to 0·2% (1 in 500) or flatter through any station platforms an application for dispensation must be applied for from HMRI.

8.3.6 Vertical Curves

The form of vertical curve to be used is a parabola.

The Relationship between Radius, Maximum Speed and Vertical Acceleration is defined by the equation:

$$A_v = \frac{V_m{}^2}{12{\cdot}96R_v}$$

Table 8.4 Vertical acceleration limits

Limits	Vertical Acceleration
Desirable limit	1.0%g = 0.098m/s²
Normal maximum	3.0%g = 0.294m/s²
Absolute maximum	5.0%g = 0.490m/s²

Every attempt should be made not to exceed the desirable limit. The absolute maximum value shall only be used in exceptional circumstances. Where rolling stock speed is slow, determining the minimum vertical radius shall be based on the following.

8.3.7 Minimum Radius – Rolling Stock Related

The minimum permitted radius of vertical curve shall be limited where a three axle rigid wheelbase vehicle is to be used. The limiting factor will be the spring travel of the suspension of the vehicle.

For example if the rigid wheelbase (C_h) is 3m long, and the maximum allowable spring travel (V) is 40mm. The minimum allowable radius shall be given by:

$$R = \frac{C_h{}^2}{8V}$$

Where $C_h = 3{\cdot}.0$ and $V = 0{\cdot}020$, *ie* $R = 56{\cdot}25$

If the positive and negative spring travels, measured about the horizontal axis, are the same, this figure applies to either hog or sag curves.

8.3.8 Minimum Radius – Clearance Related

If the maximum allowable loss of under-clearance of a vehicle is likely to affect the selection of vertical hogging curve radius then this should be evaluated using the formula provided in the section **Minimum Radius – Rolling Stock Related** substituting the maximum allowable loss of under-clearance for the spring travel. Similarly this can also be applied to loss of overhead clearance on a sagging curve.

8.3.9 Minimum Radius – Rail Related

The minimum permitted radius of vertical curve shall be limited to the minimum radius to which the rail section to be used can be bent in the vertical plane as specified by the rail manufacturer.

8.3.10 Interaction of Vertical Curves and Horizontal Alignment

Vertical curves, for reason of both safety and track maintenance, should not coincide with horizontal transitions, switch and crossing units or other special track features. If this is found to be unavoidable, every effort should be made to obtain a very large radius of vertical curve.

8.4 SIDINGS

8.4.1 Horizontal Alignment

The absolute minimum radius for slow speed sidings is 75m. To prevent buffer locking a length of straight or transition curve must be provided between reverse curves equal to at least the length of the longest wagon used, eg freight wagon 11·25m, container flat 13·5m, MOD Warwell 14·3m.

8.4.2 Vertical Alignment

Sidings must be on level track or where this is not possible on a gradient no steeper than 1 in 500.

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9 Alignment Design – Narrow Gauge Railways

9.1 DESIGN STANDARD

9.1.1 Purpose

This standard provides guidance to which all narrow gauge and range railway alignments for the MOD must conform. Notwithstanding the contents of this Standard designers must be proactive, considering all the issues that may affect their design.

The contents of this section do not absolve the designer from discharging his professional duties.

9.1.2 Application

The maximum design speed to be adopted for MOD narrow gauge railways shall be 15 mph unless agreed otherwise with the Railway Operator.

Lower design speed may be adopted for certain sections where rolling stock characteristics will limit achievable speed or in the case of range railways where the requirements for the target dictate the speed.

The maximum design speed for all switches and crossings (S&C) shall be 5mph due to the risk of derailment at simple, hand operated, non-locked switches.

Where possible alignments shall be straight line and constant grade.

9.1.3 Symbols

The following symbols have been used in this document:

R	=	Horizontal curve radius (m)
V_m	=	Maximum speed (km/h)
E	=	Applied cant (mm)
D	=	Deficiency of cant (mm)
g	=	Acceleration due to gravity (m/ s²)
s	=	Distance between contact points of wheels on rails (mm)
1 in N	=	Cant gradient
L	=	Length of transition (m)
G	=	Limiting gradient on straight track (%)
G_c	=	Limiting gradient on curved track (%)
A_v	=	Vertical acceleration (m/s²)
R_v	=	Vertical curve radius (m)
V	=	Versine (m)
C_h	=	Chord Line Length (m)

9.2 HORIZONTAL ALIGNMENT

9.2.1 Circular Curves

The relationship between cant, deficiency, radius and maximum speed is defined by the equation:

$$E = \frac{sV_m^2}{gR} \quad \text{where } D = 0$$

Where s = gauge + width of rail and g = 9·80665
For narrow gauge railways assume the use of BS35M rail section for new works which has a head width of 42·86 mm.

$$\text{therefore Constant } K = \frac{s}{12{\cdot}96g}$$

Table 9.1 provides the required K values for the variety of narrow gauge railways used by the MOD.

Table 9.1 K values for narrow gauge railways

Gauge (mm)	Constant K
600/610	5·17
762	6·33
1000	8·21

Therefore the relationship between cant, deficiency, radius and maximum speed for a 610 mm gauge railway is defined by the equation:

$$E + D = 5{\cdot}17\,\frac{V_m^2}{R}$$

The relationship between cant, deficiency, radius and equilibrium speed (ie when D = 0) for a 610mm gauge railway is defined by the equation

$$E = 5{\cdot}17\,\frac{V_e^2}{R}$$

The limiting values for cant and deficiency for narrow gauge railways are derived by proportioning those values applying to standard gauge railways.

Table 9.2 Cant and deficiency limits

Gauge (mm)	Desirable Limits		Absolute Limits	
	Cant (mm)	Deficiency (mm)	Cant (mm)	Deficiency (mm)
600/610	45	45	60	45
762	55	55	75	55
1000	75	75	100	75

Usually the cant to be applied will be given by the lesser of:

$E = \frac{2}{3}(E+D)$

or E = *Absolute maximum cant*

This recognises that some deficiency is beneficial, assisting the steering of the bogies and avoids slow running traffic from experiencing excess cant. However, in some circumstances the cant will have to represent a smaller than ideal proportion of the total cant plus deficiency - for example in the case of some reverse curves or in the vicinity of S&C.

9.2.2 Minimum Radius – Speed Related

The minimum permitted horizontal radius for a given speed can be calculated using the limits defined above for a 610mm gauge railway. For example, minimum radius for 15km/h:

$$65 + 45 = E + D = \frac{5{\cdot}16 \times 15 \times 15}{R}$$

$$ie \qquad R = \frac{5{\cdot}16 \times 15 \times 15}{65+45} = 10{\cdot}6\ m$$

9.2.3 Minimum Radius – Rolling Stock Related

The minimum radius of curve should be agreed with the Railway Operator. Where space permits, curves greater than minimum should be specified. Table 9.3 should be used as a guide.

Table 9.3 Minimum curve radii

Max Wheelbase of Rolling Stock W (m)	Recommended Minimum Radius of Curves (m)	Absolute Minimum Radius of Curves (m)
1·830	37	22
1·525	31	18
1·375	28	17
1·220	25	15
1·070	21	13
0·920	18	11
0·770	15	9

For wheelbases other than those shown above, the recommended and absolute minimums may be taken as 20 and 12 times W respectively. The use of a radius less than the recommended minimum (but not less than the absolute minimum) must be sanctioned by the Railway Operator.

9.2.4 Radii through Platforms

Where possible platforms should be located on a straight length of track. If this is not possible they should be located on a curve with as large a radius as possible. This is to ensure that acceptable stepping distances are maintained.

9.2.5 Length of Straight or Circular Curve between Transitions

It is undesirable to have very short lengths of straight or circular curve between transitions as vehicles do not have enough time to stabilise between leaving one transition and entering another. A direct reverse is preferable to a very short element. The minimum length of element should allow a vehicle 2 seconds before reaching the next transition, at the maximum speed being considered for the line.

A useful rule of thumb is:

$$\textit{minimum element} = \tfrac{1}{2}V_m \ \ m$$

9.2.6 Transition Curves

The form of transition curve to be used is a section of clothoid spiral.

The application of cant to a curve over the transition is governed by the rate at which it is applied, the cant gradient.

Table 9.4 Rate of cant application limits

Limits	Desirable	Absolute
Flattest Limit	1 in 1500	1 in 1500
Steepest Limit	1 in 400	1 in 250

If cant gradient = 1 in N, the length of transition is given by the formula

$$L = \frac{(N \times E)}{1000} \ \ m$$

9.2.7 Lengths of Transitions

The required transition length for a given cant gradient can be calculated using the equations above. If cant is applied in accordance with the above, cant will always exceed deficiency, and therefore transition lengths will always be governed by a consideration of rate of application of cant rather than rate of change of deficiency. However, where the application of cant is restricted for any reason (eg in the vicinity of S&C or the track being cast into concrete), the rate of change of deficiency may govern. When this situation occurs, the formulae and limiting values for standard gauge track shall apply. It is necessary to choose a cant gradient within the limits given and to decide on the cants to be applied to the circular curves, before a transition length can be arrived at. Taking into account the requirement to maintain the geometry of the transition the minimum practical length for a transition should be 5 m. Where the calculated length of transition equates to a length of below 5 m an instantaneous transition may be assumed; for calculation purposes when checking the rates of change a transition length of 1 m may be assumed. This figure is derived from the shortest practical distance between wagons axles.

Application of superelevation on virtual transitions is to take place ⅔ on the straight and ⅓ on the curve.

9.2.8 Transitions between Reverse Curves

The term "reverse curve" is used to denote the situation where a curve of one hand is followed by another of the opposite hand, with no intervening length of straight. The transitions between reverse curves must be designed with the same rates of cant application on both sides of the reverse point and when deficiency is the ruling factor the same rates of change of deficiency must be achieved. To prevent buffer locking a length of straight or transition curve must be provided between reverse curves equal to at least the length of the longest wagon used on the system.

9.3 VERTICAL ALIGNMENT

9.3.1 Ruling Gradients

The ruling or maximum gradients on running lines are a function of the tractive effort available from the locomotive and the weight of the train being drawn. Starting effort, curves and turnouts will reduce the power available for motion on inclines. The railway operating manager should be consulted to ascertain the capabilities of the locomotives and hence to determine the ruling gradient.

9.3.2 Intersection between Gradients

At a vertical intersection point when the change in gradient is less than 0.15% it may be assumed that a vertical curve is not required and the gradient may be allowed to change instantaneously.

9.3.3 Compensation of Gradient on Horizontally Curved Track

Limiting gradients usually refer to straight track. If a gradient is on a horizontal curve, it must be further limited to compensate for the additional resistance due to curvature. In practice, the compensation need only be applied when the horizontal curve radius is small, say 500 m or less. An estimate of the limiting gradient on curved track can be obtained from:

$$G_c = G - \frac{70}{R}$$

9.3.4 Gradients in Tunnels

Ideally tunnels should have gradients of no flatter than 0.5% (1 in 200), to facilitate free drainage. If the geology or other factors make this difficult to achieve, flatter gradients may be used, down to a limit of 0.2% (1 in 500). Every effort should be made to avoid locating a sump or low point in the vertical alignment in a tunnel.

9.3.5 Limiting Gradients through Platforms and Loading Bays

The HMRI's Railway Safety Principles and Guidance require a gradient not steeper than 0.20% (1 in 500) through a platform, where there is a likelihood that trains will be terminated, turned back, have portions attached or detached, have crews changed or stand without brakes applied. If it does not prove possible to limit the

gradient to 0·2% (1 in 500) or flatter through any platform an application for dispensation must be applied for from the HMRI.

9.3.6 Vertical Curves

The form of vertical curve to be used is a vertical parabola.

9.3.7 Minimum Radius - Rolling Stock Related

The minimum permitted radius of vertical curve shall be limited where a three axle rigid wheelbase vehicle is to be used. The limiting factor will be the spring travel of the suspension of the vehicle. For example if the rigid wheelbase is 3m long, and the maximum allowable spring travel is 40mm. The minimum allowable radius will be given by:

$$R = \frac{C_h^{\,2}}{8V}$$

Where C_h = 3·0 and V = 0·020, ie R = 56·25.

If the positive and negative spring travels are the same, this figure applies to either hog or sag curves.

9.3.8 Minimum Radius – Clearance Related

If the maximum allowable loss of under-clearance of a vehicle is likely to affect the selection of vertical hogging curve radius then this should be evaluated using the formula provided in the section **Minimum Radius – Rolling Stock Related** substituting the maximum allowable loss of under-clearance for the spring travel. Similarly this can also be applied to loss of overhead clearance on a sagging curve.

9.3.9 Minimum Radius – Rail Related

The minimum permitted radius of vertical curve will be limited to the minimum radius to which the rail section to be used can be bent in the vertical plane as specified by the rail manufacturer.

9.3.10 Interaction of Vertical Curves and Horizontal Alignment

Vertical curves, for reason of both safety and track maintenance, should not coincide with horizontal transitions, switch and crossing units or other special track features. If this is found to be unavoidable, every effort should be made to obtain a very large radius of vertical curve.

9.4 SIDINGS

9.4.1 Horizontal Alignment

The absolute minimum radius for slow speed sidings is dependent on the rolling stock to be used. Reference should be made to the table within the **Minimum Radius – Rolling Stock Related** section above. To prevent buffer locking a length of straight or transition curve must be provided between reverse curves equal to at least the length of the longest wagon used.

9.4.2 Vertical Alignment

Sidings should be on level track or where this is not possible, on a gradient not steeper than 1 in 500.

9.5 CURVES

9.5.1 Gauge Widening

The gauge must be widened by 7mm in all cases where the radius of curvature is less than 20 times the maximum rigid wheelbase of the rolling stock.

9.5.2 Continuous Check Rails

Provision of a check rail should be considered on the inside rail where the radius of curvature is less than 20 times the maximum rigid wheelbase.

9.6 SWITCHES AND CROSSINGS

The minimum angle of turnout shall be determined by the sharpest curve within the turnout which can be traversed comfortably by the rolling stock (refer to **Minimum Radius – Rolling Stock Related** above). Superelevation is not applied on turnouts. For a given angle of turnout there is only one radius of curve applicable to the gauge being used. Table 9.5 is given as a guide so that a suitable angle of turnout can be chosen for a particular wheelbase and should be read in conjunction with the preceding paragraph referring to **Minimum Radius – Rolling Stock Related**.

Table 9.5 Typical turnout geometry

Gauge (mm)	Angle of Turnout (1 in N)	Approx Centre Line Radius of Curve (m)
600/610	3	9·5
600/610	4	17·0
600/610	4·5	21·5
600/610	5	27·0
762	2·5	9·0
762	3	12·5
762	3·5	17·0
762	4	22·0
762	5	35·5

Track fastenings for narrow gauge switch and crossing work will be similar to those used on flat bottomed standard gauge, scaled down as appropriate.

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10 Level Crossings

10.1 FUNCTION

Road crossings intersecting railways at grade are termed level crossings. These allow the controlled passage of road vehicles and pedestrians across railway tracks at the same level as the rails, or at grade. Level crossings present significant safety risks and public crossings are strictly regulated.

10.2 INTERNAL LEVEL CROSSINGS

Level crossings within MOD depots are termed internal level crossings. Railway Operating Managers (ROM) are responsible for controlling all movements of rail vehicles and for signalling within their areas of jurisdiction and must be consulted prior to the erection of signs. Open Crossings as defined in *Railway Safety Principles and Guidance - Level Crossings* should normally be provided.

10.2.1 Road Traffic Management

Road traffic management is normally the responsibility of the MOD depot head of establishment with infrastructure elements delivered by the DIO prime contractor. This includes: road signage, road markings, traffic management, traffic policing, and maintenance of the road surface.

Figure 10.1 Open Crossing

10.3 PUBLIC ROAD LEVEL CROSSINGS

Crossings used by the public have to be protected. The type and design of each public road crossing is defined in the statutory level crossing order. MOD is normally responsible for all the infrastructure including the road within a boundary line of 2m outside each rail, and for all the advance road signage and road markings. Types currently in service on MOD railways:

● Automatic Open Crossing, Locally Monitored (AOCL). These have wigwag red lights controlling road traffic.

● Fully gated level crossing, manually operated.

Figure 10.2 Automatic open crossing, locally monitored.

Figure 10.3 Fully gated level crossing

For the purpose of signing MOD railway crossings shall have a statutory position equal to that of crossings operated on Network Rail infrastructure with public roads. In all cases and in co-operation with the Railway Operator, the DfT shall be consulted through the Local Highway Authority on the most suitable form of road and permanent way protection for the particular circumstances. The final arrangements must be approved by HMRI before proceeding with the installation, and the crossing must be designed by a specialist level crossing consultant.

10.4 PUBLIC FOOTPATH AND BRIDLEWAY CROSSINGS

The following protection measures shall be applied:

- Warning signs for public users: “Stop, Look and Listen, Beware of Trains”.
- Rail signs: Whistle.
- Good condition surface up to rail level with non-slip finish.
- White line edges
- Trespass guards fitted.
- Good visibility for users to see trains

10.5 ALTERNATIVE TYPES OF CROSSING PROTECTION

Alternative types of crossing protection such as manually or automatically controlled gated and barrier crossings may sometimes be used after appropriate consultation, and must be in accordance with the *Railway Safety Principles and Guidance - Level Crossings*.

10.6 TRESPASS GUARDS

Trespass guards shall be fitted at all public road, footpath and bridleway crossings to deter trespassers and prevent livestock access. Trespass guards shall be installed to provide continuity with adjacent fencing.

Figure 10.4 Trespass guards

10.7 SIGNS AND MARKINGS

Appropriate signs shall be provided in accordance with the guidelines set out in section 10.4 at all level crossings within MOD depots and where a MOD maintained track intersects with a public road at a level crossing. The character of signposting and protection required at a crossing is dependent on prevailing circumstances such as the volume and frequency of road and rail traffic and topography of the area. On public road crossings, white lines on the road surface are required to denote traffic stop lines, road centre line, and road and footpath edges. Authorised types of level crossing protection for crossings of statutory railways are described in *Railway Safety Principles and Guidance - Level Crossings*.

10.8 HIGHWAY PROFILE AND VISIBILITY

Surfaces of level crossings and of their approaches, sight lines, lay-bys and other requirements must be provided and maintained to a standard which, in conjunction with signs and crossing protection used, provide the maximum possible safety to road and railway users. Steep road gradients and sudden changes in level must be avoided to minimise risk of vehicles stalling and long vehicles grounding on the crossing.

10.9 ROADWORKS AT OR NEAR LEVEL CROSSINGS

The ROM must be informed of the intention to carry out roadworks at or near a level crossing. All works at this location must be carried out in accordance with the MOD General Railway Rulebook.

10.10 TYPES OF CONSTRUCTION

10.10.1 Panel Type

The railway consists of conventional ballasted and sleepered track with the roadway formed by proprietary designs of rubber or precast concrete panel units supported either on the foot of the rail or on the sleepers. Flangeways are pre-formed into the profile of the panels.

Figure 10.5 Rubber panel type crossing with rubber trespass guard panels

10.10.2 Cast in-situ concrete

The roadway and rails are supported on a common reinforced concrete slab foundation with the highway surface provided by a reinforced concrete top slab, concrete block paving, or asphalt. Check rails or steel flange guards are cast into the top slab to form a flangeway 50-60mm wide. Running-on/off slabs should be provided under the track ballast where the paved track starts/ends, in order to provide a transition for the change of resilience in the track support between rigid and flexible track form.

Figure 10.6 In-situ concrete paved type crossing

10.11 RUNNING RAILS

Due to the difficulty of access for maintenance, and the minimisation of joint movement and impact forces, rails should be designed to be continuous through the level crossing with no joints in the road crossing area or within 4m of the edge.

10.12 ACCOMMODATION, TEMPORARY AND EMERGENCY CROSSINGS

Level crossings for occasional use such as farm access, grounds maintenance, short-term works access etc may be formed from wood sleepers or S&C timbers laid longitudinally between the rails and along the sleeper ends. These must be supported on timber bearers set in the track ballast, and secured by spikes or coach screws. As with permanent level crossings the road surface must be flush with the top of the rails and flangeway gaps must be left between the timbers and the rails. It is not acceptable to permit road vehicles, agricultural machinery or tracked plant to cross rail tracks without some form of temporary crossing.

10.13 LEVEL CROSSING INSPECTIONS

Faults on open crossings within MOD depots shall normally be recorded as part of the track inspection routine. Specific annual inspections are required for public road level crossings in order to determine general condition, identify significant defects, and identify safety issues in respect of both MOD and third party liabilities. In particular inspections should verify correct signage is in place, warning lights and sirens are serviceable, and operating mechanisms are functioning correctly. The standard level crossing inspection report is at Annex G. Simple functional checks weekly by the railway operator are required for all public road level crossings to assist in early identification of urgent or major safety concerns.

10.14 LEVEL CROSSING RISK ASSESSMENTS

Due to the significant safety risk, an operating risk assessment is required annually for every public road level crossing, usually conducted at the same time as the level crossing inspection. The level crossing risk assessment form is at Annex H.

11 Other Railway Specific Infrastructure

11.1 BUFFER STOPS AND WHEEL STOPS

11.1.1 Buffer Stops

Buffer stops should be installed at the termination of all sidings. The buffer stop is usually a fixed, braced frame connected to the running rails that supports a buffer beam in line with the rolling stock buffers. Modern types of sliding buffers are designed to offer some dynamic resistance to prevent damage to rolling stock and track, but these are not normally justified in MOD sidings. Buffer beams, often timber, should be maintained and painted in red, to signify a “stop” signal.

Figure 11.1 Buffer stop – traditional type

Figure 11.2 Buffer stop – modern type

Designs for installing new buffer stops should include a clear over-run zone behind the buffer stop.

11.1.2 Wheel Stops

The requirement for wheel stops should be determined by risk assessment of specific protection measures at a particular site. Where permanent wheel stops are to be installed they must be fitted to both rails of the track to protect personnel, property (and wheels themselves) wherever there is a risk from slow moving runaway rolling stock or unauthorised train movements in a railway yard as follows:

They should be provided in the vicinity of store houses, freight loading sidings, locomotive sheds, washing platforms, repair yards and other such places.

Every wheel stop should be designed for its particular location, and requirements for its particular location and use on the track should be determined by the Railway Operator.

The stops must be correctly installed in pairs and in such positions that both wheels on the leading axle of a vehicle simultaneously contact the stops.

Where used to protect locomotive sheds or other buildings where men work in or under rolling stock, they must be hinged and locked to the 'on' position at all times whether the shed doors are open or closed, except when rail movements in or out are required, in which case they may be locked after obtaining the approval of the shed master.

Wheel stops are suitable only to hold a rail vehicle which is moving with minimum momentum and are NOT an alternative safety device to a buffer, sand drag, derailer or catch points.

Figure 11.3 Typical hinged wheelstop for use in paved areas

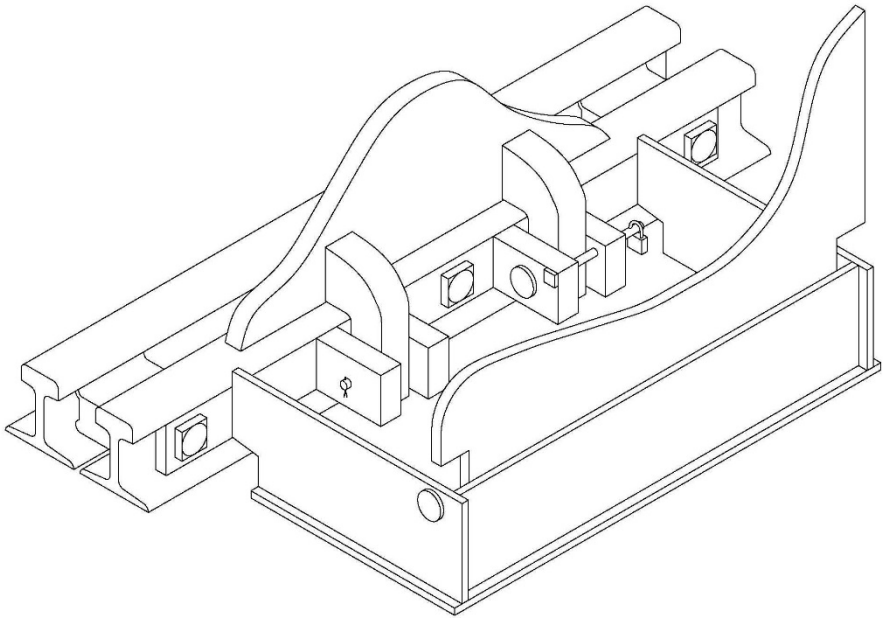
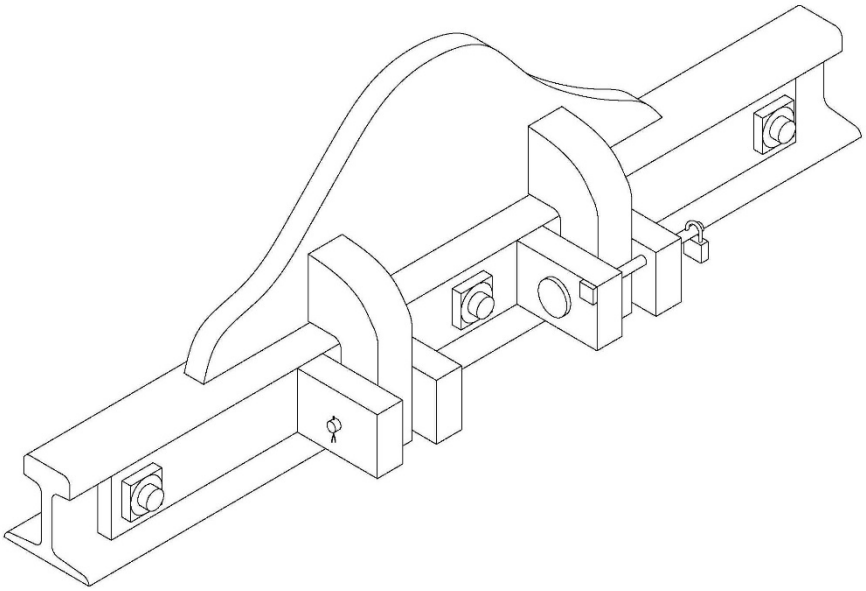


Figure 11.4 Typical hinged wheelstop for use on ordinary plain track



11.2 PROTECTION OF MAIN LINES

Depot rail gates and national network boundary points must be assessed for risk of runaways or unauthorised train movements running on to main lines, for example where there is a down gradient leading to a main line connection. There are two devices to prevent these movements: the derailer and the catch point.

11.2.1 Derailers

The derailer is a device bolted to the web of one rail that allows a shaped channel to hinge from an “out of use” position at the rail side, to the running surface of the rail in a “protected position”. The channel catches any passing wheel flange and directs it from the rail edge on to the top of the rail and then over the outside, causing the vehicle to derail. Derailers are lockable in each position to prevent unauthorised use.

Figure 11.5 Hinged derailer

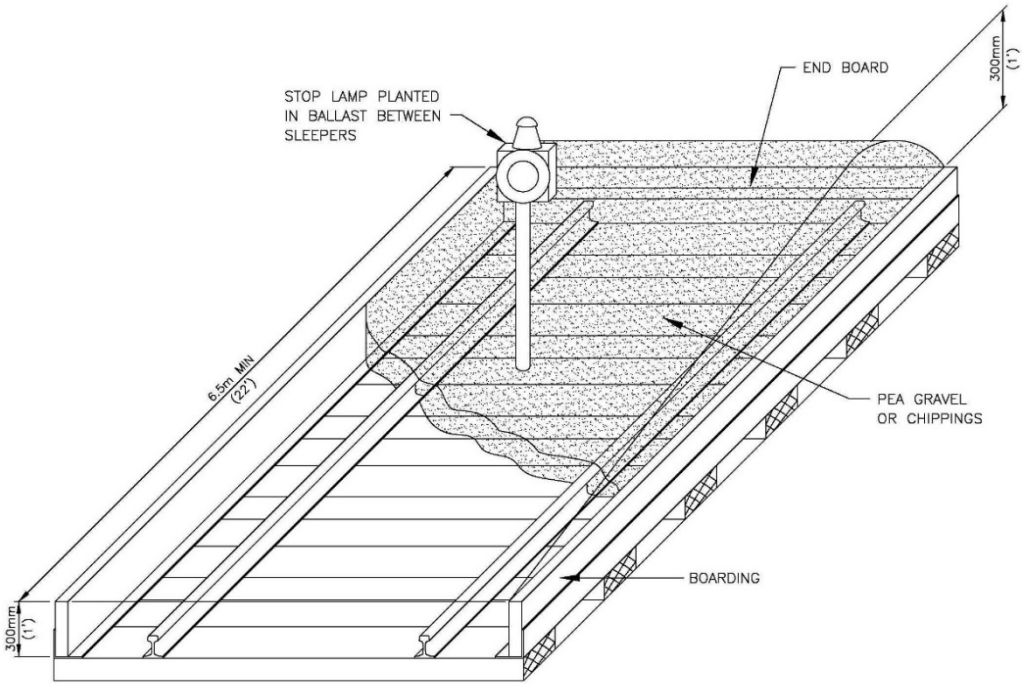
11.2.2 Catch Points

Catch points are facing switches held normally in a position to direct rolling stock off to one side and derail. The switches are held by manual lever against a spring to allow passage of an authorised train movement. Spring switches are designed to be trailed through without operation of the lever mechanism for trailing direction movements.

11.2.3 Sand Drags

Catch points may lead into sand drags which act as an arrestor rather than producing a derailment. The maintenance requirements are to ensure that the level of sand is maintained to the top of the boarding, that any defective boards are replaced and that the boarding is at the correct spacing either side of the track.

Figure 11.6 Typical sand drag



11.3 SIGNALS

Most MOD UK railways do not have conventional railway signalling however some have block sections and radio controlled block working. Block section limits are identified by fixed signs showing the section number. Consequently there is no requirement for interlocking of points and signals.

Red targets, stop signs and limit of shunt signs all show red aspects, and these are in effect fixed signals.

Automatic and manual public road level crossings with raising barriers and/or wig-wag lights have signals that indicate that the crossing road signals are correctly indicating stop, and it is clear for the train to proceed. These signals may be either a white flashing light or a red/green continuous colour light signal.

11.4 SIGNS

Appropriate signs shall be provided in accordance with current legislation and where local management may deem appropriate to satisfy Health and Safety requirements. Signs shall be manufactured in accordance with BS873. Photographs of many of the most common signs are in Annex L.

11.4.1 Signs for Rail Traffic on the Permanent Way

Signs are generally required at the following locations:

- Level crossing advance warning sign
- Whistle sign on approaches to level crossings and specific locations
- Red targets on rail gates and shed doors
- Permanent speed restriction signs
- Limit of shunt and stop signs
- Block section signs
- Limited clearance signs
- Boundary markers MOD/Network Rail track ownership

Railway Group Standards shall be used as the standard for rail traffic signs.

Signs governing the movement and control of rail traffic must be authorised and sited by the Railway Operator in consultation with the railway engineer.

Temporary engineering and speed restriction signs shall be provided to give warning of permanent way maintenance or other works in progress which necessitate a restriction on speed of rail traffic.

11.4.2 Signs for Road and Pedestrian Traffic

A General Warning Sign must be displayed at the road entrance to all rail served establishments and repeated within the establishment where considered necessary for pedestrian and vehicular traffic.

Signs are generally required at level crossings.

Road and pedestrian signs shall be in accordance with the Road Traffic Act regulations and relevant DfT standards, see: The Traffic Signs Regulations and General Directives 2016. This includes the requirement for signs to be reflective.

Figure 11.7 General warning sign and additional warning notices

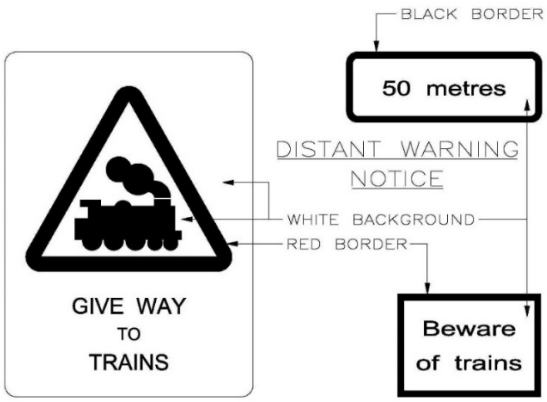
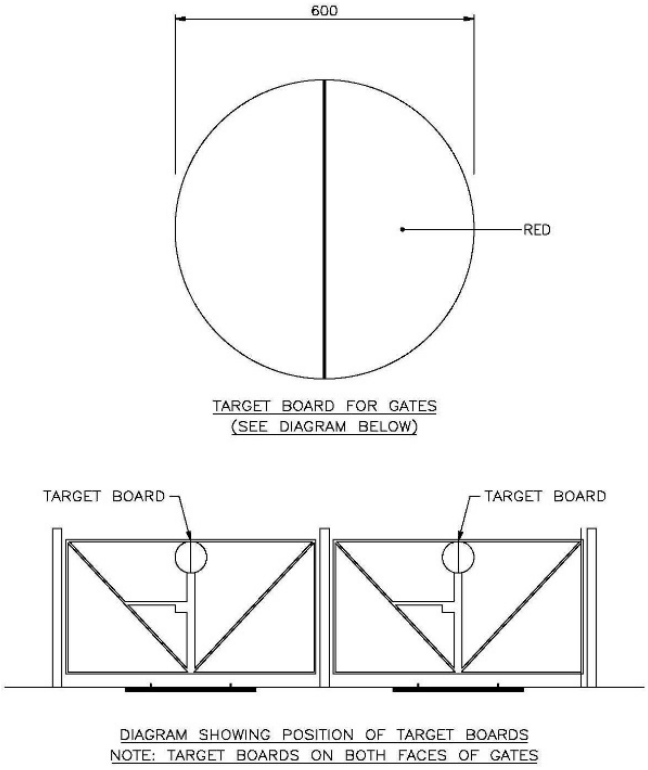


Figure 11.8 Gates with target boards



11.4.3 Rail Entrance to a Depot

Gates with target boards shall be provided at the railway entrance to the depot, as indicated on Figure 11.8. The Railway Operator must determine the railway entrance signing, and Stop Board, Restriction Sign etc provided to suit the requirements and local arrangements with Network Rail.

11.5 OPEN AREAS

11.5.1 Traffic Control

Areas of railway track in paving such as road/rail transfer areas, loading areas, hard standings and shed floors are termed open areas. By their nature these require careful control and in the interests of safety, all non-rail traffic (pedestrian and vehicular) must be encouraged, and where possible, channelled, to cross the permanent way at selected points. This will not only limit the number of signs required but it will also enhance the usefulness of the signs used. In cases of restricted visibility it is essential to establish crossings which provide the maximum practicable visibility for users of both the roadway and the railway.

Where channelling of traffic and signing as for the Open Level Crossing layout is not feasible, strategic use may be made of the General Warning Sign for road traffic approaching the open area.

It is desirable to provide further warning to road traffic and to prevent obstruction by parking, by applying road lining consisting of a 100mm wide continuous line in yellow or white parallel to the track at a distance of 2m from the running edge.

11.5.2 Rails and Road Surfaces

The rail and roadway are integral with rail and road top levels in the same plane. The road and rail may be supported on a common reinforced concrete slab foundation with the running surface provided by reinforced concrete top slab, or concrete block paving. Alternative designs have conventional ballasted track supporting a running surface consisting of shaped timbers or proprietary designs of rubber or precast concrete units. Specialist railway and structural design is required for new or replacement installations.

Guard rails are required in these forms of track to maintain the flangeways required for the passage of vehicles. The flangeway formed by the guard rails shall be 50-60mm wide. This must be increased by the same amount as any gauge widening which may be required.

Running rails should be continuous through in-situ concrete paved areas with no joints in the paved surface area or within 4m of the edge of the paved surface. Joints are difficult to maintain when covered by paving and the thermal induced stresses in the rails are contained by the encasing concrete.

Running-on slabs are provided under the track ballast where the in-situ concrete paved track starts/ends, in order to provide a transition for the change of resilience in the track support.

11.6 RAIL/RAIL GRADE CROSSINGS

One rail track crossing another at the same grade without a facility to switch from one track to the other is known as a rail/rail grade crossings or diamond crossing. These are not common and must not be designed into new layouts as they are high maintenance items and incur higher signalling and traffic control risks. Design and repairs require advice from a specialist railway engineer.

Figure 11.9 Standard/Narrow gauge grade crossing

11.7 TURNTABLES

A turntable is a moving structure that allows a rail vehicle to be turned or directed onto a choice of radiating tracks. It is, in effect an underbridge inside a pit, with a pivoting central support and rolling or sliding supports at each end. There must be an effective clamping arrangement to lock the turntable into each operating position whilst ensuring that rail head and running faces are exactly aligned to allow free travel of the rail vehicle on and off the turntable. The rail end gaps at these positions must be kept no larger than 12mm to reduce the risk of damage and derailment.

Figure 11.10 Turntable

11.8 BRIDGES

11.8.1 Underbridges

Underbridges carry railway track over roads, rivers, defiles, etc. The track is supported on the bridge either on sleepers in conventional ballast, secured to timber way beams or directly secured to the bridge structure (with or without sleepers). Special care needs to be exercised in maintaining track level and alignment particularly at bridge ends. Track joints must not be positioned over the ends of bridge spans to avoid impact loading at the change of support. Joints must be positioned a minimum of 4m before the bridge span, and these should be kept well maintained to allow for enhanced thermal movement effects transmitted from the bridge. Similarly, continuous welded rail (CWR) expansion joints must be fitted at both ends of a bridge in the case of CWR track.

Running-on slabs are provided under the ballast at each end of the bridge to provide a transition for the change of resilience in the track support.

Figure 11.11 Underbridge

Where there is insufficient collision protection provided by the underbridge parapets, guard rails should be fitted to the track, either outside or inside the running rails, in order to contain the direction of any derailed rolling stock and reduce the risk of a catastrophic fall from the bridge.

Figure 11.12 Derailment Guard Rails

11.8.2 Overbridges

Overbridges carry roads, pipes and utilities over the railway. These are usually owned and maintained by parties outside MOD. These must be kept under observation to ensure no encroachment into the structure gauge, upkeep of maintenance, and general safety issues.

Figure 11.13 Overbridge

11.8.3 Bridge Inspections

A visual inspection of all underbridges and overbridges must be conducted at 3 year intervals. This is required to determine general condition, identify significant defects, and identify safety issues in respect of both MOD and third party liabilities. Photographic records should be kept with inspection reports, to show defects and general condition. The standard bridge inspection form is at Annex F. A risk assessment is included with the bridge inspection, covering operating risks from bridge strikes, vehicle incursion, derailment containment, and rail staff place of safety.

11.8.4 Underbridge Structural Assessments

An initial bridge structural assessment is required for all underbridges. Where the loading or usage changes, or when the loading codes change, or if routine inspections show a significant deterioration in condition; then a bridge structural assessment (professional appraisal) is required.

11.9 RAMPS AND PLATFORMS

11.9.1 Road Rail Transfer Areas

These facilities cover the activities of loading/unloading ISO containers on/off trains, loading freight into/off rail vans, transferring freight between rail and road vehicles, and transferring freight between narrow gauge and standard gauge trains. Facilities usually have reinforced concrete paved surfacing with integral railway track. They may be all at same grade or have platforms to allow loading level with van floors, and they may have covered roof areas for weather protection. Track maintenance in these areas is usually particularly difficult due to the additional wear and tear caused by road vehicles and mechanical handling equipment (MHE). Design of these facilities is usually a civils and railway engineering cooperation.

11.9.2 End Loading Ramps

Figure 11.14 End loading ramp

End loading ramps allow road vehicles, usually tracked and wheeled military vehicles, to be loaded onto a train of flat and well wagons, by driving under their own power up the ramp, across a bridging piece onto the wagon deck and along the full length of the train. A civil engineering design is required for new facilities.

11.9.3 Side Loading Platforms

These allow freight to be loaded by hand or by MHE into rail vans and on to rail flats from the side. In the past these facilities have also been used to side load road vehicles on to trains but this function is now always done with end loading ramps due to higher risks of damage and dropping over the side of wagons when side loading road vehicles.

11.9.4 Platforms in Sheds

These are no different to side loading platforms. Storehouse operatives often refer to the railway and platform in a shed as a "well" if the main shed floor is level with the top of the platform.

11.9.5 Passenger platforms

These structures have specified dimensions. They may be of any required length but must comply with cross sectional dimensions: platform edge 915mm vertical height above rail level, and 730mm horizontal from rail running edge. There must be 2m minimum width from platform edge to rear of platform.

11.9.6 Safety of Platforms and Ramps.

A white line must be painted on the horizontal edge of all platforms, 100mm wide to denote the edge of the drop to platform users. Yellow lines set back 1-2m and yellow hatching may be used in addition subject to local risk assessments and working practices.

11.10 BUILDINGS AND FACILITIES

11.10.1 Locomotive Sheds

Locomotive sheds are purpose designed buildings to berth locomotives providing security, weather shelter and maintenance facilities. There may be pits below the tracks or tracks raised above floor level on supports to allow access under locomotives. Track support in these situations requires specialist design.

11.10.2 Fuel Points

Fuel points for locomotive refuelling usually involve a concrete captive apron with bunding, drainage and fuel compatible interceptors. Running rails are usually directly supported and fastened to the concrete surface.

Figure 11.15 Fuel Point

11.10.3 Wash Down Aprons

Wash down aprons are used for brushing and jet washing locomotives and rolling stock, including steam cleaning or power washing of oil contaminated underframes. They are very similar to fuel aprons only with detergent and contaminated water interceptors incorporated into the drainage.

Figure 11.16 Wash down apron

11.11 UNDER TRACK UTILITY CROSSINGS

Where cables, pipes and other utilities are installed to cross under the railway track, the structural stability of the track must be maintained during construction of the crossing and after installation. The standard specification requirement is at Annex I. It is not normal practice to excavate a trench through the track, nor to lay utilities on or through the ballast.

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12 Loading and Structure Gauges

12.1 GENERAL

The dimensional limits of rolling stock and structures are known as loading and structure gauges. The minimum clearance for straight, level track is obtained by comparison of a loading gauge with the appropriate structure gauge. This clearance could be reduced to such an extent as to be dangerous, by one or more of the following:

- overhang of rolling stock due to cant
- centre throw and/or end throw of rolling stock due to track curvature
- loading of stock exceeding the recommended load gauge
- infringements of structure gauge.

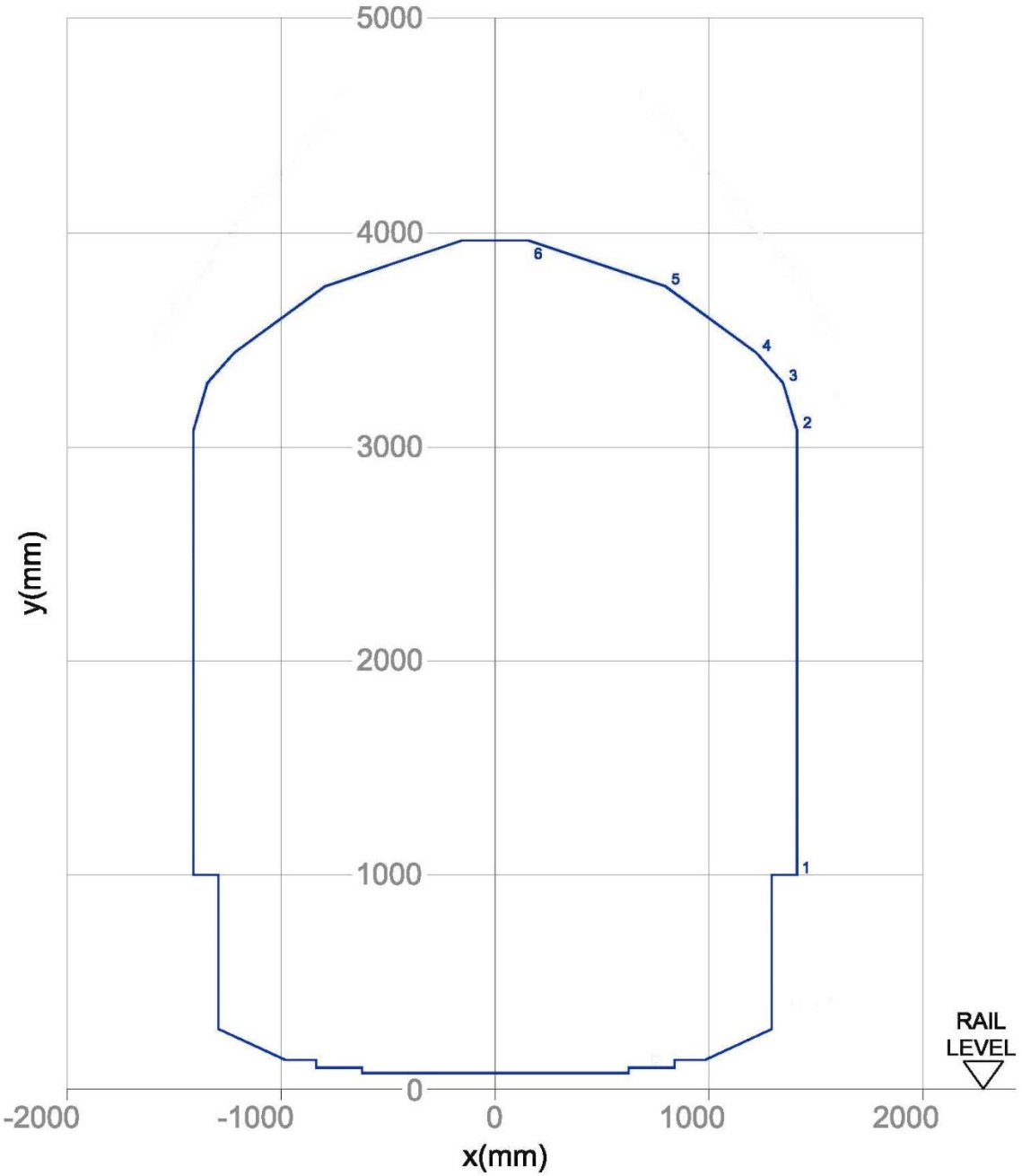
12.2 LOADING GAUGE

The loading gauge is the maximum profile inside which all rolling stock and wagon loads must be contained. The loading gauge is line specific and will vary according to the minimum clearances to structures and other trains. In special circumstances wagons with loads protruding outside the loading gauge may be allowed but this shall be deemed an “out of gauge load” and must be controlled accordingly by the railway operating manager and railway engineer.

Whilst the loading gauge is related to static clearances, these clearances must be enlarged when considering moving rolling stock. The increased profile will be as a result of the effects of dynamic sway and vertical movement caused by speed, track curvature and cant, track positional tolerances, rail wear, rail/wheel tolerances, vehicle wear and suspension performance. The resulting new profile is known as the kinematic swept envelope.

Where an MOD establishment is connected to the national rail network the load gauge shall be a minimum standard of W6A. However, where rail traffic is expected via the Channel Tunnel the load gauge shall be to UIC GB+. Details of these gauges are published in Network Rail Group Standards and UIC Code *506R - Rules governing application of the enlarged GA, GB & GC Gauges*.

Figure 12.1 W6A Loading Gauge



Co-ordinates Only co-ordinates for upper part of gauge shown for clarity (dimensions in mm)											
Point 1		Point 2		Point 3		Point 4		Point 5		Point 6	
x	y	x	y	x	y	x	y	x	y	x	y
1410	1000	1410	3080	1345	3300	1220	3440	795	3750	152.5	3965

12.3 STRUCTURAL CLEARANCES – STANDARD GAUGE RAILWAYS

12.3.1 Clearances to Structures

The clearances to be used in determining the structure gauge must ensure the safe passage of trains including the additional clearance where vehicles have windows from which staff may lean out. The standard structure gauge for all new works on MOD railways is shown on Drawing 4601 at Annex J.

The derived structure gauge (see Network Rail Group Standards and UIC Code *506R - Rules governing application of the enlarged GA, GB & GC Gauges)* should be used to determine dimensions from a fixed datum preferably the running edge of the nearest running rail.

The lateral clearances between the structure gauge and the swept envelope must be at least 450mm. This dimension may be reduced to 250mm on lines where the rolling stock does not permit people to lean out. The dimension may be further reduced to 150mm where there are no windows from which either passengers or staff can lean out and adequate measures are taken to positively fix the position of the track.

The vertical clearance between the swept path and the structure gauge must be not less than 250mm. This may be reduced to 100mm where the level of the track is permanently fixed in relation to the structure.

All wires, cables and conductors and any stay wires, which cross over the railway in the open, must be at least 6000mm above rail level after allowance for wind and temperature effects.

In the case of electric cables the height may need to be increased to ensure adequate electrical clearances. This height will be determined by the type of electricity carried by the cable and advice must be sought from the cable owners concerning this matter.

Structures such as bridge girders, ground signals and similar railway operational equipment below platform level may encroach within the structure gauge. There must be a minimum clearance of 50mm from the swept envelope. This clearance may be reduced to 25mm where the swept envelope includes the maximum displacements combined with an allowance for serious rolling stock suspension fault.

Platforms must have a clearance of at least 50mm to the swept envelope. The platform level must be determined taking into account all rolling stock using the platform but desirably should be 75mm below the floor of an unloaded wagon.

12.3.2 Clearances between Trains

The clearance between swept paths of trains on adjacent tracks must not be less than the clearance between the swept paths of trains and a structure.

A reduced clearance of 380mm between adjacent swept envelopes may be used on existing railways where this is the current standard clearance.

Where there are more than two running lines or there are sidings adjacent to running lines wider intervals may be necessary between pairs of running lines and between running lines and sidings to ensure safety of trains and staff.

Where the place of safety for staff is between two running lines or between a running line and a siding, its width must be 900mm to allow for the possible effects of staff disorientation.

Where work being carried out involves side access for entry or for simple tasks such as examination of rolling stock, train preparation or coupling of vehicles the total clearance between adjacent sidings swept envelopes must be 1130mm.

12.3.3 Fouling Point

A fouling point is the point on converging lines, eg at a turnout, beyond which a rail vehicle standing on one line is in danger of striking a vehicle passing on the other. Fouling points are usually marked by a plinth set in the ballast or by painted sleeper end.

12.4 STRUCTURAL CLEARANCES - NARROW GAUGE RAILWAYS

Due to the variations in rolling stock and rail gauge found between the various MOD Establishments, it is not possible to set a universal structure gauge for narrow gauge railways and the requirements for each site must be considered on their own account in consultation with the railway operating manager and the railway engineer. As a guide the clearances defined for standard gauge railways may be used with appropriate allowances for the swept path of the vehicle.

12.5 INFRINGEMENTS AND OUT OF GAUGE LOADS

When designing new works or alterations to existing structures the structure gauge must be taken into account. Where infringements exist they must be specially checked for rolling stock using the route and a record kept so that changes of rolling stock or out of gauge loads can be assessed.

On maintenance work care must be taken to ensure that the work carried out does not worsen clearances to structures. Every effort should be made to improve tight clearances by slewing or lowering of track.

Where the railway operating manager wishes to carry out of gauge loads, the required kinematic profile must be checked against the structure gauge and particularly any infringements on the route.

Annex A
Track Inspection Report

As a general principle the inspection report should be an exception report. Only those items which have changed since the last inspection should be reported, and previous faults still awaiting repair should be shown in italics. Reports should not include a description of the facilities or any superfluous material.

It is recommended that the report contains track inspection record sheets supplemented by inspector's comments. A typical track inspection record sheet follows:

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TRACK PATROL AND INSPECTION RECORD SHEET

Depot	
Date	
Patroller/ Inspector	
Company	

Defect Categories	
Category	**Definition**
A	An urgent or critical fault with high risk of derailment, damage to rolling stock, injury to people, or safety of the track.
B	A fault with a low risk of derailment, damage, injury or safety, but which will deteriorate further. Fault may be deferred to a period of planned maintenance due to its non-critical nature.
C	A fault that is acceptable without rectification, but which requires observation at subsequent inspections to monitor and detect any further deterioration.

Corrective Action Key	
Close	Close track
Inv	Investigate further
MM	Address fault on monthly maintenance
ARW	Add work to next annual remedial works package
Refer	Refer work requirement to non-rail facilities management
Monitor	Monitor
Nil	No action required

Track Section	**Report**	**Category**	**Corrective Action (initials/date)**

General Observations	**Corrective Action (initials/date)**

Track Section	**Repairs Completed During Patrol**

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Annex B
List of Common Track Defects

The following check list is intended to be an aide memoire to those inspecting the permanent way. It does not include every defect that may be found but rather seeks to act as a guide to the more common problems associated with the track.

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COMMON TRACK DEFECTS

Component	Defect	Remedial Action
PLAIN LINE		
Rail condition	Broken or cracked rail	Emergency action as Section 5.7.13. Arrange to replace rail
Rail condition	Excessive rail wear	Locations to be monitored in accordance with Section 5.13 and actioned accordingly
Rail condition	Wheel burns, squats, tache ovales	Remedial action as specified in Section 5.7.15
Horizontal alignment	Poor horizontal line	Rectify to methods as specified in Section 5.17
Vertical alignment	Incorrect cross level/cant	Rectify to values specified in Section 5.14 by lifting and packing as specified in Section 5.15
Vertical alignment	Twist	Rectify to values specified in Section 5.14 by lifting and packing as specified in Section 5.15
Vertical alignment	Poor vertical line/slacks	Rectify by lifting and packing as specified in Section 5.15
Vertical alignment	Dipped joints	Pack sleepers at joints, mechanically straighten rail ends or fit fishplate shims
Gauge	Incorrect track gauge	Rectify in accordance with Section 5.12
Fastenings	Expansion gaps closed	Maintain to table included in Section 5.8.9 using methods in Section 5.6.9
Fastenings	Fishplates, cracked, broken, loose, seized	Maintain to Section 5.8
Fastenings	Spikes, keys, clips not fully home, loose, missing	Maintain to Section 5.6
Sleepers	Incorrect spacing	Inspect and adjust where necessary in accordance with Section 5.4
Sleepers	Not square to rails	Re-set square to rails
Sleepers	Defective sleepers rotten or broken	Inspect and replace where necessary in accordance with Section 5.4
Ballast	Deterioration of quality or contaminated	Replace sub-standard ballast with new ballast
DRAINAGE		
Formation	Wet spots or priming	Check track drainage is running. Check that debris/spoil has not been deposited on cess restricting run-off
Ditches	Overgrown or blocked	Carry out maintenance/remedial work to bring the drainage ditch to a standard where it is functioning
Catch pits	Blocked	Remove gravel and silts to ensure free running of drain
Catch pits	Gratings damaged or missing	Replace grating or cover
BANKS AND CUTTINGS		
Earthworks	Instability of slopes	Review bank/cut stability and carry out remedial works accordingly
VEGETATION		
Weed growth	Weed growth	Weed killing treatment
Lineside trees	Obstructing vision at level crossings and signals. Infringing into load gauge.	Tree lopping or flailing.

Component	Defect	Remedial Action
TURNOUTS		
Switches	Excessive wear on switch or stock Rails	Check gauge at toes (100mm front) and at drive points and heel blocks and adjust accordingly. Stop operators “trailing through points”.
Switches	Damaged stretcher bars	Check opening at switches and flangeway. Adjust/repair stretcher bars to achieve clearance specified in Section 5.10
Switches	Indentation of slide baseplate surface	Replace slide baseplate
Switches	Loose bolts in switches	Tighten to torque as specified in Section 5.10
Switches	Slide plates dry or fouled	Scrape clean and lubricate slide plates
Switches	Lever box dry or fouled	Clean our lever box and lubricate pins, tongue and moving parts
Switches	Connecting rod obstructed	Clean out bed to allow free movement
Switches	Switch lever box boards rotten or missing	Replace
Switches	Switches gapping, stiff or failure to bang home	Lubricate slide plates and lever box. Adjust mechanism.
Switches	Excess play in lever operation and weak operation	Replace lever box spring and stop operators “trailing through points”
Crossings	Excessive wear on crossing nose, wing rail or checkrail	Check gauge and flangeways at crossing nose and associated checkrails with reference to those values given in Section 5.11
Crossings	Loose blocks and bolts in crossing splice rail, wing rail or check rail	Tighten bolts ensuring correct seating of blocks
WHEEL STOPS AND BUFFERS		
Complete item	Not reasonably vertical in the up position	Check clamping mechanism and replace stop when necessary
Complete item	Buffer stop unsound	Replace timber buffer beam where necessary
Complete item	Buffer beam not clearly painted	Paint red with single white stripe
WARNING SIGNS, POSTS AND MARKERS		
Signs and posts	Not visible	Trim back vegetation where view obstructed. Review positioning
Signs and posts	Not legible	Clean or replace sign
LEVEL CROSSINGS		
Flangeways	Obstructed or full of debris	Clean out flangeways
Gates and barriers	Gates, barriers, wig-wags or signals not functioning correctly	repair
Signs	Correct signs not in place or missing	Fix new signs
OBSTRUCTIONS TO GAUGE		
Obstructions to gauge	Debris or inappropriately placed stores	Clear track, remove obstruction
PLATFORMS		
Edges	White line not displayed	Repaint 100mm wide white line on platform edge

Annex C
Track Maintenance Tasks

The following list summarises common tasks that form the basis of routine planned preventative maintenance.

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TRACK MAINTENANCE TASKS

Item	Tasks
PLAIN LINE MAINTENANCE	
Service Fishplates	Frequency every 2nd year. Remove fishplates, clean the web area of the rail around the bolt holes and the fishing tables with a scraper and wire brush, inspect bolt holes for signs of cracks. Clean the fishing tables of the fishplates and the threads of the fishbolts. Apply fishplate oil (Tracklube M3) to the fishing tables of the rail, offer up the fishplates turning them so they fit on the opposite rail face to their previous position. Fit an oiled fishbolt in a hole close to the rail end and hand tighten. The bolts must be refitted so the nut is facing opposite to its original position ie nuts inwards to 4 foot or outwards to cess. Fit the other 3 bolts and nuts. Tighten using a one handed pull on a long handle fishplate spanner. Do not over tighten.
Lift and Pack	Track levels settle due to a number of factors: time, traffic and ground movement. The level may settle on one rail causing twist faults or on both rails causing dips or slacks. The level should be reinstated by lifting the rail evenly with one or more track jacks, taking great care not to over-lift, and mechanically packing ballast under the bearing areas of the sleepers. 3 or 4 sleepers either side of each lift point must also be packed to retain firm ballast support. Jacks are removed and ballast is then topped up and dressed off. Levels are checked by sighting boards, by eye along the rail top and by cross level gauge.
Dipped Joints	Slacken off the fishbolts of the dipped joint. Place a jack in the joint bed of the datum rail. Use a steel straight edge across the rail joint and carefully jack the joint until it is slightly humped. Tighten fishbolts and mechanically pack around the sleeper bearing area. Pack to 2 sleepers either side of the joint. Cross level at the joint to the other rail and repeat bearing in mind any applied cant on curved track the datum rail is the high rail.
Alignment	Alignment of rails may require minor adjustment due to a number of factors eg settlement, thermal movement, etc. Corrections are made by slewing the track laterally. A minimum of 4 men are required to hand slew. Top ballast is first shovelled out from the sleeper ends in the direction of the slew. It may be necessary to remove top ballast from between sleepers to reduce the resistance to movement. Slewing bars are used to lever the track into its required position, working the bars together and in small, sharp, coordinated moves at the shouted commands of the ganger. Alignment is best checked by eye, sighting along the alignment at rail level, to achieve a smooth curve or exact straight.
Broken Rails	If the break is vertical or near vertical, place a pair of fishplates to suit that rail section to span the break and clamp the plates with the Robel emergency clamps. Apply a 5mph temporary speed restriction until the rail can be replaced. If the break is any other type, then close the track to traffic until the rail can be changed.
Track Gauge	Maintain gauge between running edges of rail at 1435mm. Gauge tends to spread as wood sleepers become old and worn, particularly on curves and through turnouts. Gauge can be adjusted by use of tie bars, changing sleepers, and by refixing baseplates with new holes.
Fixings	Check fixings visually for missing, broken or loose clips, nuts, spikes, etc. Replace and tighten as necessary. Where Pandrol clips cannot be inserted due to closeness to fishplates or other obstructions in turnouts, use left handed version of clip inserted from the opposite end of the baseplate.

Item	Tasks
PLAIN LINE MAINTENANCE	
Spot Sleeper Changing	Change the wood sleeper if rot is visible around the baseplates or fastenings. Monitor if rot is evident only in the 4 foot part of the sleeper. The condition of a wood sleeper can be checked by thumping with the point end of a bar. Dig out the shoulder ballast to one end of the sleeper, deep enough to expose the underside of the sleeper, and the ballast bed either side of the sleeper. Unfasten fastenings, jack both rails just enough to take pressure off the sleeper and slide out fastenings from foot of rail, set to one side if fit for re-use and draw out the sleeper. Shovel scrape the sleeper bed level and slide in the new sleeper heartwood side downwards. Refix fastenings, refill ballast beds with new stone. Mechanically pack bearing areas of sleeper, top up beds and clean off tops of sleeper. Remake shoulder. Remove old sleeper to scrap area.
Ballast Dressing	1. Box-in sleepers. Remove surplus ballast from around rails, fixings and off sleeper tops. Fill between sleepers flush up to top of sleeper level. Extend ballast outwards 300mm from sleeper ends. 2. Build up raised ballast shoulders at sleeper ends on outside of curves and on CWR lengths. Shoulder approximately 450mm width x 300mm high. 3. In sidings form a shunter's walkway by spreading a thin layer of 10mm chippings onto the flat ballast surface alongside the track.
Level Crossings	1. Clear flangeways in paved track by scraping out debris, stone, mud, etc. 2. Check road and rail signs are present, correct, facing right way and in good order. 3. Check good line of sight for approaching road traffic by cutting back vegetation.
Buffer Stops	Check timber buffer beam mounting bolts tight, and condition of beam is sound. Paint beam white with horizontal red line along the centre.
GENERAL AND TRACKSIDE MAINTENANCE	
Patrolling	Regularly walk all track (frequency depends on usage, say once per month for average depots). Observe for missing, broken or worn components, or movement of the track (defective track geometry). Correct minor faults where possible. Report all other faults.
Debris	Remove all wind-blown tree branches, litter and debris from track. Remove in bags or other means such that the debris will not later blow back onto the track. Remove or prevent fine materials such as sand, soil, etc from dropping onto the top of the ballast. This clogs the ballast preventing free drainage and stopping the ballast carrying out all its proper functions.
Drainage	Keep undertrack and trackside pipes, ditches and culverts free from debris and vegetation to allow free flow of drainage water.
Painting	1. Paint in yellow or white, all check and guard rail ends at turnouts, level crossings, curves, etc, to indicate trip hazards. 2. Paint red target on gates and doors.
Signs	Maintain by cleaning, washing, securing or replacing correct signs at level crossings, speed restrictions, whistle, etc.
Vegetation	Cut back vegetation – pull weeds, strim, saw/slash shrubs, branches and brambles.

Item	Tasks
TURNOUT MAINTENANCE	
Slide Plates	Clean and oil regularly. Using a pad scraper, clean off all old oil and grease from the plates on the closed switch side and from the plates in space behind the open switch. The scrapings of the old oil or grease are to be collected for proper disposal and not left on the ballast. Throw the switch lever and repeat the above. Apply new plate oil to all cleaned plate surfaces. Throw the switch and repeat the oiling. Check the switches for correct closing.
Split Points	The gap between the fine point of the switch and the stock rail should measure 125mm. The gap at both switches should be equal. Adjust using the turnbuckle on the connecting rod. Further adjustment can be made by inserting washers between the switch blade and the connecting rod bracket.
Adjust Switches	Remove debris from around the lever box. Check condition of the spring and renew if necessary. Oil the spring, tongue and all moving parts and pivot pins. Adjust the spring tension by moving the spring back nut. If the tongue frequently fails to engage the shifter, replace the box.
Lift Switches	If the foot of the switch is not sitting on the slide plates and the top of the switch is proud of the stock rail, carefully jack at the heel of the switch. Do this a few millimetres at a time, if the switch settles back onto the slide plates then pack 2 or 3 timbers either side of the heel. Cross level across the switches and stocks to ensure no twist. If the switch does not settle back onto the plates stop jacking – the switch is likely crippled.
Lever Platform	Replace or repair timber lever platform to maintain a firm, non-slip footing for shunter to throw switch. Platform should be easily removable to allow access for maintenance, and chamfered to prevent a tripping hazard.
Loose Bolts	Keep bolt heads and threads oiled whenever oiling slide plates, to prevent bolts from seizing. Check and tighten using correct size spanner. If nut is loose but cannot be tightened, try slacking off nut and insert 2 half washers behind nut. If the nut is completely seized, cut off the nut, hammer out the bolt with a drift, and insert new bolt and nut.
Painting	1. Keep point levers painted yellow to show the trip/obstruction hazard. Paint TO number in black on handle. 2. Keep fouling point marker (usually concrete block or sleeper ends opposite fouling points) painted yellow.

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Annex D
Permit to Work Form

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PERMIT TO WORK ON OR ABOUT THE MOD RAILWAY

Permit number	

Authority is granted for work on, or within 3 metres of the railway, as detailed below.

Depot	

Line designation (location or number)	

Boundary limits, between		and	

Permit given to (name of person in charge)	

Department or company	

Authority included for plant and equipment	Yes/No (delete as necessary)	Specify items:

Authority included to erect scaffold	Yes/No (delete as necessary)	Description:

Authority included for excavations within 3 metres of railway track	Yes/No (delete as necessary)	Description:

from (time/date)		to (time/date)	

Signature Railway Operating Manager		time/date	

Signature Railway Traffic Controller		time/date	

Signature Person in Charge		time/date	

Notes to Person in Charge:

1. This permit is an accountable document and must be returned to the Railway Operating Manager at or before its expiry date/time.

2. Under no circumstances may work continue beyond the time/date authorised. A new permit must be obtained for any extension.

3. A railway safety guide is issued with this permit. The Person in Charge must ensure that all persons included in his work group read and understand this guide.

4. All damage, obstructions or incidents involving or affecting the railway must be notified immediately to the Railway Operating Manager.

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Annex E
Track Possession Certificate

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MOD TRACK POSSESSION CERTIFICATE

PART 1:
ISSUE OF POSSESSION BY RAILWAY OPERATING MANAGER TO PERSON IN CHARGE

Absolute possession of the railway track detailed below is granted to the Person in Charge.

Depot		Certificate number	

Line designation (location or number)	

Boundary limits, between		and	

Possession given to (name of person in charge)	

Department or company	

from (time/date)		to (time/date)	

Signature Railway Operating Manager		time/date	

Signature Railway Traffic Controller		time/date	

Signature Person in Charge		time/date	

PART 2: CANCELLATION OF POSSESSION BY NOMINATED PERSON IN CHARGE

The section of railway track within the boundaries of this possession is returned to MOD.
The Person in Charge certifies that he has personally inspected the railway track and that it is fit for normal use by rail traffic, all protection has been removed and it is free from all obstructions.

Signature Person in Charge		time/date	

Signature Railway Operating Manager		time/date	

Signature Railway Traffic Controller		time/date	

Note to Person in Charge: This certificate is an accountable document and must be returned to the Railway Operating Manager when work is complete. The line shall remain closed to all rail traffic until Part 2 is completed and the certificate is signed back to the Railway Operating Manager.

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Annex F
Bridge Inspection Report

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MOD RAILWAY BRIDGE INSPECTION REPORT

Depot	
Bridge number	
Location	
Mileage	
Ownership	

Date of examination	
Name of examiner	
Signature	

LOCATION MAP

BRIDGE DESCRIPTION

Over/Under bridge	
Interface	
Spans	
Skew	
Construction description	
Construction materials	
Height signs	
Restrictions	
Route availability category	
Number of rail tracks	
Rail track operating category	
Rail track type/description	
Rail line speed	

CONDITION SURVEY

Bridge Part	G -Good F - Fair P - Poor N - None	Notes
Main Girders		
Cross Girders		
Deck		
Rivets & Bolts		
Rail bearers		
Bearings		
Trestles & Cross heads		
Columns & Cylinders		
Painting		

Arch Rings		
Spandrels		
Abutments		
Piers		
Wing & Retaining Walls		
Parapets & Pilasters		
Buttress		
Jack Arches		
Plinth Courses		
Springers		
Ballast Walls		
Pointing		
Copings & Caps		
Bedstones & Cills		
Ballast Plates / Boards		
Gutters & Downpipes		
Longitudinal Timbers		
Waterproofing		
Drainage		
Handrails		
Number Plates		
Span Floor		
Vegetation		
Foundations		
Voussoirs		
Signs		
Service pipes		
Derailment protection		
Earthworks		
Others		

DETAILS OF DEFECTS AND SAFETY ISSUES

RECOMMENDATIONS

OPERATING RISK ASSESSMENT

Risk	Mitigation	Risk Acceptable
Bridge strike		
Road vehicle incursion to drainage channel.		
Rail vehicle derailment/containment.		
Rail staff place of safety		
Bridge load assessment		

PHOTOGRAPHS

Annex G
Level Crossing Inspection Form

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MOD RAILWAY LEVEL CROSSING INSPECTION REPORT
PUBLIC ROAD AND FOOTPATH LEVEL CROSSINGS

Depot	
Level Crossing Nr	
Location	
Grid Reference	
Mileage	

Date of inspection	
Name of inspector	
Signature	

LOCATION MAP

LEVEL CROSSING DESCRIPTION

Number of tracks	1
Road classification/identity	Unclassified, Merton Road
Road speed limit	30 mph
Level crossing type	Fully gated road and rail, manually operated
Road surface type	Concrete cast in-situ integral road/rail slab
Railway track type	BS113A rail
Railway operating category	Main running line
Railway line speed	10 mph

CONDITION SURVEY

Component	Element	Condition G -Good F - Fair P - Poor N - None	Fully Functioning (Compliant)	Observations
Road	Surface			
	Pedestrian			
Railway	Track			
	Flangeways			
Trespass Guards	Guards			
	Fencing			
Road Lining	Stop lines			
	Centre lines			
	Carriageway			
	Footpaths			
Road Signage	At crossing			
	Advance			
	Pedestrians			
Rail Signage	Whistle			
	Advance warning			
	Other			
Visibility	Road visibility			
	Rail visibility			
	Vegetation			
Barriers & Gates	Barriers			
	Gates			
Traffic Control System	Rail signals			
	Wig wags			
	Audible warning			
	Manual controls			
	Treadle controls			
	Other			
Timing	Amber lights			
	Time to crossing			
	Cancelling			
Crossing Cabin	Power supply and switch for red gate lights			
Road Lighting				

ACTIONS FROM PREVIOUS REPORTS

DETAILS OF DEFECTS AND SAFETY ISSUES

ACTIONS REQUIRED

PHOTOGRAPHS

Annex H
Level Crossing Risk Assessment Form

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LEVEL CROSSING RISK ASSESSMENT AND MONITORING

Level Crossing No/Location	

Key
Risk minimised and accepted
Risk/consequences moving towards unacceptable
Risk unacceptable

Risk	**Mitigation Measures**	**Risk ALARP**
LC type		
Operation of LC by rail staff		
Operating documents		
Rail signage		
Rail speed		
Rail signalling		
Operation by road vehicle users		
Road markings		
Road signage		
Wigwag lights		
Road speed limit		
Visibility		
Road/rail approaching traffic		
Hours of darkness		
Vegetation		
Operation by pedestrians		
Trip free & non-slip surface		
Pedestrian incursion onto track		
Infrastructure		
Condition inspection		
Functional checks by rail staff.		
Regular electrical/lights checks by maintenance contractor.		

Risk Assessment Reviewed	
Date	**Reviewer**

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Annex I
Under Track Crossing Specification Requirements

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MOD RAILWAY INFRASTRUCTURE

PROPOSALS FOR NEW UNDERTRACK CROSSINGS CABLES, PIPES AND SERVICES

STANDARD GENERIC REQUIREMENT

1. **Introduction**. DIO is the MOD technical authority for railway track and infrastructure, including the areas on, under, over and alongside the track.

2. **Proposals for New Undertrack Crossings**. The contractor, in conjunction with the MOD sponsor department, must apply for construction approval to the DIO Principal Railway Engineer. The following information, demonstrating how the proposer intends to satisfy the MOD requirements must be submitted in written or electronic format, and must include a plan and cross sectional drawing:

Locations of proposed crossing
Details of services
Method statements, specific to the crossing
Construction details, specific to the crossing

3. **Construction Requirements**.

a. All cables, pipes and services shall be in a duct below the track formation level.

b. The top of the duct shall be set at a depth of no less than 900 mm below the bottom of the track sleepers.

c. The line of the duct shall be square to the line of the track where possible.

d. The duct shall be of a material and strength suitable to withstand the dispersed live and dead loading below the track. The material is traditionally cast iron but a HDPE pressure pipe such as that used for water services and gas services would be acceptable. Standard underground PVC cable duct is not sufficient, although this can be passed through the stronger outer duct to avoid a disruption to the whole cable duct route.

e. The length of the duct shall be such that the ends are no closer to the rails than 2000mm, measured square to the track. Sides of excavations for duct pits/chambers shall be a minimum of 2000mm from the outside rail.

f. The duct is to be installed under the track by a non-disturbance method such as thrust boring, pipe-jacking or earth auger. Care must be taken to ensure that installation works do not heave the ground and raise or lower the levels of the rail over the site. Levels must be taken on the rail head at intervals before and after works to provide evidence of stability.

g. The rails, sleepers, fixings, track ballast and membrane over the formation must not be disturbed.

h. No part of the works, temporary works, excavations, plant, materials, access etc is to encroach within 2000mm of the outside rail of the track, whether above or below ground level. A standard railway industry approved blue plastic temporary fence must be placed alongside the track at a minimum 2000mm from outside rail for a length commensurate with working area, access and safety of operatives.

i. No vehicles, plant or equipment are to be driven or stood on the track or ballast or ballast shoulders.

j. No spoil or materials are to be placed on ballast shoulders or track. Surplus spoil from works adjacent to the track is to be removed off site.

4. **Site Restrictions**. The contractor must make arrangements for the following with the Depot Railway Manager:

a. Access to the Depot.

b. Railway specific safety briefing.

c. Depot safety briefing as required by host unit.

d. Railway PPE (Railway orange pattern approved high visibility clothing is essential. This must be provided by the contractor for his staff).

e. Permit to dig (usually provided by the Depot host unit, landowner, or Highway Authority as appropriate).

f. Track Possession.

END

Annex J
Standard Drawings

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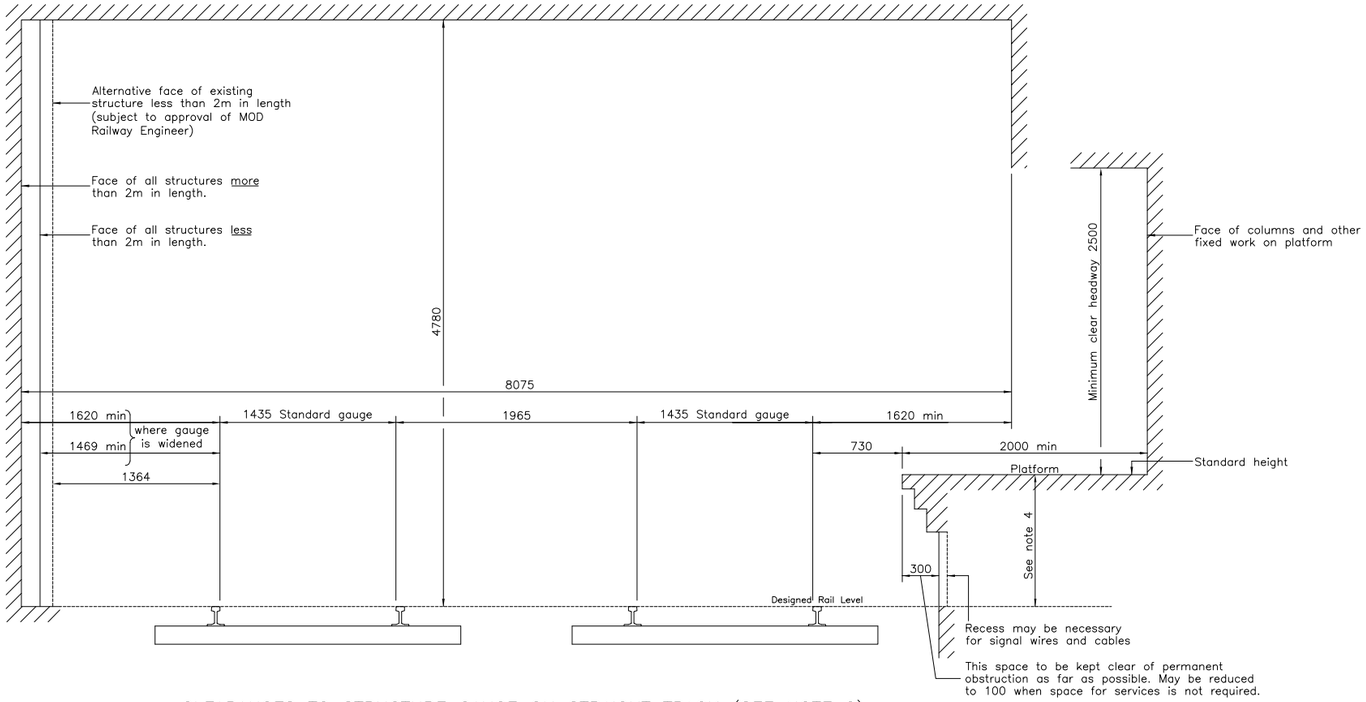
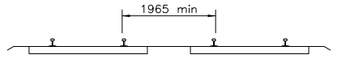


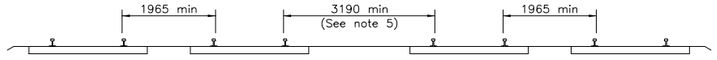
CLEARANCES TO STRUCTURE GAUGE ON STRAIGHT TRACK (SEE NOTE 2)
(Scale 1 : 50)

NOTES

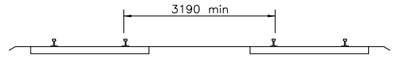
1. All dimensions are in millimetres.
2. Minimum dimensions must be increased to allow for the following :–
   2.1 Curvature and super elevation of track.
   2.2 Length and contour of rolling stock on curves.
3. Infringements
   No new construction or reconstruction shall infringe on the standard requirement as shown without prior approval of the Ministry of Defence Railway Engineer (MOD RE). In the case of infringement arising from the re–alignment of existing track the prior approval of the MOD RE is required.
4. Height of vehicle end loading platforms to be 1220mm above rail level – for details see Standard Drawing 4617.
   Height of vehicle side loading platforms to be 1075mm above rail level.
   Height of platform for passengers and other freight to be 915^{+0}_{-25}mm above rail level.
5. The track interval spacing of 3190mm for condition 2 may be reduced to 2890mm in cases of special difficulty and subject to approval by the MOD RE.
6. Overhead telegraph, telephone and stay wires crossing the railway in the open shall be at least 6100mm above rail level.
7. Clearances shown are for standard gauge track only. Narrow gauge track clearances must be determined from rolling stock dimensions (See Standard Drawing 4619).
8. Compliance with this Drawing is mandatory for all MOD UK standard gauge railways.



1. BETWEEN RUNNING LINES (AS ABOVE) 1965 min

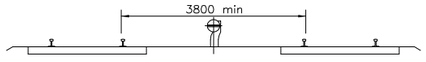


2. BETWEEN (a) PAIRS OF RUNNING LINES
   (b) PAIRS OF / SINGLE RUNNING LINES AND (EXISTING) MAIN LINES } 3190 Normal minimum but see note 5



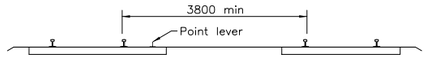
3. BETWEEN RUNNING LINE AND NEAREST SIDINGS 3190 min

4. BETWEEN SIDINGS 2275 min

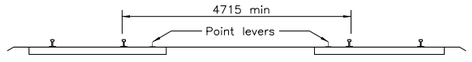


5. BETWEEN GROUPS OF SIDINGS AND WHERE SIGNAL OR LAMP POSTS ARE REQUIRED } 3800 min

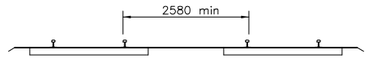
6. WHERE BOLLARDS CAPSTANS ETC ARE TO BE PROVIDED } 2885 min



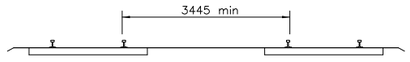
7. IN SHUNTING ROADS WITH POINT LEVER ON ONE SIDE } 3800 min



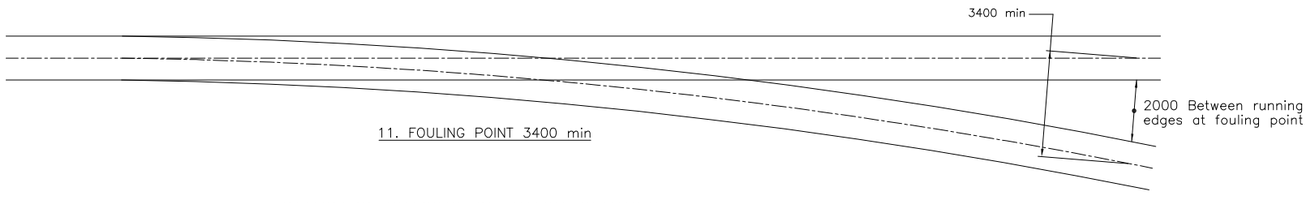
8. IN SHUNTING ROADS WITH POINT LEVERS ON BOTH SIDES } 4715 min



9. BETWEEN CARRIAGE SIDINGS 2580 min



10. WHERE RAIL MOUNTED CRANES ARE REQUIRED } 3445 min



11. FOULING POINT 3400 min

STANDARD SPACING OF TRACK CENTRES ON STRAIGHT TRACK (SEE NOTE 2)
(Not to Scale)

DRAWING INFORMATION TAKEN FROM PSA STANDARD DRAWING DCES/RLY/1 (ISSUE A)

ISSUE	CHANGES	DATE	SIG
1	INITIAL ISSUE	24:05:10	D.C.B.

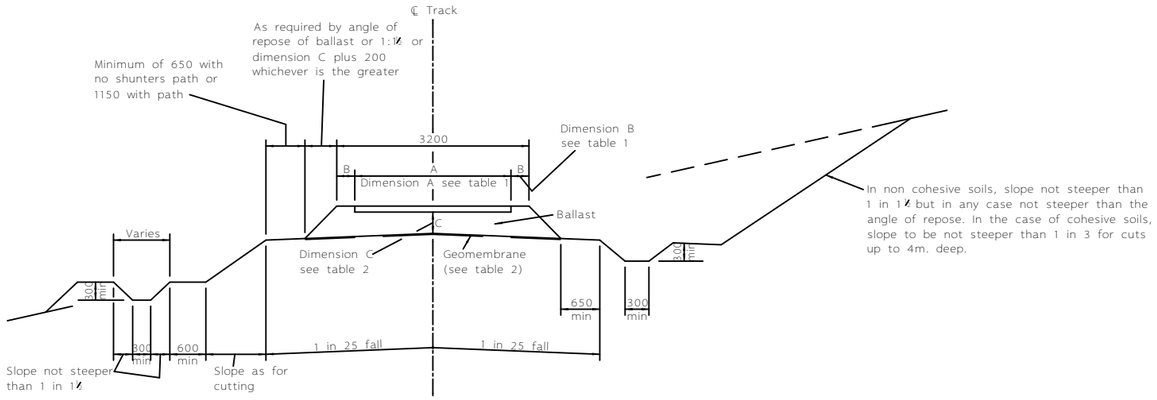
DRCS FILE NUMBER	SCALE	DRAWN BY
4601001S01	1 : 50 OR N.T.S.	*D.C.Belringer*

MOD UK RAILWAYS PERMANENT WAY DESIGN AND MAINTENANCE ANNEX 'J' STANDARD DRAWINGS

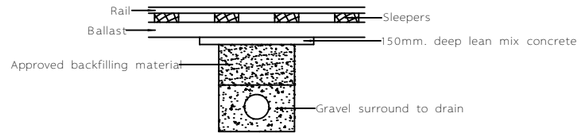
DRAWING TITLE
STRUCTURE GAUGE CLEARANCES AND TRACK SPACINGS

DRAWING NUMBER
4601

A3

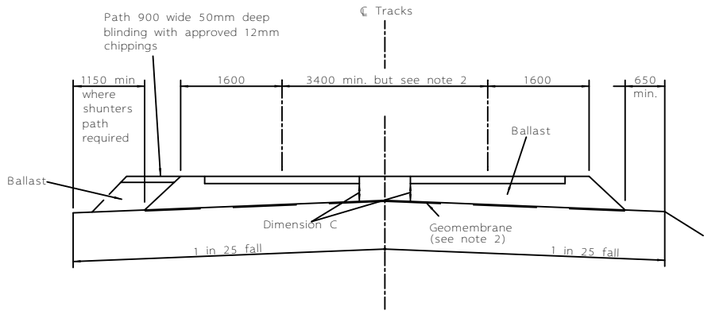


SINGLE TRACK SHOWING EMBANKMENT CUTTING



SKETCH DETAIL OF TRENCH BACKFILLING

TABLE 1 : Ballast/sleeper dimensions		
Type of sleeper	Dimension A	Dimension B
Wood	2600	300
Concrete F27	2515	342
A + 2B = 3200		



DOUBLE TRACK
(Embankment/Cutting as detailed above)

TABLE 2 : Depths of ballast		
Type of subgrade	Minimum depth of ballast required Dimension C	
	In sidings	In running lines
Good : eg. sand or sandy gravel or CBR not less than 10%	100	150
Average : eg. sandy clay or sandy silt with CBR not less than 3%	150	200
	See note 6	
Poor : eg. silt or heavy clay with CBR less than 3%	250	300
	See note 6	

NOTES

1. Dimensions are in millimetres unless otherwise stated.
2. This drawing to be read in conjunction with Drawing No 4601.
3. Drainage details to be shown on layout drawings.
4. Shunters paths - it is essential to agree with the operator where shunters paths are required and their route must be shown on the layout plan.
5. To reduce mud pumping on clay formations geomembrane should be provided. In sidings, areas between tracks to be filled with ballast to top of sleeper.
6. Geogrid reinforcement may be required under ballast and on top of geomembrane, for weak formations.

DRAWING INFORMATION TAKEN FROM PSA STANDARD DRAWING DCES/RLY/2 (ISSUE A)

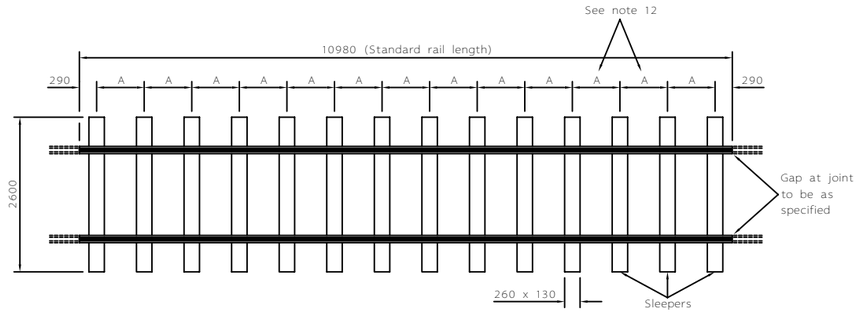
ISSUE	CHANGES	DATE	SIG
1	INITIAL ISSUE	24:05:10	D.C.B.

DRCS FILE NUMBER 4602001S01 | SCALE 1 : 100 | DRAWN BY D.C.Belringer

MOD UK RAILWAYS PERMANENT WAY DESIGN AND MAINTENANCE ANNEX 'J' STANDARD DRAWINGS

DRAWING TITLE
TRACK LAYOUT
TYPICAL CROSS SECTIONS

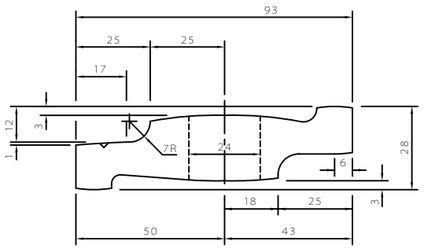
DRAWING NUMBER 4602 | A3



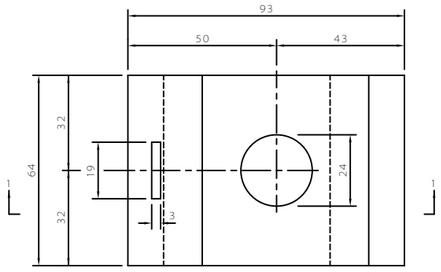
LAYOUT OF WOOD SLEEPERS

(IDENTICAL SPACING FOR CONCRETE SLEEPERS)

Scale :- 1 : 100



SECTION 1-1

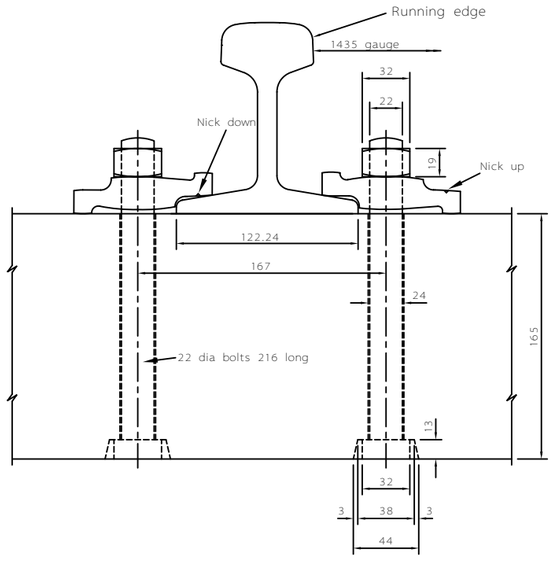


PLAN OF REVERSIBLE RAIL CLIP

Scale :- Half full size

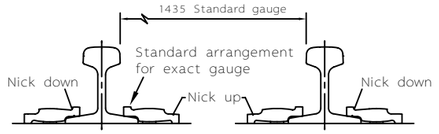
NOTE

There are some variations between the rail clip shown and the BS 4521 M.O.W. clip. The clip illustrated here should be restricted to use with concrete sleepers and through bolts 22 dia. The M.O.W. clip is used with wood sleepers and a 25 dia. coachscrew.

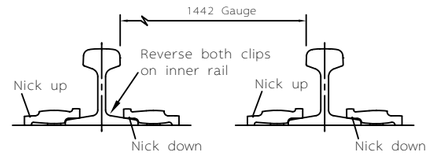


CLIP FIXING DETAILS

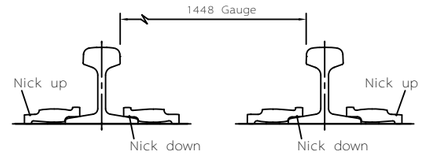
Scale :- Quarter full size



STANDARD : For straight and curved track of not less than 200m. radius.



SLACK GAUGE : 7mm. for curved track of not less than 160m. but less than 200m. radius.



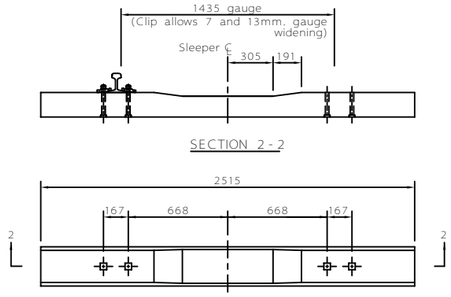
SLACK GAUGE : 13mm. for curved track of not less than 120m. but less than 160m. radius.

GAUGE WIDENING USING CONCRETE SLEEPERS

(For curves of less than 120m. radius wood sleepers must be used)

See note 8 and 9

Scale :- 1 : 10



SECTION 2-2

PLAN OF CONCRETE SLEEPER

SCALE :- 1 : 40

NOTES

1. Dimensions are in millimetres unless otherwise stated.
2. The design maximum axle loading shall be agreed with the Operating Authority.
3. Details are not suitable for BS 75A rail.
4. Type of sleeper and fastening to be as specified by the designer.

CURVED TRACK

5. Superelevation (cant) to be determined by the designer and in accordance with parameters given in MOD UK Railways Permanent Way Design and Maintenance (MOD UK Rly PW D&M).
6. Minimum radii of curves to be determined by the designer and in accordance with parameters given in MOD UK Rly PW D&M.
7. Curves of 200 radius or less shall be laid with staggered joints to be determined by the designer and in accordance with parameters given in MOD UK Rly PW D&M. On such curves the joints in one rail shall be approx. opposite the centre of the other rail length, a closure rail being inserted in the inner rail at the end of the curve. The length of any closure rail shall be not less than 4m.
8. Gauge widening over standard 1435 to be determined by the designer and in accordance with parameters given in MOD UK Rly PW D&M.
9. Gauge widening shall be achieved by :-
   (a) Shortening the radius of curvature of the inner rail
   (b) Building up the gauge widening at the rate of 3 or 4mm per sleeper to maximum required at the start of the curve
   (c) Easing off the gauge widening at the same rate from the end of the curve
10. Check rails are required on all running lines where the radius of the curve is less than 120m. Check rails are required on all passenger lines where curves of less than 200m are used. Check rails are not required in sidings in sleepered track.
11. In sleepered track with BS 75R rail where check rails are required or the radius is less than 120m wood sleepers must be used.
12. Sleeper spacings to be as follows :-

Max. axle loading (tonnes)	Dimension A equally spaced (approx)	No. of sleepers per standard rail length (10.98m)
17	800	14
20	700	16
22.5	600	18

13. Detail on this dwg is for information only - new turnouts and new works will not normally be constructed in BS 75R rail.
14. Dog spikes and elastic spikes should not be used for new works.

DRAWING INFORMATION TAKEN FROM PSA STANDARD DRAWING DCES/RLY/3 (ISSUE A)

ISSUE	CHANGES	DATE	SIG
1	INITIAL ISSUE	24:05:10	D.C.B.

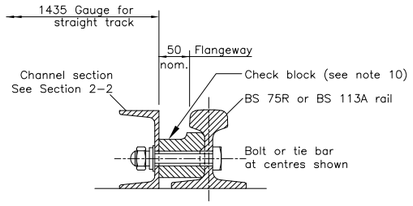
DRCS FILE NUMBER 4603001S01 | SCALE As shown | DRAWN BY D.C.Belringer

MOD UK RAILWAYS PERMANENT WAY DESIGN AND MAINTENANCE
ANNEX 'J' STANDARD DRAWINGS

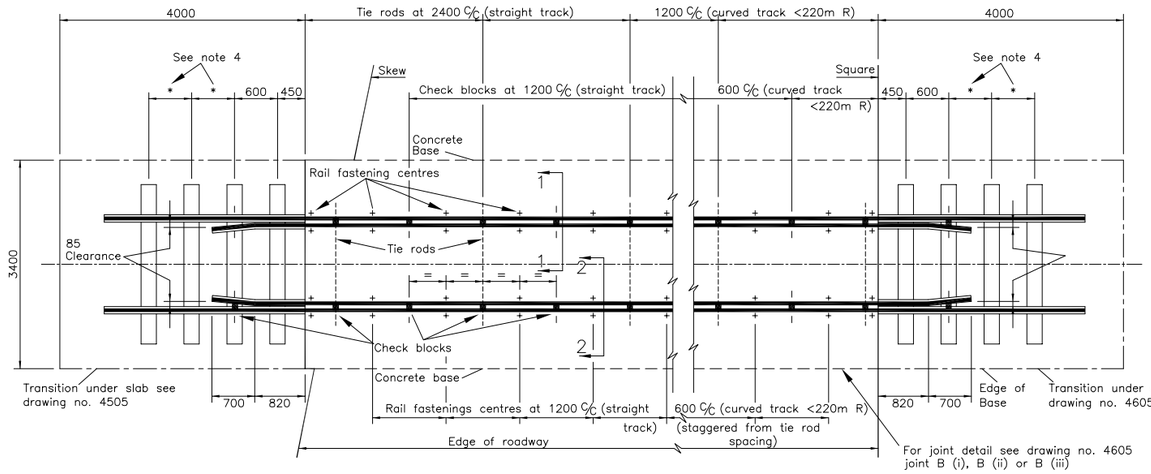
DRAWING TITLE

TRACK DETAILS FOR BS 75R RAIL

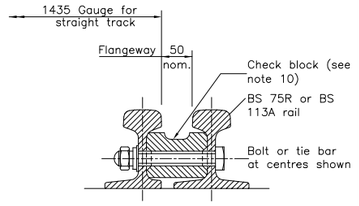
DRAWING NUMBER 4603 A3



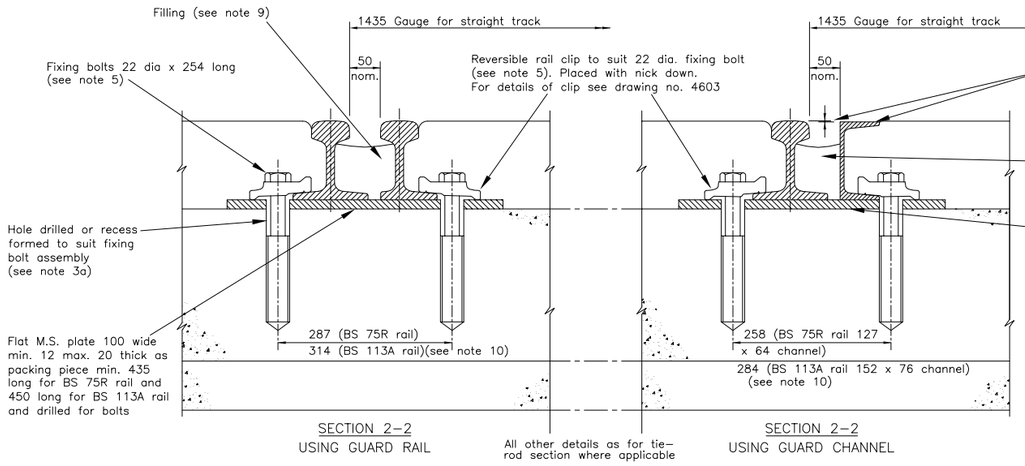
SECTION 1–1
USING GUARD CHANNEL



PLAN OF LEVEL CROSSING



SECTION 1–1
USING GUARD RAIL

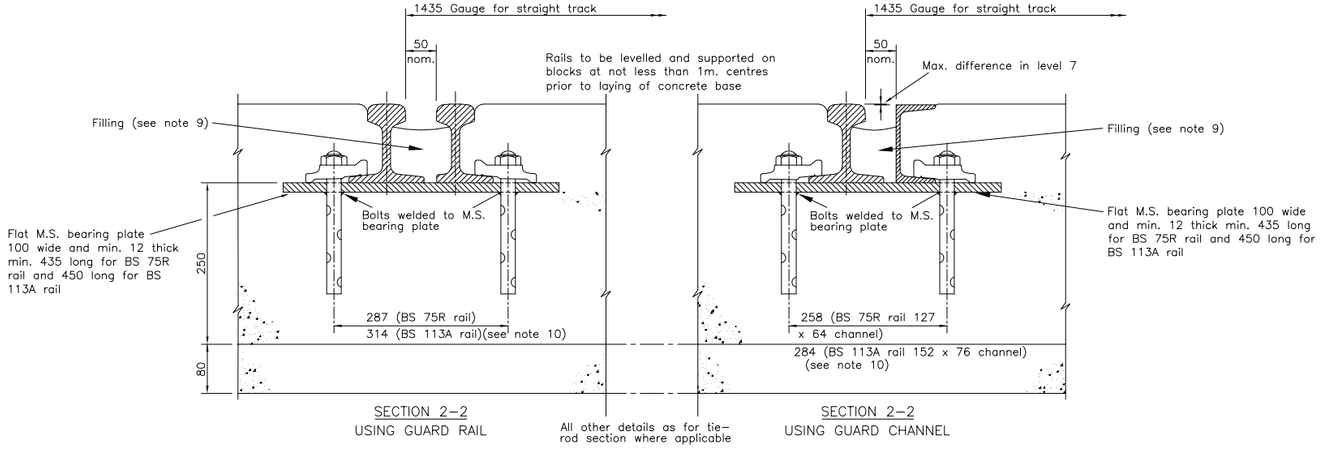


SECTION 2–2
USING GUARD RAIL

All other details as for tie–rod section where applicable

SECTION 2–2
USING GUARD CHANNEL

WHERE BASE SLAB IS CAST PRIOR TO LAYING OF TRACK



SECTION 2–2
USING GUARD RAIL

All other details as for tie–rod section where applicable

SECTION 2–2
USING GUARD CHANNEL

WHERE BASE SLAB IS CAST AFTER TRACK IS LAID AND LEVELLED

RAIL FASTENING DETAILS

NOTES

1. Dimensions are in millimetres unless otherwise stated.
2. For turnouts in hardstandings see drawing no 4610.
3. CONSTRUCTION
   (a) Holes to be drilled or recesses formed to accommodate fixing bolt assemblies for rail fixing in accordance with manufacturer's instructions.
   (b) Tie rods, fastenings and check blocks to be staggered as shown on plan.
   (c) Fish bolts through fish plates to be fixed so that the nut is located in the flangeway.
   (d) Rails to be laid and adjusted to the correct gauge and alignment and then brought up to the required level by use of packing pieces spanning the full width of both running and check rail flanged.
   (e) Rails to be supported on a solid bed over the entire length and width of flange. Tie rods / bars to be similarly supported before the infill is laid.
   (f) Packing pieces for adjusting rail levels shall be steel or other approved material.
4. * denotes standard sleeper spacing in accordance with the following criteria
   (a) For BS 75R rail

Axle loading (T)	Sleeper spacing (mm)
17	800
20	700
22.5	600

   (b) For BS 113A rail a sleeper spacing of 800mm.
5. Fixing bolts 22dia. with similar approved fixing bolt assemblies may be used with M.O.W. clips to BS 4521 Part 2.
6. The following equivalent rail sections may also be used BS 98, BS 109, BS 113A, or BS 110A (in lieu of BS 113A). BS 98 to be used with guard rail only unless suitable approved channel can be obtained.
7. Specification details of concrete slabs, infill and sub base to be determined by the designer for individual locations.
8. Running rail to be continuous over level crossings, with thermit welded rail joints. No fishplated joints in adjacent ballasted track to be positioned within 4m of level crossing concrete edge.
9. Flangeway filling to be 6mm size bitumen macadam to BS 4987. Filling top to be level with top of spacer block.
10. Gauge widening to be in accordance with drawing no. 4603. Flangeways to be increased by the amount of any gauge widening.
11. This drawing must be read in conjunction with drawing no. 4605.

ISSUE	CHANGES	DATE	SIG
1	INITIAL ISSUE	24:05:10	D.C.B.

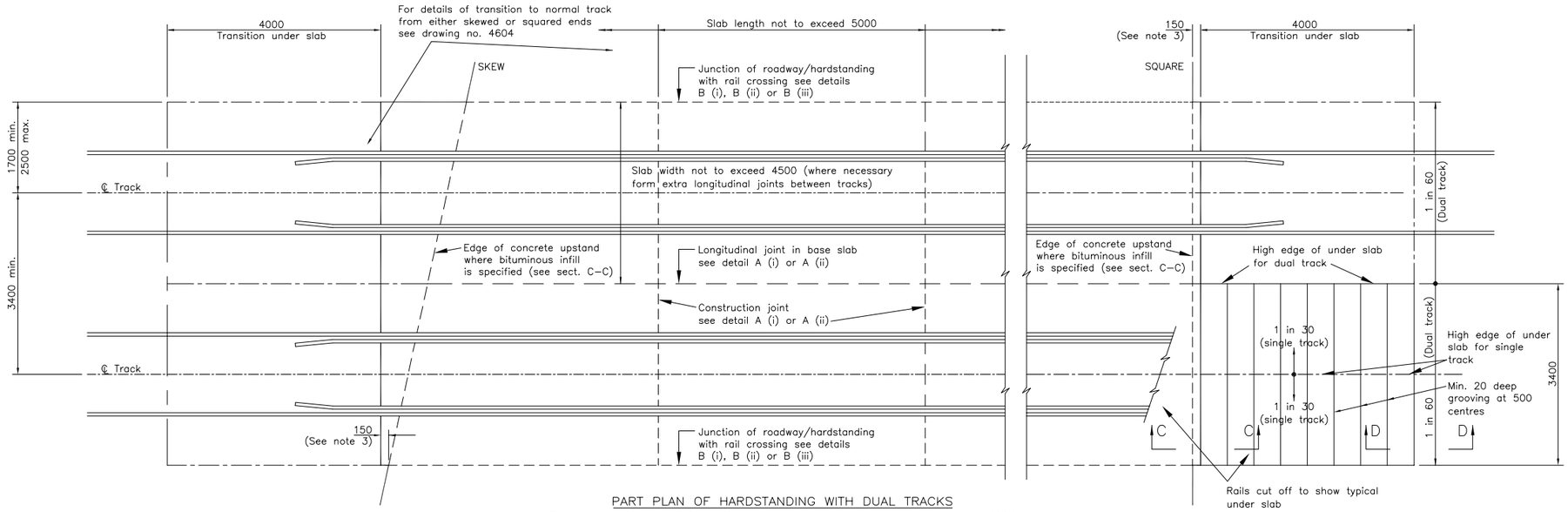
DRCS FILE NUMBER 4604001S01 | SCALE | DRAWN BY D.C.Belringer

MOD UK RAILWAYS PERMANENT WAY DESIGN AND MAINTENANCE ANNEX 'J' STANDARD DRAWINGS

DRAWING TITLE
LEVEL CROSSINGS AND HARDSTANDINGS BS 75R AND BS 113A RAIL

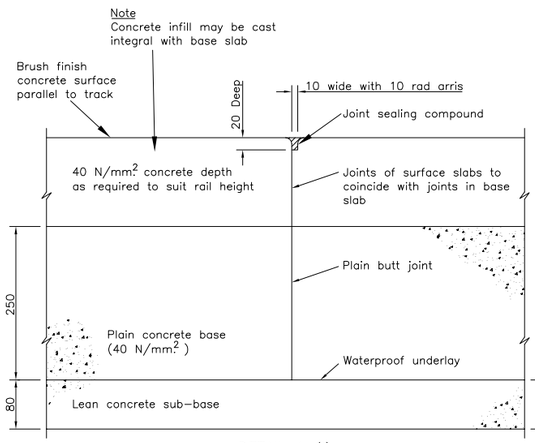
DRAWING NUMBER 4604 | A3

DRAWING INFORMATION TAKEN FROM PSA STANDARD DRAWING DCES/RLY/4 SHEET 1 (ISSUE A)



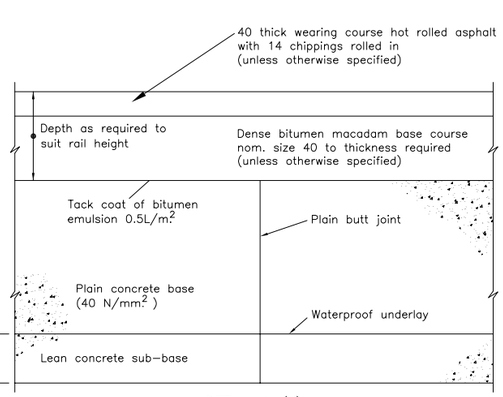
PART PLAN OF HARDSTANDING WITH DUAL TRACKS

For details of track, fixings, tie rods and check blocks see drawing no. 4604



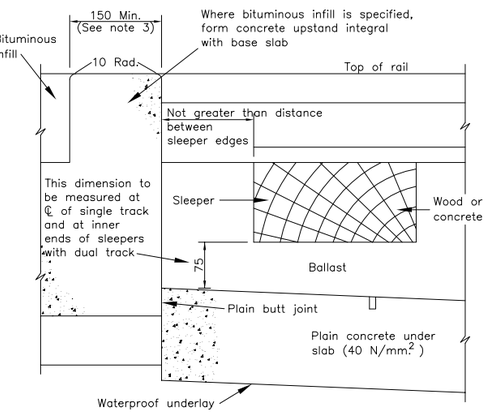
DETAIL A (i)

DETAIL OF CONTRACTION AND LONGITUDINAL JOINTS IN CROSSINGS SURFACED IN CONCRETE

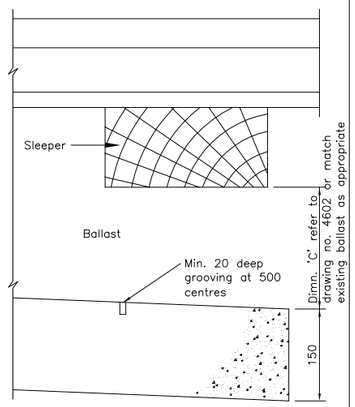


DETAIL A (ii)

DETAIL OF CONTRACTION AND LONGITUDINAL JOINTS IN CROSSINGS SURFACED IN BITUMINOUS MATERIAL

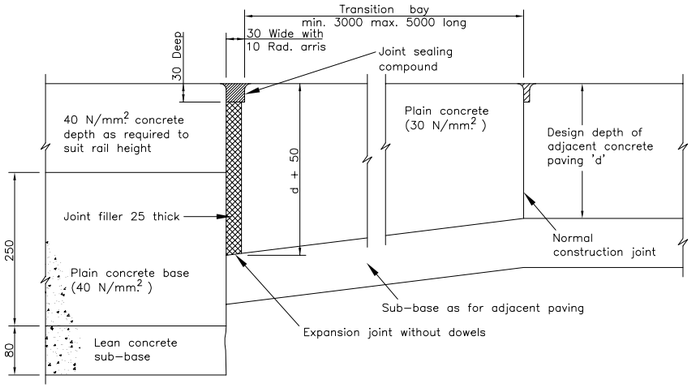


SECTION C–C



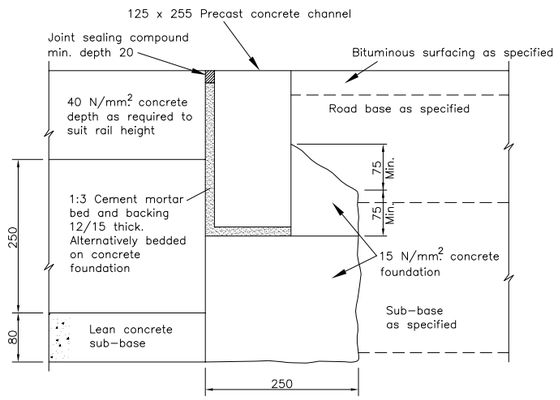
SECTION D–D

TRANSITION UNDER SLAB



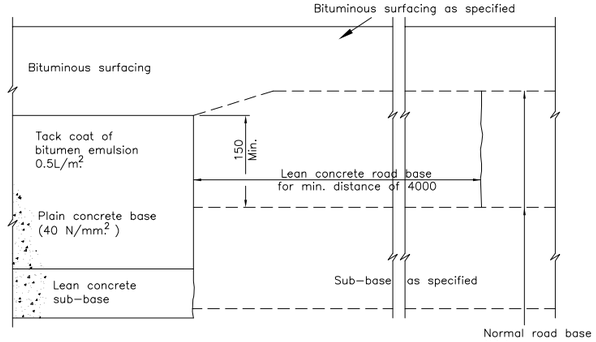
DETAIL B (i)

DETAIL OF JUNCTION OF RIGID PAVING WITH CROSSING SURFACED IN CONCRETE



DETAIL B (ii)

DETAIL OF JUNCTION OF FLEXIBLE PAVING WITH CROSSING SURFACED IN CONCRETE



DETAIL B (iii)

DETAIL OF JUNCTION OF FLEXIBLE PAVING WITH CROSSINGS SURFACED IN BITUMINOUS MATERIAL

DRAWING INFORMATION TAKEN FROM PSA STANDARD DRAWING DCES/RLY/4 SHEET 2 (ISSUE A)

NOTES

1. Dimensions are in millimetres unless otherwise stated.
2. Specification details of concrete slabs, bituminous material, joint sealing compound, filler, concrete channel and bedding to be determined by the designer for individual locations.
3. Where matching existing sleeper spacing, the 150mm horizontal step in the slab may be varied. If bituminous infill is specified, however, a minimum width of 150mm shall be maintained for the upstand (see Section C–C).
4. Expansion joints shall be provided at not more than 60 metre intervals where the hardstanding exceeds that dimension in length or width.
   e.g. where the length is 80m an expansion joint shall be formed at the centre of the slab at 40m.
   Joint details shall follow that of Detail B (i) except that the depth of the expansion joint shall extend from the bottom of the base slab to the top of the concrete infill, where used. Where bituminous infill to the rails is specified, the joint filler shall be included in the base slab only and the joint sealing compound shall be omitted.

ISSUE	CHANGES	DATE	SIG
1	INITIAL ISSUE	24:05:10	D.C.B.

DRCS FILE NUMBER	SCALE	DRAWN BY
4605001S01		D.C.Belringer

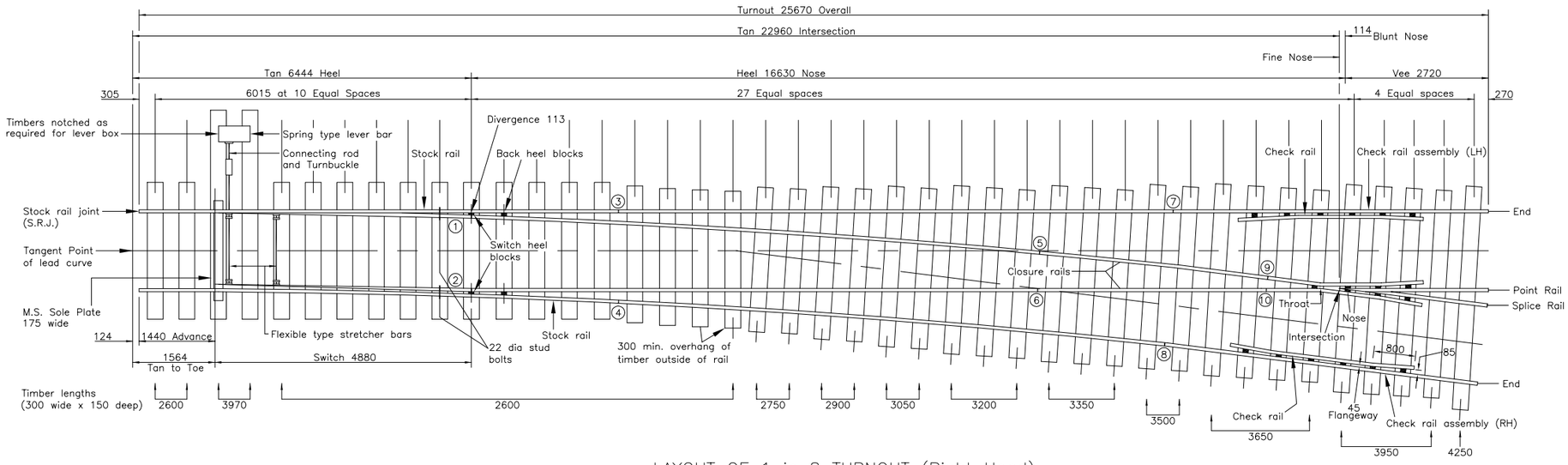
MOD UK RAILWAYS PERMANENT WAY DESIGN AND MAINTENANCE ANNEX 'J' STANDARD DRAWINGS

DRAWING TITLE

LEVEL CROSSINGS AND HARDSTANDINGS DETAILS OF BASE

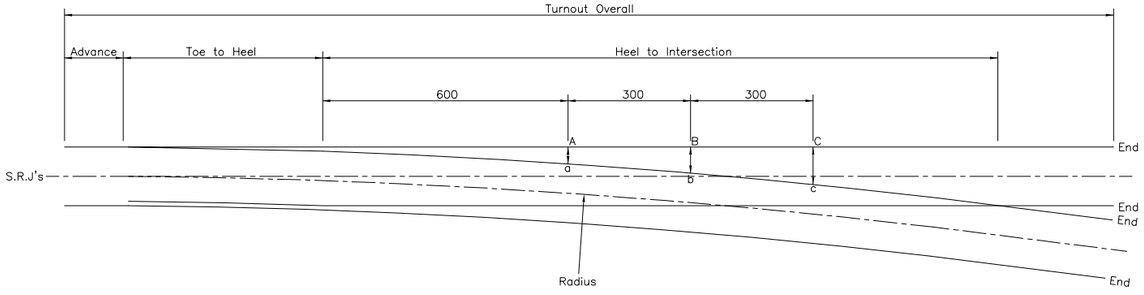
DRAWING NUMBER 4605 — A3

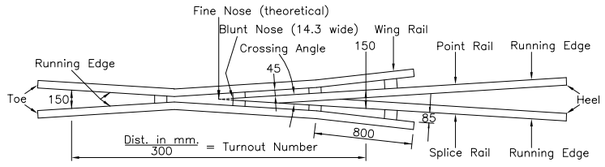
DETAILS OF EXISTING TURNOUTS – FOR INFORMATION ONLY



LAYOUT OF 1 in 8 TURNOUT (Right Hand)

Scale 1 : 100

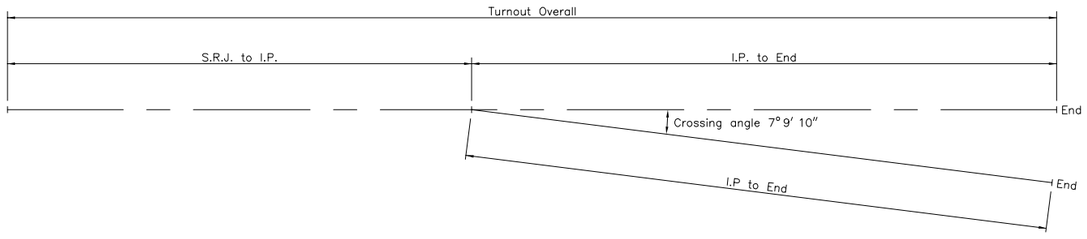




The distance in millimetres between the points where the running edges of the rails are 150 apart on each side of the fine nose, divided by 300 is the turnout number.
e.g. Distance = 2400 Turnout Number = $\frac{2400}{300}$ = 1 in 8

CROSSING ASSEMBLY

Scale 1 : 50



DATA FOR SETTING OUT

Scale Not to scale

PRINCIPLE DIMENSIONS FOR LOCATING TURNOUT	
Notation	Dimensions
Radius of lead curve (centre line)	183693
Heel to intersection	16516
Stock Rail Joint (S.R.J.) to I.P.	11357
I.P. to End	14313
Offsets (between running edges – approx)	
A a	420
B b	650
C c	925

DRAWING INFORMATION TAKEN FROM PSA STANDARD DRAWING DCES/RLY/5 (ISSUE A)

NOTES

1. Dimensions are in millimetres unless otherwise stated.
2. The turnout dimensions given are typical and minor variations arising from different manufacturer's may occur.
3. The layout details (excluding setting out data) are intended as a basis for inviting quotations from manufacturer's and manufacturer's working drawings will be used for construction of the turnout.
4. When ordering the turnout
   (4.1) Specify section of rail – BS 75R.
   (4.2) Specify whether left or right hand turnouts are required.
   (4.3) Specify radius of curve, if any, out of turnout.
   (4.4) Specify turnouts to be of vertical design.
5. ① to ⑩ on the layout indicate rail joints.
6. Rail fastenings throughout to be Pandrol clips. Where the closeness of rails precludes the use of clips between rails, cast iron blocks are to be fitted.
   All slide plates, check plates and crossing plates to have welded brackets. All plates to be 12.5 thick and to have 4 No. holes for 25 dia coach screws, except sole plate which is to be 10 thick and with 8 No 25 dia coach screws.
7. 1 in 8 turnouts should always be used in preference to a 1 in 6 or 1 in 6½ wherever space permits.

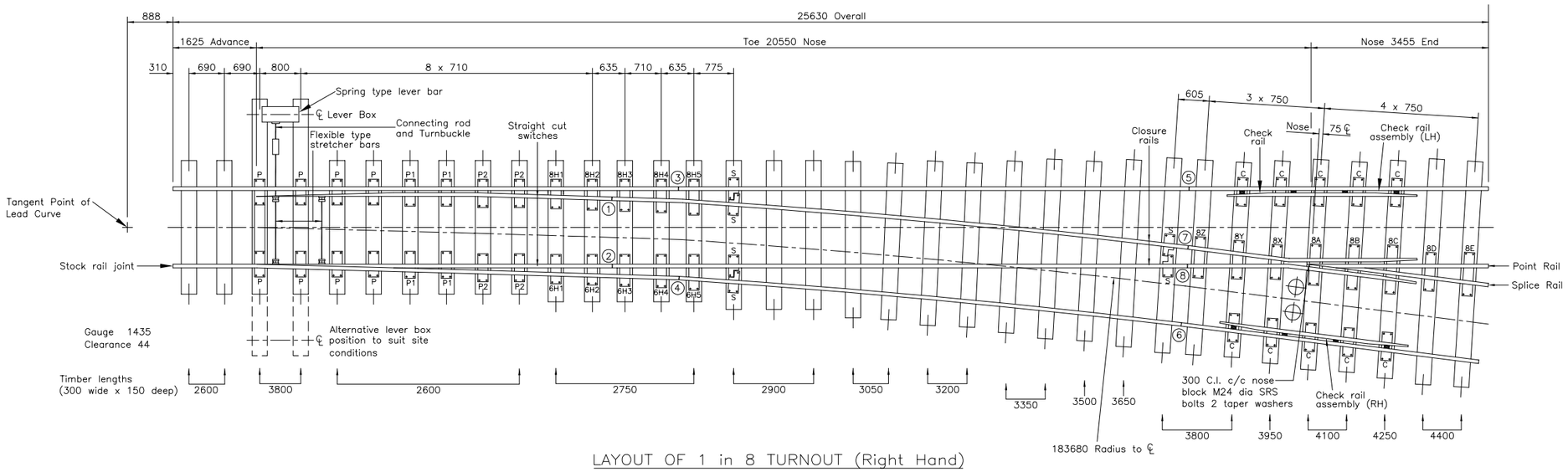
ISSUE	CHANGES	DATE	SIG
1	INITIAL ISSUE	24:05:10	D.C.B.

DRCS FILE NUMBER 4606001S01 | SCALE As shown | DRAWN BY D.C.Belringer

MOD UK RAILWAYS PERMANENT WAY DESIGN AND MAINTENANCE
ANNEX 'J' STANDARD DRAWINGS

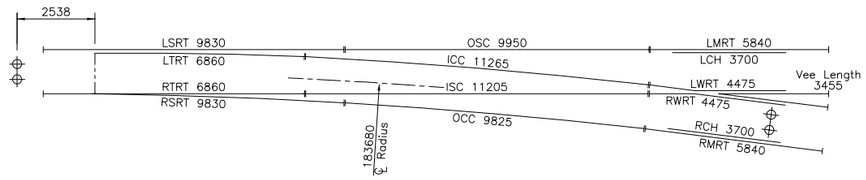
DRAWING TITLE
1 IN 8 HEEL SWITCH TURNOUT
BS 75R RAIL

DRAWING NUMBER 4606 A3



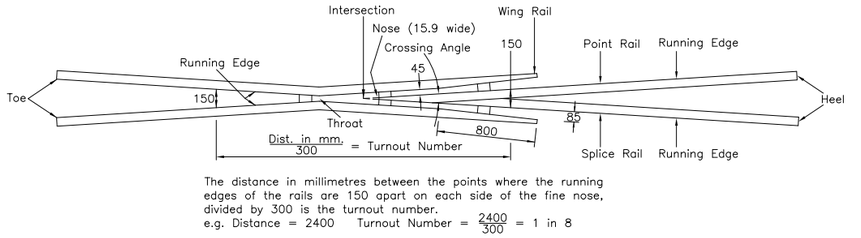
LAYOUT OF 1 in 8 TURNOUT (Right Hand)

Scale 1 : 100



DETAILS OF RAILS

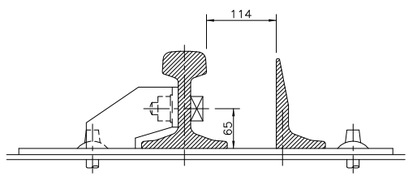
Scale 1 : 100



The distance in millimetres between the points where the running edges of the rails are 150 apart on each side of the fine nose, divided by 300 is the turnout number.
e.g. Distance = 2400 Turnout Number = $\frac{2400}{300}$ = 1 in 8

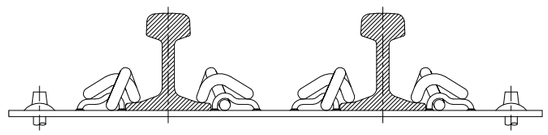
CROSSING ASSEMBLY

Scale 1 : 50



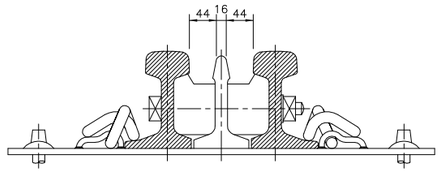
SECTION AT TOE

Scale 1 : 10



SECTION THROUGH HEEL PLATE

Scale 1 : 10



SECTION AT NOSE

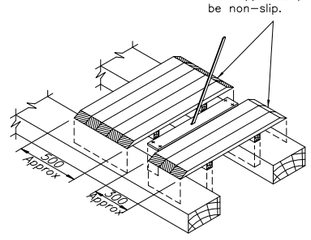
Scale 1 : 10

MATERIALS FOR 1 SET OF 1 IN 8 SWITCHES			
Qty.	Description	Matl.	Specification
1 Pr.	113A FB Stock rails 9830 lg	Rolled steel	B.S. 11
1 Pr.	113A FB Tongue 6860 lg	" "	"
8	Distance Blocks	Cast Iron	B.S. 1452 grade 12
6	Back Heel Blocks	" "	" "
22	M24 SRS Bolts c/w Washers		B.S. 4190 grade 4.6
16	Slide Plates	Mild steel	B.S. 4360 grade 43A
10	Back Heel Plates	" "	" "
4	Common Plates	" "	" "
36	Pandrol PR401A Clips		Pandrol Drg. 1370/1
1	Sole Plate	Mild steel	B.S. 4360 grade 43C
104	Coachscrews 25 dia x 140		
1	Connecting Rod Short Std.		
1	Lever Box		
	SWITCH OPERATION		
1 Pr.	Stretcher Bars or } Specify		
1 Set	Switch Lock } Requirement		
1	Direction Indicator } Specify if req'd		

MATERIALS FOR 1 IN 8 CROSSING C/W CHECK ASSEMBLY (1 No)			
Qty.	Description	Matl.	Specification
1	No Vee Welded or Fabricated	Rolled steel	B.S. 11
1 Pr.	113A FB Wing Rails 4475 lg	" "	"
1 Pr.	113A FB Main Rails 5840 lg	" "	"
1 Pr.	113A FB Check Rails 3700 lg	" "	"
8	Crossing Blocks	Cast Iron	B.S. 1452 grade 12
8	Check Blocks	" "	" "
12	M24 SRS Bolts c/w Washers		B.S. 4190 grade 4.6
8	Crossing Plates	Mild steel	B.S. 4360 grade 43A
10	Check Plates	" "	" "
6	Common Plates	" "	" "
52	Pandrol PR401A Clips		Pandrol Drg. 1370/1
96	Coachscrews 25 dia x 140		

MATERIALS FOR 1 SET OF 1 IN 8 CLOSURES			
Qty.	Description	Matl.	Specification
1	113A FB Closure Rail 11265 lg	Rolled steel	B.S. 11
1	113A FB Closure Rail 11205 lg	" "	"
1	113A FB Closure Rail 9825 lg	" "	"
1	113A FB Closure Rail 9850 lg	" "	"
6	Cut Common Plates	Mild steel	B.S. 4360 grade 43A
42	Common Plates	" "	" "
96	Pandrol PR401A Clips		Pandrol Drg. 1370/1
192	Coachscrews 25 dia x 140		
8 Prs.	113A FB Fishplates	Rolled steel	
32	113A FB Fishbolts		

100 x 32 Sawn SWD boards bevelled at each end and galv. nailed to 50 x 50mm sawn battens. Boards to be approx 1.0m long and battens spaced to suit timber spacing. Boards not to be nailed to turnout timbers. Boards and battens to be treated with approved preservative. Top surface to be non-slip.



TURNOUT LEVER PLATFORM FOR STANDARD GAUGE TURNOUT

Scale Not to scale

DRAWING INFORMATION TAKEN FROM PSA PSA STANDARD DRAWINGS DCES/RLY/7 (ISSUE A) & DCES/RLY/22 (ISSUE A)

NOTES

1. Dimensions are in millimetres unless otherwise stated.
2. The turnout dimensions given are typical and minor variations arising from different manufacturer's may occur.
3. The layout details (excluding setting out data) are intended as a basis for inviting quotations from manufacturer's and manufacturer's working drawings will be used for construction of the turnout.
4. The turnout details are suitable for spring switch turnouts made with BS 98, BS 109 and BS 113 rail as well as for BS 110A and BS 113A rail.
5. ① to ⑧ on the layout indicate rail joints.

ISSUE	CHANGES	DATE	SIG
1	INITIAL ISSUE	24:05:10	D.C.B.

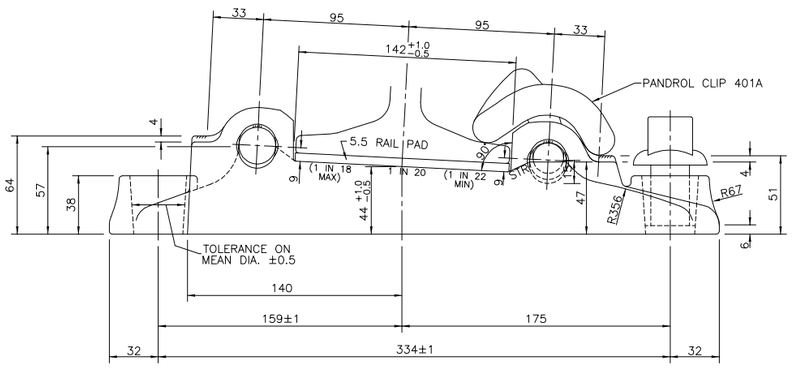
DRCS FILE NUMBER 4607001S01 | SCALE As shown | DRAWN BY *D.C.Belringer*

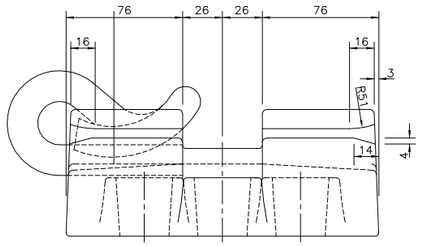
MOD UK RAILWAYS PERMANENT WAY DESIGN AND MAINTENANCE ANNEX 'J' STANDARD DRAWINGS

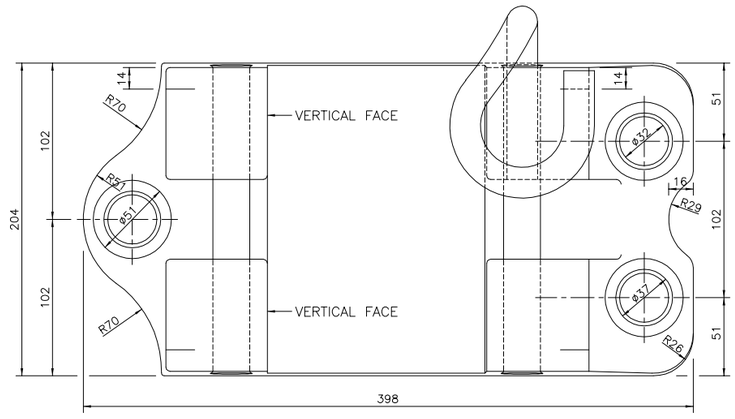
DRAWING TITLE

1 IN 8 SPRING SWITCH TURNOUT (BV8) USING BS 113A RAIL OR SIMILAR

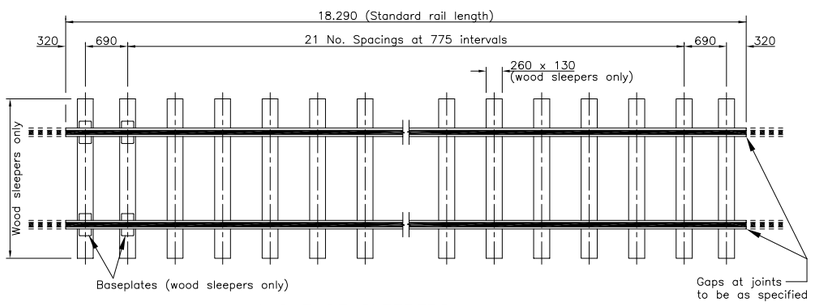
DRAWING NUMBER 4607 — A3



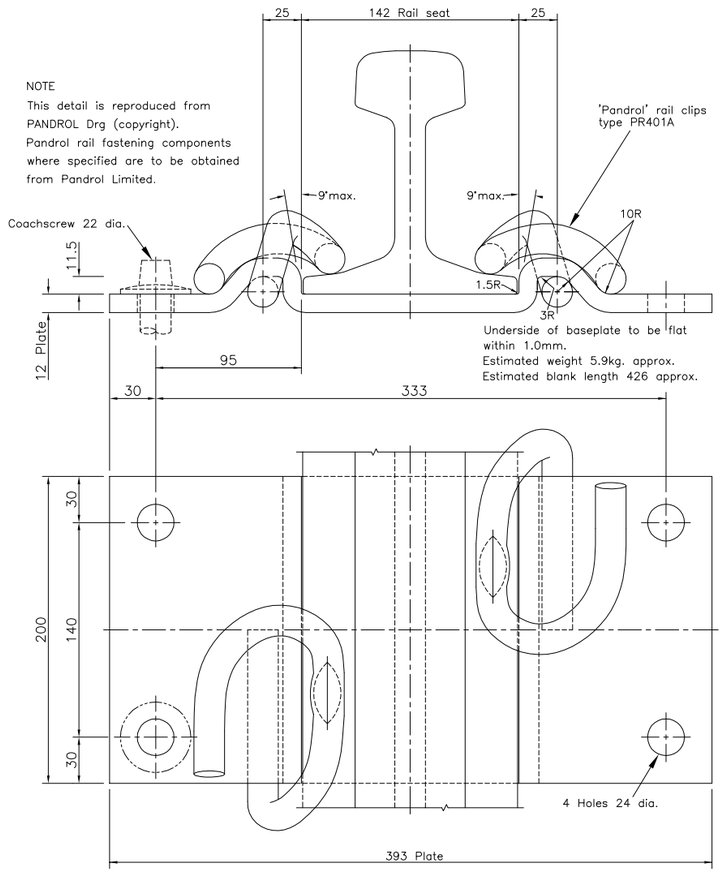




PANDROL CAST IRON BASEPLATE (PAN 6)
INFORMATION OBTAINED FROM PANDROL DRAWING NO. RE/PW/255 B
Scale Quarter full size



LAYOUT OF SLEEPERS (24 No. for 18.290 rail length)
Scale 1 : 100



PANDROL CLIPS AND PRESSED STEEL BASEPLATE
(VERTICAL RAIL) FOR USE WITH WOOD SLEEPERS
Scale Quarter full size

NOTES

1. Dimensions are in millimetres unless otherwise stated.
2. The design maximum axle loading for this rail is 22.5 tonnes with sleeper spacing not exceeding 800mm.
3. The following rail sections when specified may also be used with the sleepers and fastenings shown :–

Rail Section	Standard Weight (kg / m)
BS 98	48.56
BS 109	54.00
BS 110A	54.44
BS 113	56.30

4. Flat or inclined baseplates may be used in sidings.
5. CURVED TRACK
   Superelevation (cant) to be determined by the designer and in accordance with parameters given in MOD UK Railways Permanent Way Design and Maintenance (MOD UK Rly PW D & M).
6. Minimum radii of curves to be determined by the designer and in accordance with parameters given in MOD UK Rly PW D & M.
7. Curves of 200 radius or less shall be laid with staggered joints to be determined by the designer and in accordance with parameters given MOD UK Rly PW D & M. On such curves the joints in one rail shall be approximately opposite the centre of the other rail length, a closure rail being inserted in the inner rail at the end of the curve. The length of any closure rail shall be not less than 4m.
8. Gauge widening over standard 1435 to be determined by the designer and in accordance with parameters given in MOD UK Rly PW D & M.
9. Gauge widening shall be achieved by :–
   (a) Shortening the radius of curvature of the inner rail
   (b) Building up the gauge widening at the rate of 3 or 4mm per sleeper to maximum required at the start of the curve
   (c) Easing off the gauge widening at the same rate from the end of the curve
10. Check rails are required on all running lines where the radius of the curve is less than 120m. Check rails are required on all passenger lines where curves of less than 200m are used. Check rails are not required in sidings in sleepered track.
    track.

SOME DRAWING INFORMATION TAKEN FROM PSA STANDARD DRAWING DCES/RLY/9 (ISSUE B)

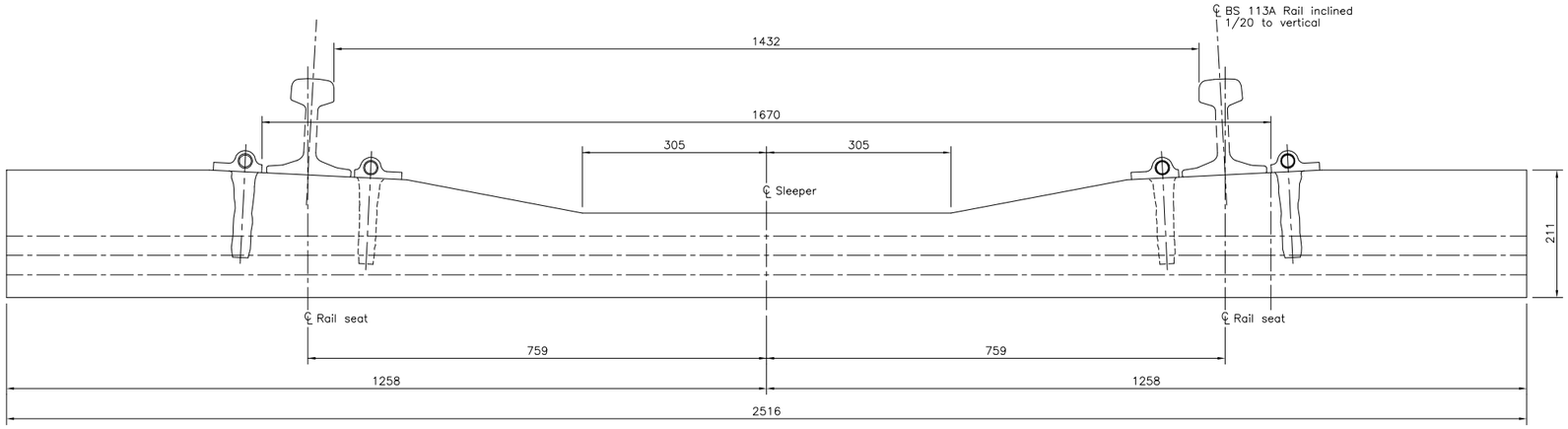
ISSUE	CHANGES	DATE	SIG
1	INITIAL ISSUE	24:05:10	D.C.B.

DRCS FILE NUMBER	SCALE	DRAWN BY
4608001S01	As shown	*D.C.Belringer*

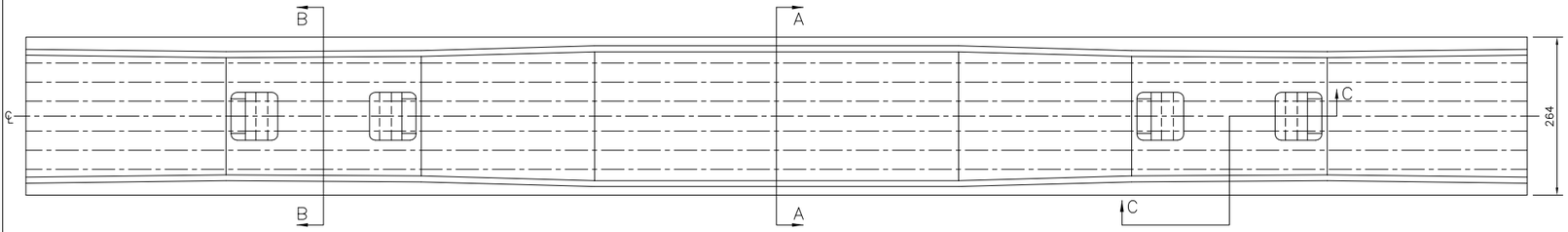
MOD UK RAILWAYS PERMANENT WAY DESIGN AND MAINTENANCE
ANNEX 'J' STANDARD DRAWINGS

DRAWING TITLE
TRACK DETAILS FOR BS 113A RAIL WITH WOOD TIMBERS

DRAWING NUMBER 4608 — A 3



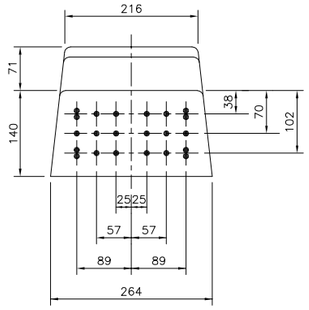
ELEVATION



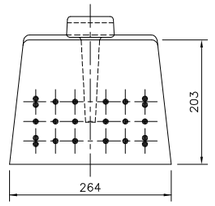
PLAN OF CONCRETE SLEEPER F27

Scale:– 1:10

Note
Details of malleable iron shoulder assembly are reproduced from PANDROL Drg no 1290 (copyright). Pandrol rail fastening components, where specified, are to be obtained from Pandrol Limited.



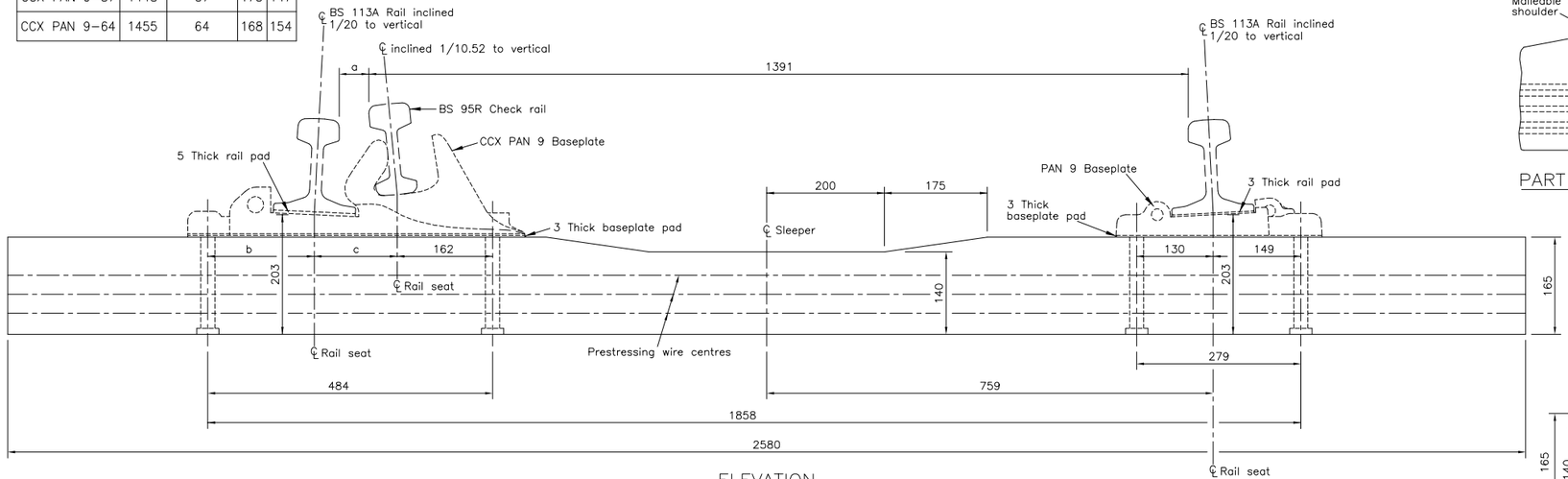
SECTION A–A



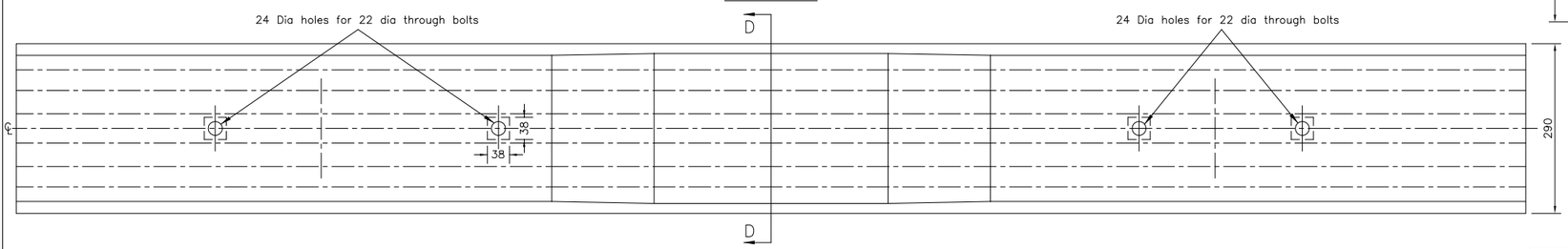
SECTION B–B

SCHEDULE OF BASEPLATES

BASEPLATE	GAUGE	FLANGEWAY a	b	c
CCX PAN 9–51	1442	51	181	141
CCX PAN 9–57	1448	57	175	147
CCX PAN 9–64	1455	64	168	154

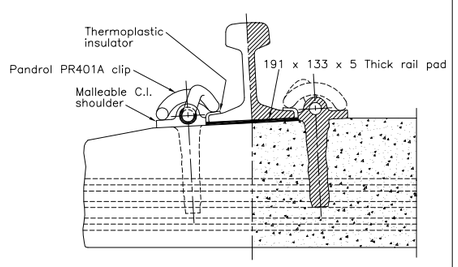


ELEVATION



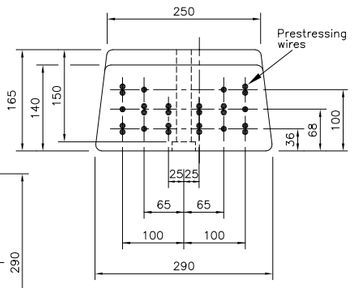
PLAN OF CONCRETE SLEEPER EF30A

Scale:– 1:10



PART ELEVATION / SECTION C–C

Scale:– 1:10



SECTION D–D

DRAWING INFORMATION TAKEN FROM PSA STANDARD DRAWING DCES/RLY/10 (ISSUE A)

NOTES

1. Dimensions are in millimetres unless otherwise stated.
2. The design maximum axle loading for this rail is 22.5 tonnes with sleeper spacing not exceeding 800mm.
3. The following rail sections when specified may also be used with the sleepers and fastenings shown :–

Rail Section	Standard Weight (kg / m)
98 B.R.F.B.	48.56
109 B.R.F.B.	54.00
110A B.R.F.B.	54.44
113 B.R.F.B.	56.30

4. Unless otherwise specified concrete sleepers are to be used only on running lines.
5. Concrete sleepers type F27 are for use on straight track with a standard gauge of 1432 (normally 1435 for DRCS installations).
6. CURVED TRACK
   Concrete sleepers type F27 are suitable for use on curves of not less than 200m radius and with a standard gauge of 1432.
7. Concrete sleepers type EF30A are for use on curves of less than 200m radius and where a check rail is required on sleepered track. Where gauge widening only is required use wood sleepers – see Standard Drawing 4608.
8. Superelevation (cant) to be determined by the designer and in accordance with parameters given in MOD UK Railways Permanent Way Design and Maintenance (MOD UK Rly PW D & M).
9. Minimum radii of curves to be determined by the designer and in accordance with parameters given in MOD UK Rly PW D & M.
10. Curves of 200m radius or less shall be laid with staggered joints to be determined by the designer and in accordance with parameters given in MOD UK Rly PW D & M. On such curves the joints in one rail shall be approxrimately opposite the centre of the other rail length, a closure rail being inserted in the inner rail at the end of the curve. The length of any closure rail shall be not less than 4m.
11. Gauge widening over standard 1435 to be determined by the designer and in accordance with parameters given in MOD UK Rly PW D & M.
12. Gauge widening shall be achieved by :–
    (a) Shortening the radius of curvature of the inner rail
    (b) Building up the gauge widening at the rate of two sleepers with identical CCX PAN9 baseplates for each increment of gauge widening.
    (c) Easing off the gauge widening at the same rate from the end of the curve
13. CCX PAN9 baseplate should be ordered from the manufacturer to suit the gauge widening required eg. CCX PAN9 – 51 for a nominal gauge widening of 7. CCX PAN9 – 51 is outside the normal range of baseplates and must be ordered as a special.
14. Check rails are required on all running lines where the radius of the curve is less than 120m. Check rails are required on all passenger lines where curves of less than 200m are used. Check rails are not required in sidings in sleepered track.

ISSUE	CHANGES	DATE	SIG
1	INITIAL ISSUE	24:05:10	D.C.B.

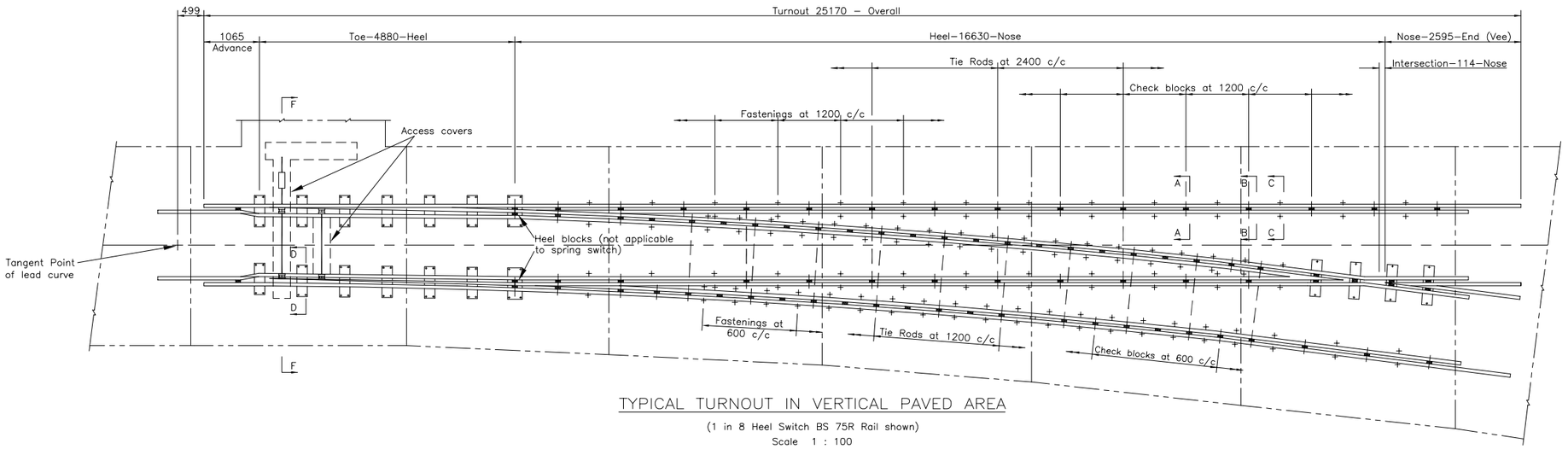
DRCS FILE NUMBER	SCALE	DRAWN BY
4609001S01	As shown	D.C.Belringer

MOD UK RAILWAYS PERMANENT WAY DESIGN AND MAINTENANCE
ANNEX 'J' STANDARD DRAWINGS

DRAWING TITLE
TRACK DETAILS FOR BS 113A RAIL

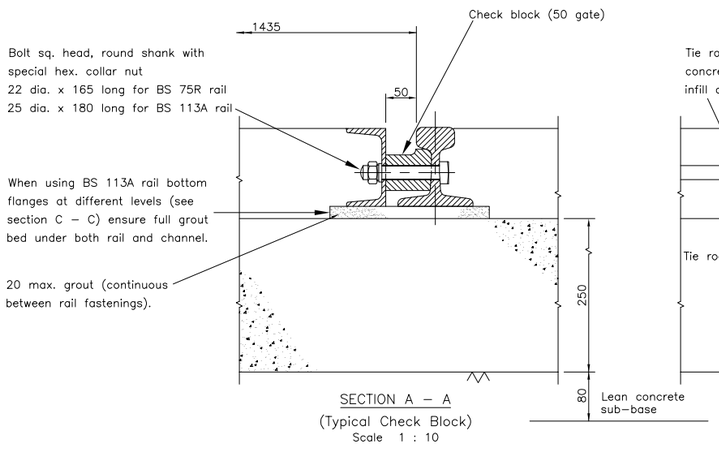
DRAWING NUMBER
4609

A 3

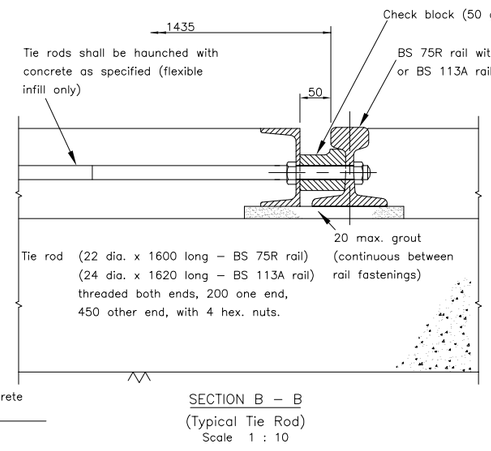


TYPICAL TURNOUT IN VERTICAL PAVED AREA

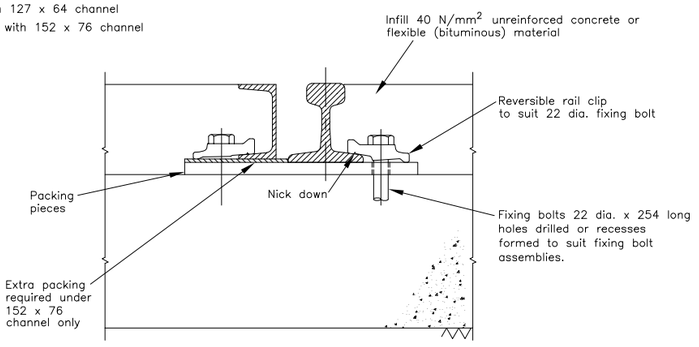
(1 in 8 Heel Switch BS 75R Rail shown)
Scale 1 : 100



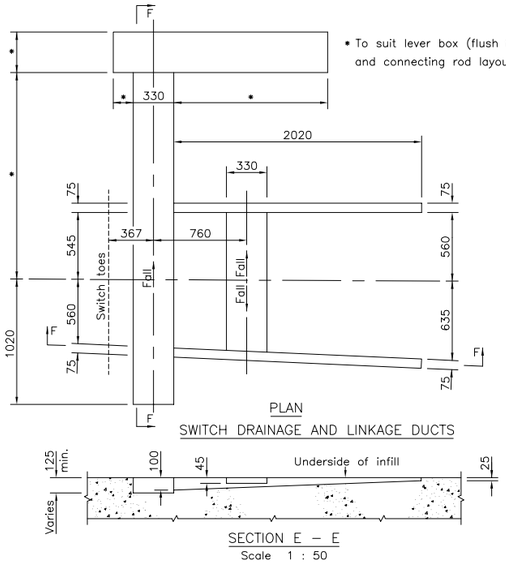
SECTION A – A
(Typical Check Block)
Scale 1 : 10



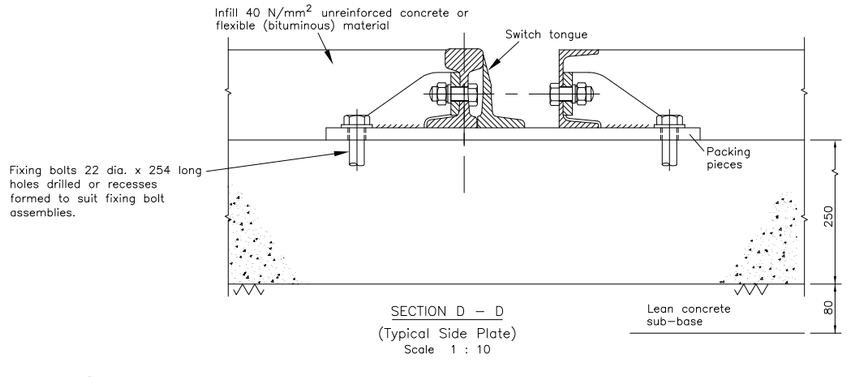
SECTION B – B
(Typical Tie Rod)
Scale 1 : 10



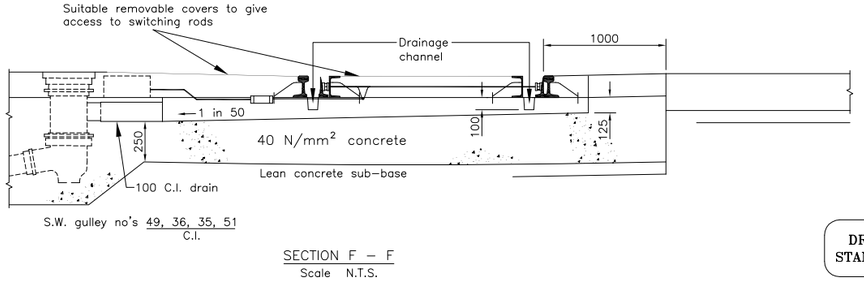
SECTION C – C
(Typical Fastening)
Scale 1 : 10



SECTION E – E
Scale 1 : 50



SECTION D – D
(Typical Side Plate)
Scale 1 : 10



SECTION F – F
Scale N.T.S.

For details of junctions with adjacent pavings in concrete or flexible material see Standard Drawing no. 4605.

DRAWING INFORMATION TAKEN FROM PSA STANDARD DRAWING DCES/RLY/12 (ISSUE A)

NOTES

1. Dimensions are in millimetres unless otherwise stated.
2. This drawing illustrates the arrangement of and modifications to a standard 1 in 8 BV8 turnout for use in paved areas. Modifications similar for other turnouts.
3. This drawing is to be read in conjunction with relevant turnout drawing. For BS 75R rail, heel switches to be used (see Standard Drawing no. 4606).
   For BS 113A rail, spring switches to be used (see Standard Drawing no. 4607).
   The turned dimensions are typical and minor variations arising from different manufacturers may occur.
4. The layout details (excluding setting out data) are intended as a basis for inviting quotations from manufacturers. The manufacturer's working drawings will be used for construction of the turnout.
5. When ordering the turnout :–
   (a) Specify section of rail BS 113A or BS 75R for new works unless otherwise specified.
   (b) Specify whether left or right hand turnouts are required.
   (c) Specify radius of curve, if any, out of turnout.
   (d) Specify turnouts of vertical design.
6. CONSTRUCTION
   (a) Holes drilled or recesses formed to accommodate fixing bolt assemblies for rail fixings to be in accordance with the bolt manufacturer's instructions.
   (b) Tie rods, fastenings, and check blocks to be staggered as shown on plan.
   (c) Fish bolts through fish plates to be fixed so that the nut is located in the flangeway.
   (d) Rails to be laid and adjusted to the correct gauge and alignment and then brought up to the required level by use of packing pieces spanning the full width of both running and check rail flanges.
   (e) Rails to be supported on a solid bed over the entire length and width of flange.
   (f) Packing pieces for adjusting rail levels shall be steel or other approved material.
   (g) Refer to Standard Drawings no. 4604 & 4605 for approved methods of fastening down rail and for hard–standing details.
   (h) A final check shall be made of gauge alignment and fastenings, and any adjustments made before infill shall be laid.

ISSUE	CHANGES	DATE	SIG
1	INITIAL ISSUE	24:05:10	D.C.B.

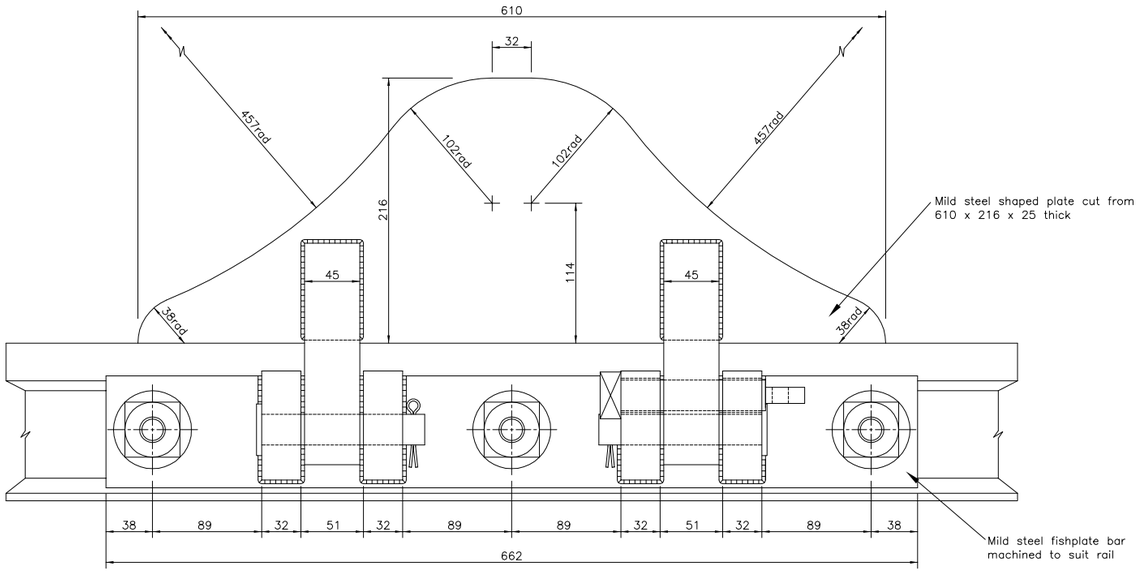
DRCS FILE NUMBER	SCALE	DRAWN BY
4610001S01	As shown	D.C.Belringer

MOD UK RAILWAYS PERMANENT WAY DESIGN AND MAINTENANCE ANNEX 'J' STANDARD DRAWINGS

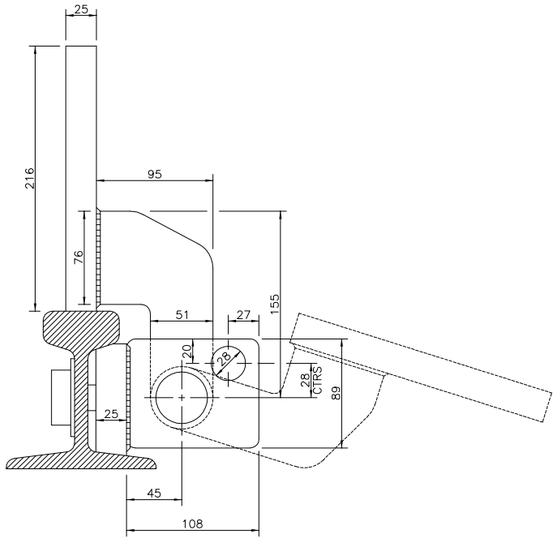
DRAWING TITLE
TRACK DETAILS IN PAVED AREAS BS 75R OR BS 113A RAIL

DRAWING NUMBER
4610

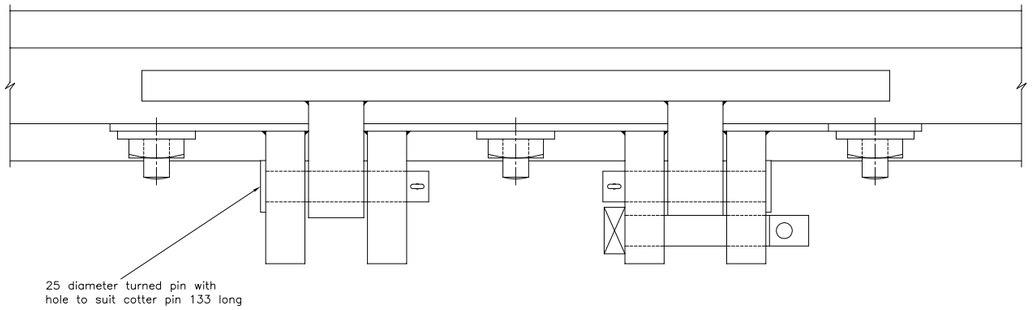
A 3



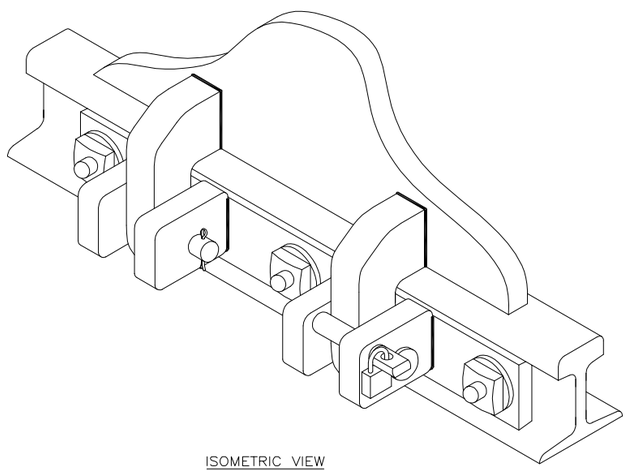
ELEVATION



ARRANGEMENT TO SUIT BS 75R RAIL

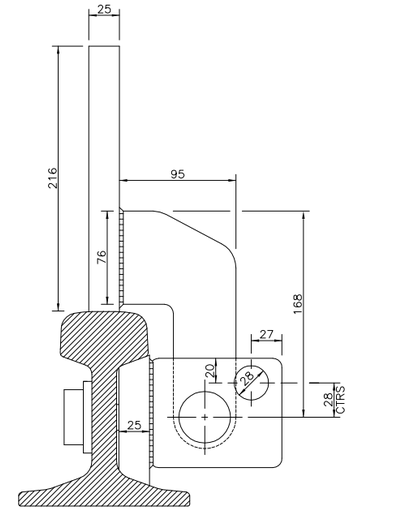


PLAN

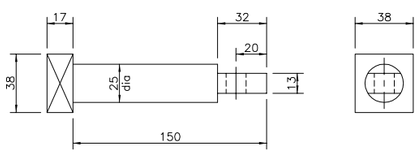


ISOMETRIC VIEW

Scale N.T.S.



ALTERNATIVE ARRANGEMENT FOR BS 113A RAIL



RETAINING BOLT

NOTES

1. Dimensions are in millimetres unless otherwise stated.
2. Wheel Stops can only be authorised and sited by the appropriate Railway Operating Authority.
3. For sections of rail other than as shown, the profile of the wheel stop must be retained but other dimensions altered to suit. This profile is not suitable for narrow gauge rolling stock.
4. When ordering wheel stops accurate rail dimensions must be provided of the particular rails where the stops are to be fitted.
5. Compliance with this drawing is mandatory for all MOD standard gauge railways where wheel stops are required on sleepered track. For wheel stops in paved areas see Standard Drawing 4518 (also mandatory drawing).

DRAWING INFORMATION TAKEN FROM PSA STANDARD DRAWING DCES/RLY/13 (ISSUE A)

ISSUE	CHANGES	DATE	SIG
1	INITIAL ISSUE	24:05:10	D.C.B.

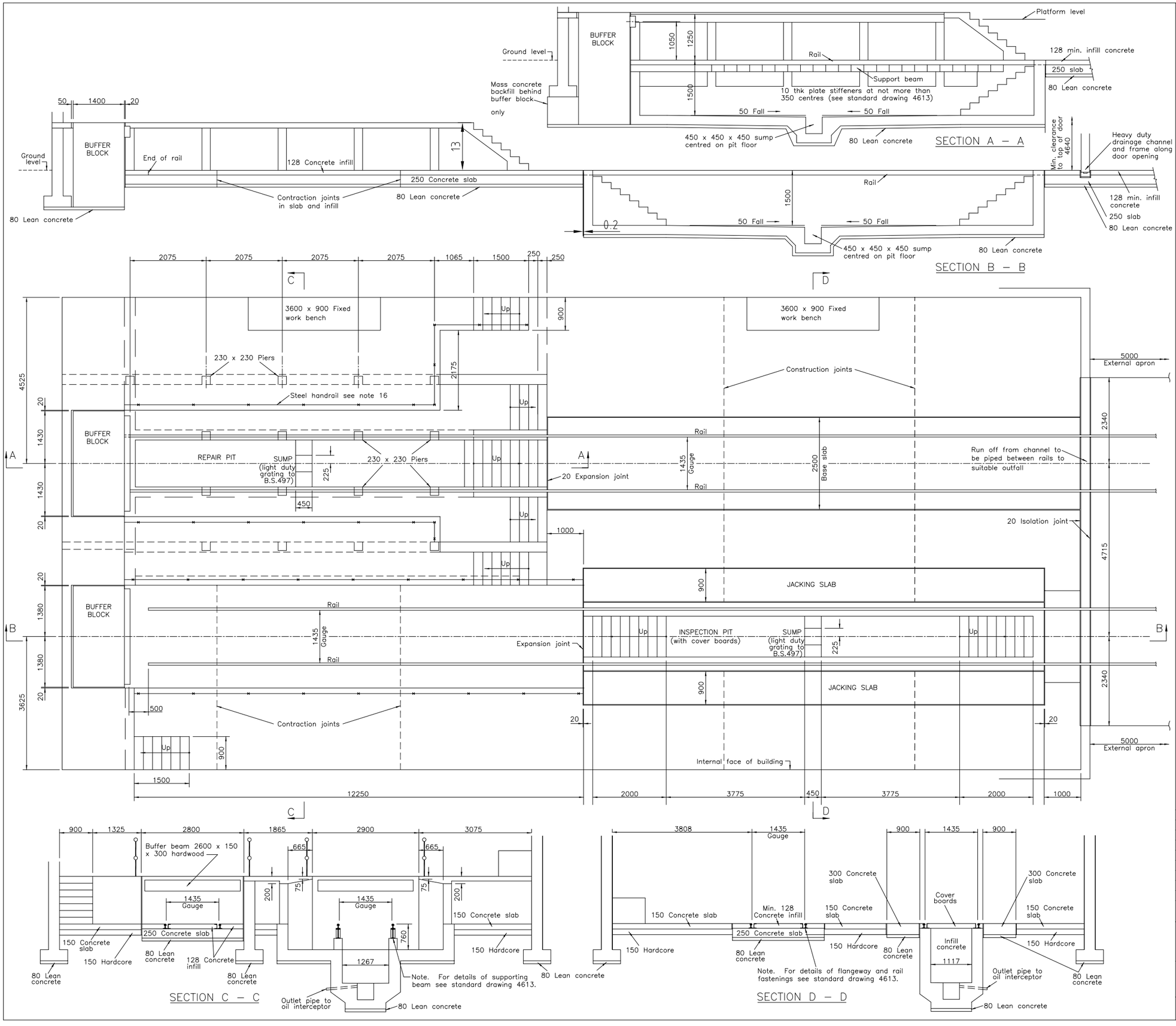
DRCS FILE NUMBER 4611001S01 | SCALE 1 : 5 OR N.T.S. | DRAWN BY *D.C.Belringer*

MOD UK RAILWAYS PERMANENT WAY DESIGN AND MAINTENANCE ANNEX 'J' STANDARD DRAWINGS

DRAWING TITLE

RAIL WHEEL STOP HINGED AND LOCKED

DRAWING NUMBER 4611 | A 3



NOTES

1. All dimensions are in millimetres.
2. This drawing to be read in conjunction with Standard drawing 4613.
3. The standard lengths for repair pits and inspection pits are 9200 and 8000 respectively. It should be verified with the client that these dimensions are appropriate for the rolling stock to be accommodated.
4. External walls behind buffer blocks should not have structural supports within them. These sections of walls should be capable of demolition without affecting the stability of the rest of the building.
5. Details shown are for a 4 or 3 locomotive shed. Where only 2 or 1 locomotive to be housed, a single track shed may be provided with either a three level repair pit or an inspection pit at the inner end. When modifying the layout, dimensions relating to pit and platform widths, heights and clearances must be maintained.
6. Sumps to drain to external manhole with oil interceptor.
7. All floors and platforms to be finished with an approved non–skid epoxy surface.
8. Washdown area to be constructed in continuation of the external apron, and of same construction, centrally across one track 6500 wide x length to be determined by the designer. Surface to be flush with level rails, with falls not less than 1:200 between and away from rails to gullies. Oil and detergent interception to be provided at a suitable point. Standpipe, fully protected from frost, to be sited clear of structure gauge (see Standard drawing 4601).
9. Storeroom, office, lockers, rest room, toilets and washing facilities will be required to suit particular needs.
10. Emergency escape door(s) to be provided off platform through end or side walls with steps to ground level, where necessary.
11. Main doors to be, powered roller shutter type with manual operation, one per railway track. Separate personnel door(s) as required in end or side walls. Access to offices should be possible from outside the main shed. All doors to be draught proofed.
12. Fuel storage tanks should be installed outside the shed, capable of holding one months supply of fuel for each locomotive, normally 2750 litres (600 gallons) per loco.
13. Heating to be determined by the designer. Local heating in working areas, may be necessary. Heating in pits to be recessed. Ventilation by extractor fans, capable of being reversed, sited on gable end walls on each track.
14. Lighting to be determined by the designer, for the pits and other working areas. Wall mounted battery chargers (24 x 35A) will be required adjacent to inspection pit, with leads to locomotive batteries. Power points (110V) to be spaced maximum of 7m (metre) intervals mounted on walls at normal working height, staggered on opposite walls. A minimum of 3 power points are required on each working platform and inside each pit wall.
15. Gantry crane (SWL 3 Tons) capable of serving all parts of the building to be provided. Maximum hook clearance when fully retracted to suit rolling stock heights. Crane to be electrically operated.
16. Steel handrail 1000 high, uprights at 1500 centres shown thus:–
    Fixed
    Detachable
17. Superstructure, foundation and R C details to be determined by the designer for each project.

DRAWING INFORMATION TAKEN FROM PSA STANDARD DRAWING DCES/RLY/14 (ISSUE A)

ISSUE	CHANGES	DATE	SIG
1	INITIAL ISSUE	24:05:10	D.C.B.

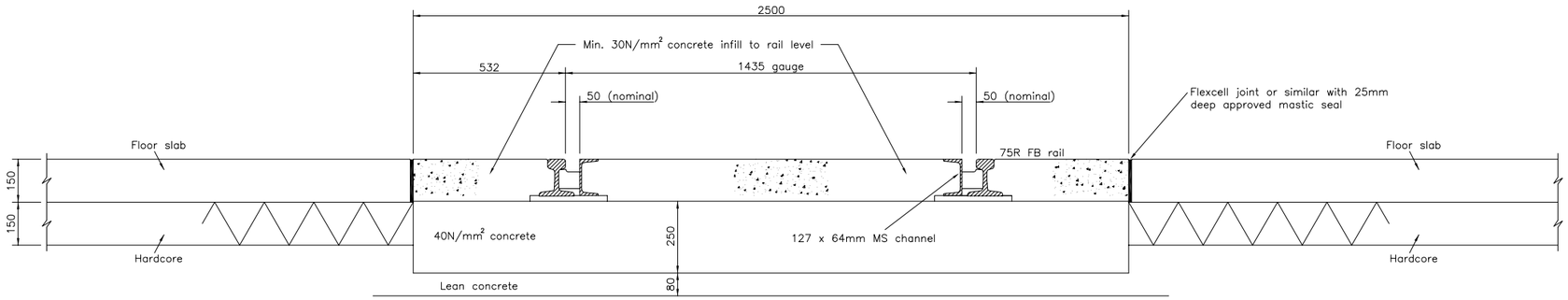
DRCS FILE NUMBER 4612001S01 | SCALE 1 : 100 | DRAWN BY *D.C.Belringer*

MOD UK RAILWAYS PERMANENT WAY DESIGN AND MAINTENANCE ANNEX 'J' STANDARD DRAWINGS

DRAWING TITLE

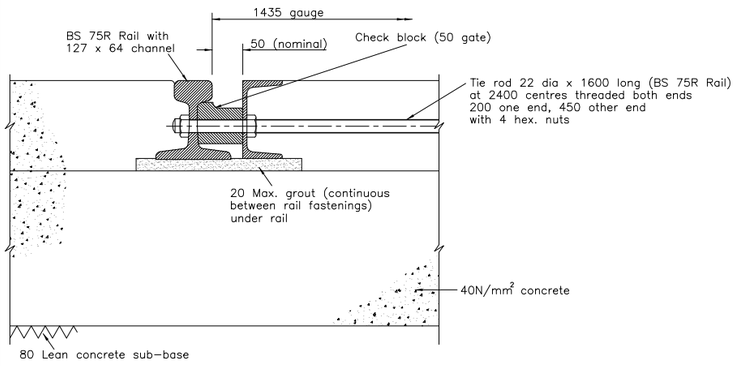
LOCOMOTIVE SHED 2 TRACK – 4 LOCOS BS 75R RAIL

DRAWING NUMBER 4612 | A 3



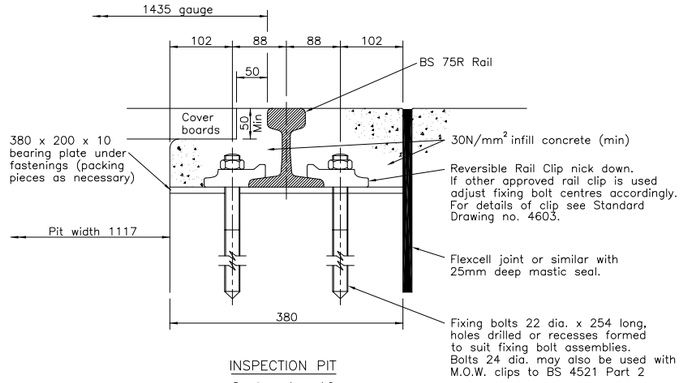
SECTION THROUGH PLAIN TRACK

Scale 1 : 20



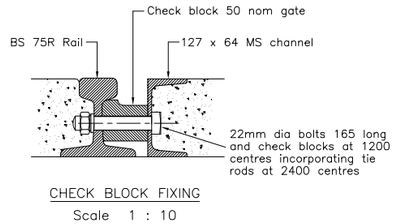
TYPICAL TIE ROD AND CHECK BLOCK

Scale 1 : 10



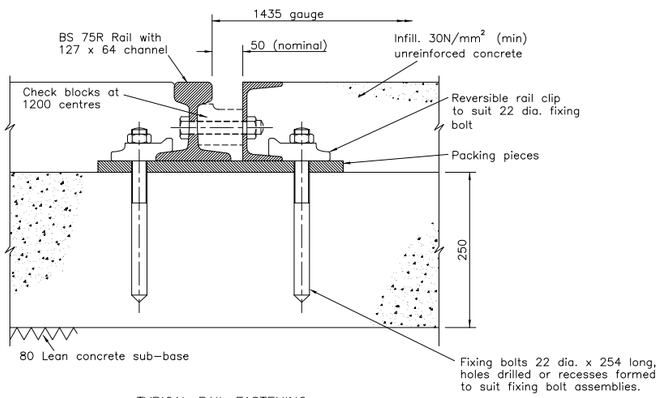
INSPECTION PIT

Scale 1 : 10



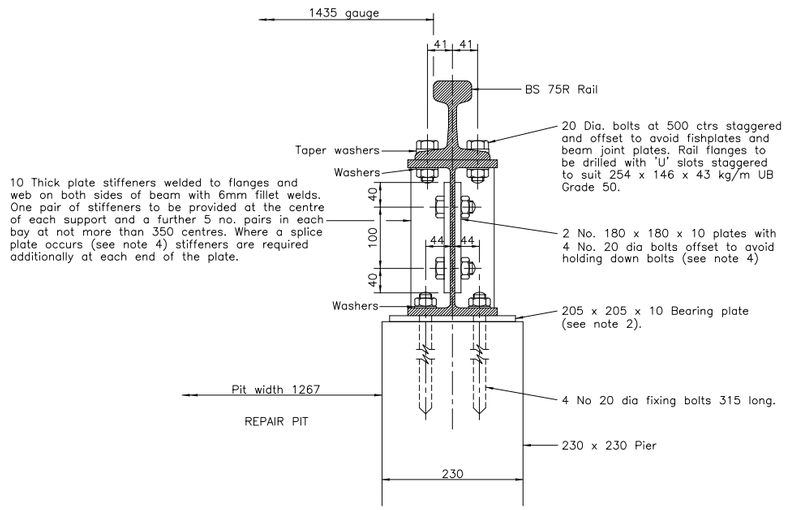
CHECK BLOCK FIXING

Scale 1 : 10



TYPICAL RAIL FASTENING

Scale 1 : 10



DETAILS OF REPAIR PIT

RAIL FASTENINGS AND SUPPORT BEAM

Scale 1 : 10

NOTES

1. All dimensions are in millimetres.
2. Packing of beam supports in repair pit, where required, shall comprise shims 205 x 205 to a maximum thickness of 6mm.
3. Shims shall be steel or other equal or approved material.
4. Joints in the Universal Beam shall be located over pier supports and kept to a minimum.
5. This drawing to be read in conjunction with Standard Drawing no. 4604.

DRAWING INFORMATION TAKEN FROM PSA STANDARD DRAWING DCES/RLY/15 (ISSUE A)

ISSUE	CHANGES	DATE	SIG
1	INITIAL ISSUE	24:05:10	D.C.B.

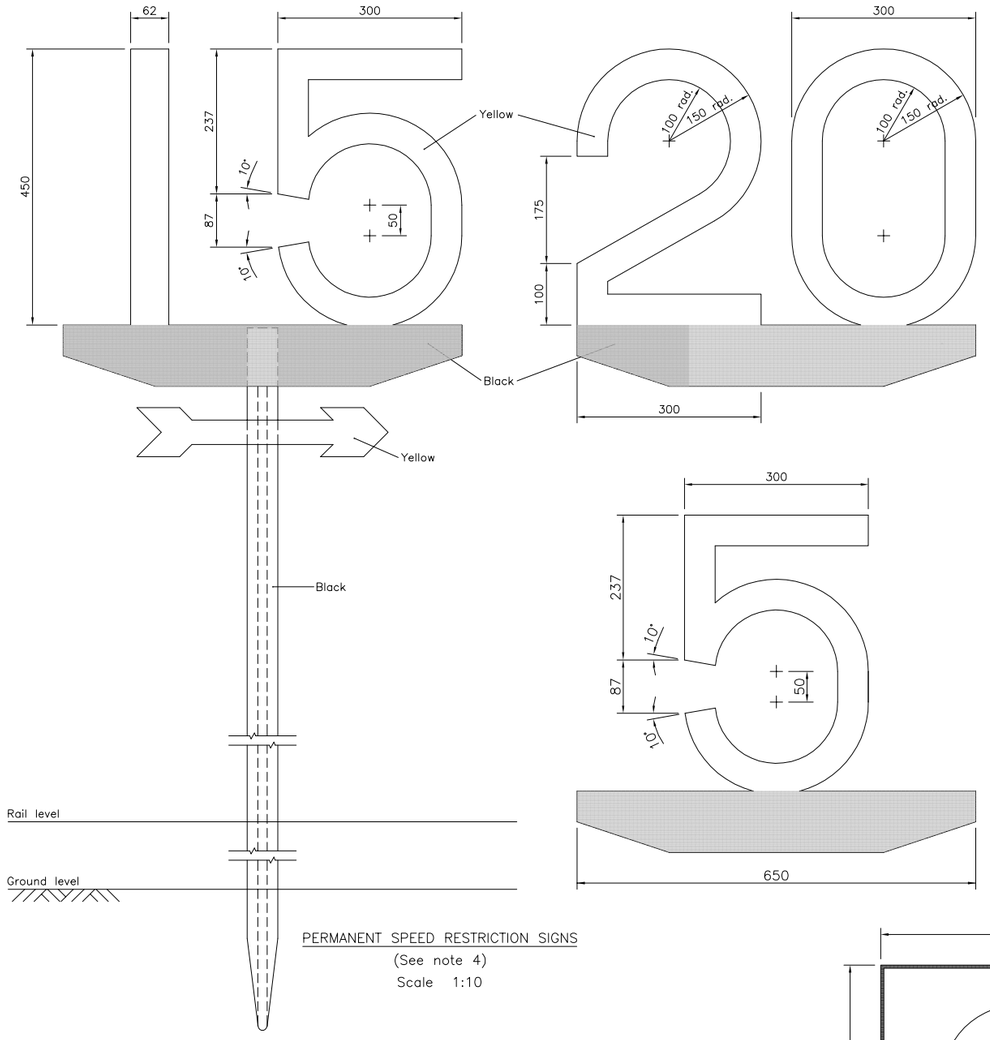
DRCS FILE NUMBER	SCALE	DRAWN BY
4613001S01	1 : 10 & 1 : 20	D.C.Belringer

MOD UK RAILWAYS PERMANENT WAY DESIGN AND MAINTENANCE ANNEX 'J' STANDARD DRAWINGS

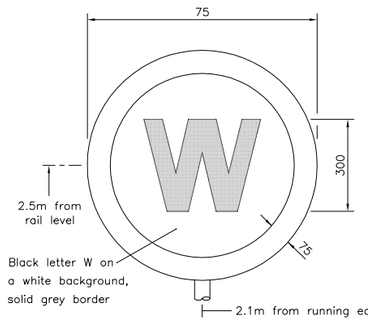
DRAWING TITLE

LOCOMOTIVE SHED TYPICAL DETAILS

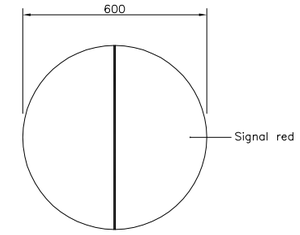
DRAWING NUMBER 4613 A3



PERMANENT SPEED RESTRICTION SIGNS
(See note 4)
Scale 1:10



WHISTLE BOARD (RIR 056/115981)
Scale 1:20



TARGET BOARD FOR GATES
(RIR 056/68402 (HALF BOARD))
(See diagram below)
Scale 1:20

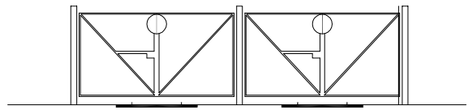
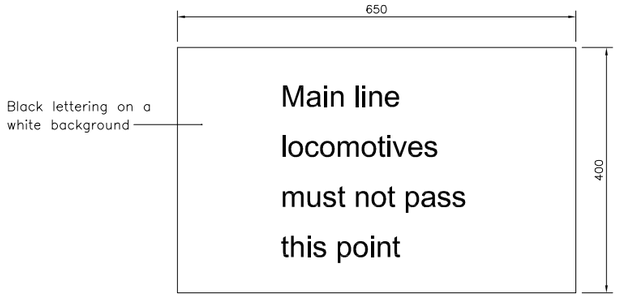
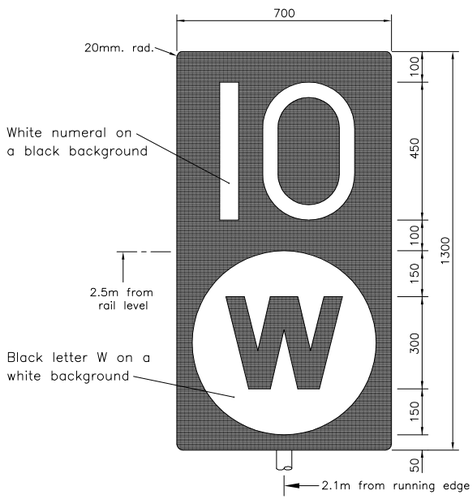


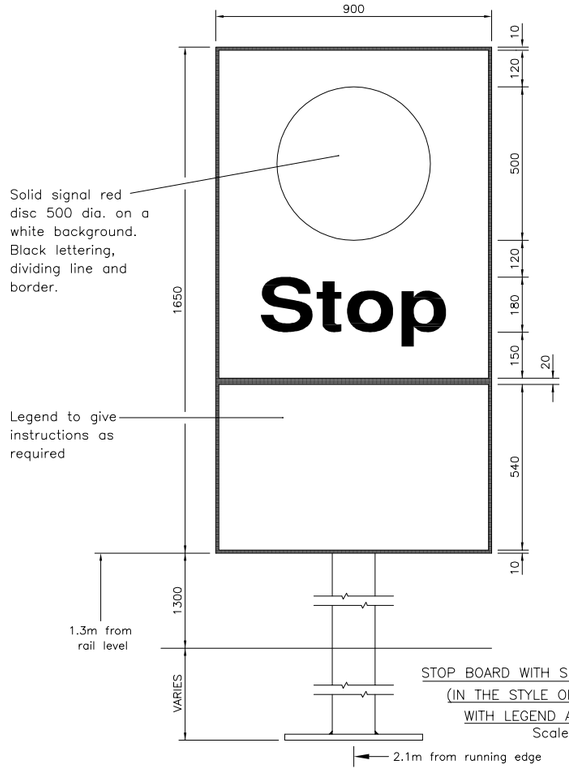
DIAGRAM SHOWING POSITION OF TARGET BOARDS
NOTE: TARGET BOARDS ON BOTH FACES OF GATES



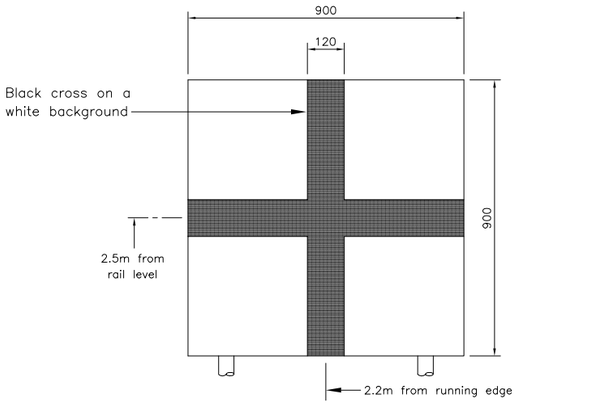
RESTRICTION SIGN (Scale 1:10)



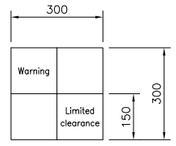
COMBINED SPEED RESTRICTION / WHISTLE SIGN (Scale 1:20)



STOP BOARD WITH SUPPLEMENTARY NOTICE
(IN THE STYLE OF RIR 056/115866
WITH LEGEND AS APPROPRIATE)
Scale 1:20



ADVANCE WARNING BOARD FOR OPEN CROSSINGS (RIR 056/115046)
(Scale 1:20)



Red letters on a white background with red quarters

LIMITED CLEARANCE SIGN (RIR 056/113380) (Scale 1:20)

DRAWING INFORMATION TAKEN FROM PSA STANDARD DRAWING DCES/RLY/16 (ISSUE A)

NOTES

1. This drawing refers only to sign posting relating to rail traffic.
2. These signs must be authorised and sited by the Ministry of Defence Railway Engineer (MOD RE) or other railway operating authority concerned.
3. These signs generally conform to Network Rail practice. Unless otherwise stated the reference numbers of signs are those of NR information sheets.
4. Post foundation details for Stop, Advance warning and Whistle Boards etc are shown on Standard Drawing 4615.
5. General advice on these signs is available from the MOD RE.
6. All dimensions are in millimetres unless otherwise stated.
7. MANDATORY DRAWING
   Compliance with this drawing is mandatory for all MOD standard gauge railways.
8. The abbreviation RIR represents the Railway Industry Reference (no).

ISSUE	CHANGES	DATE	SIG
1	INITIAL ISSUE	24:05:10	D.C.B.

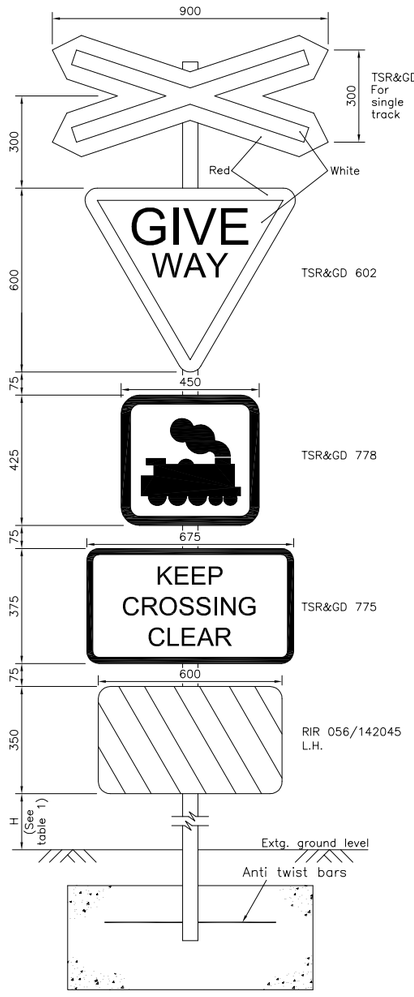
DRCS FILE NUMBER	SCALE	DRAWN BY
4614001S01	1 : 10 & 1 : 20	D.C.Belringer

MOD UK RAILWAYS PERMANENT WAY DESIGN AND MAINTENANCE ANNEX 'J' STANDARD DRAWINGS

DRAWING TITLE

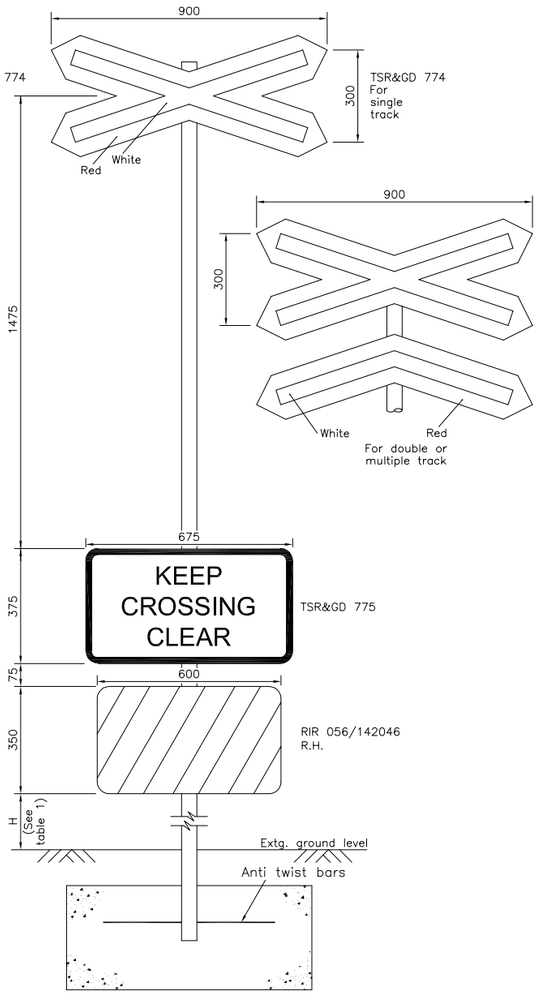
RAILWAY TRACK SIGNAGE

DRAWING NUMBER 4614 — A3



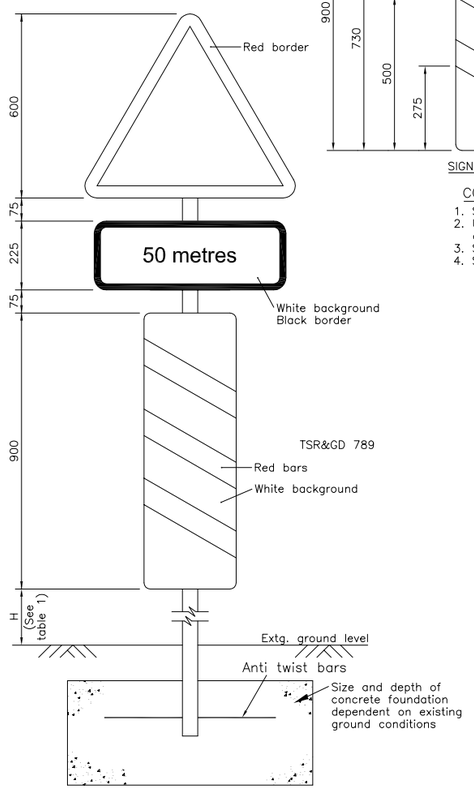
NEARSIDE COMBINATION SIGN TSR&GD 774, TSR&GD 602, TSR&GD 778, TSR&GD 775, RIR 056/142045

1. Sited on all approaches to open level crossings in line with Give Way line but not less than 1.625m. from the nearest running rail to the extremity of the sign



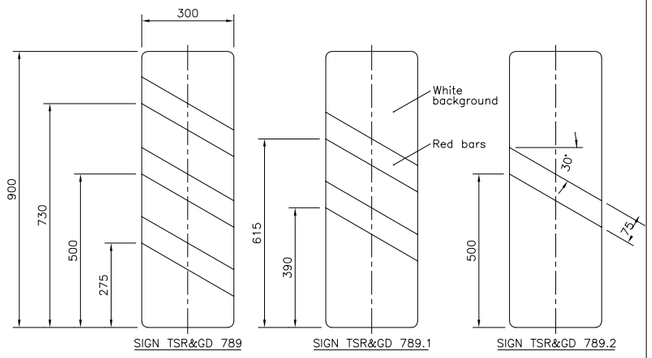
OFFSIDE COMBINATION SIGN TSR&GD 774, TSR&GD 775, RIR 056/142045

1. Used to define crossing limits.
2. Siting conditions as for Nearside Combination Sign.



CONCEALED CROSSING SIGN TSR&GD 770 or TSR&GD 771, TSR&GD 572, TSR&GD 789

1. Signs TSR&GD 770, TSR&GD 572 & TSR&GD 789 used where visibility of gated crossing is less than 45m. To be sited more than 45m. from crossing.
2. Signs TSR&GD 771, TSR&GD 572 & TSR&GD 789 used where visibility of Combination sign is less than 45m. To be sited more than 45m. from crossing.
3. To be visible from at least 60m.



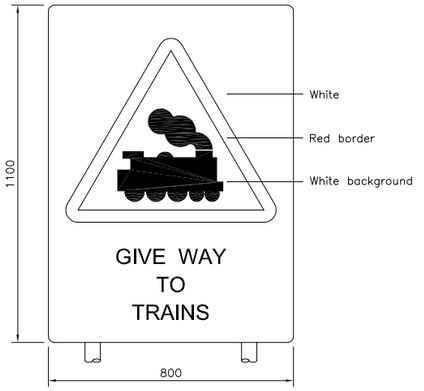
CONCEALED LEVEL CROSSING AHEAD – COUNTDOWN SIGNS

1. Signs used only where level crossing is obscured.
2. Underside of signs TSR&GD 789.1 and TSR&GD 789.2 placed 300mm. from existing ground level.
3. Signs illustrated for nearside siting. For offside siting reverse slope of bars.
4. Signs sited as follows :–

TABLE 4

Distance from level crossing	Sign used
L	TSR&GD 789
2/3 L	TSR&GD 789.1
1/3 L	TSR&GD 789.2

See note 5

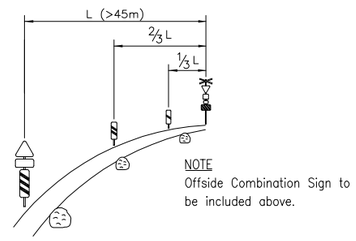


GENERAL WARNING SIGN

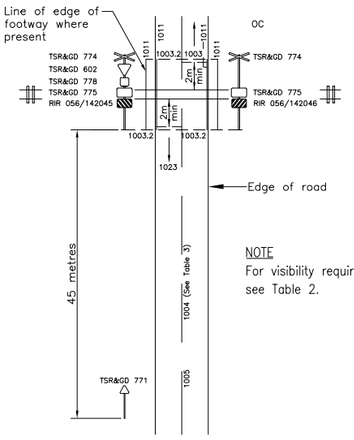
1. Signs typically at entrances to Establishments where rail network is in hardstanding and the pattern of road / rail traffic would otherwise require multiplicity of warning signs.

NOTES

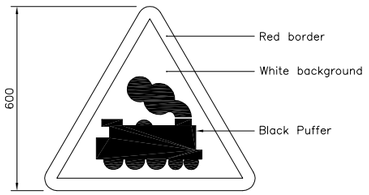
1. All dimensions are in millimetres unless otherwise stated.
2. This drawing refers only to sign posting of the railway level crossings that are situated within the boundaries of MOD depots.
3. Unless otherwise stated the reference numbers of signs and road markings correspond to those given in the Traffic Signs Regulations and General Directions 1981 and amendments, if any.
4. For open crossings, signs should be sited wherever possible as shown in note 8 below. Thee should be a minimum clearance of 500mm. between the edge of the roadway and the nearest part of the sign.
5. Example of concealed open level crossing.



8. Example of layout for an open crossing (OC) ie without traffic lights or gates.

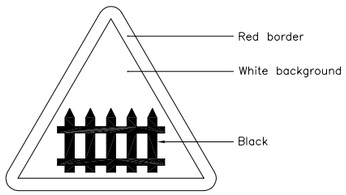


9. Compliance with this Drawing is mandatory for all MOD standard gauge railways.
10. The abbreviation TSR&GD represents the Traffic Sign Regulations & General Directions 2002 (no).
10. The abbreviation RIR represents the Railway Industry Reference (no).



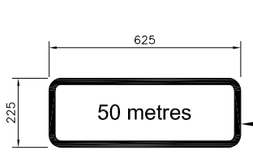
PUFFER SIGN TSR&GD 771

1. Sited at 45m. from all open level crossings unless visibility of Combination sign is less than 45m.
2. Incorporated in Concealed crossing sign where visibility of Combination sign is less than 45m.
3. To be visible from at least 60m.
4. Distances assume that a speed limit of 25 m.p.h. is in operation on the road.



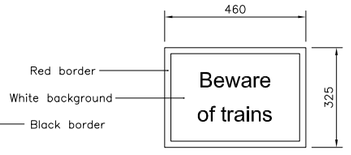
SIGN TSR&GD 770

1. Sited at 45m. from all gated crossings unless visibility of Combination sign is less than 45m.
2. Incorporated in Concealed crossing sign where visibility of Combination sign is less than 45m.
3. To be visible from at least 60m.
4. Distances assume that a speed limit of 25 m.p.h. is in operation on the road.



SIGN TSR&GD 572

1. Used only where level crossing is obscured.
2. Distance from level crossing shown in metres to nearest 10 metres.



WARNING NOTICE

Alternative to General Warning Sign
(a) Manufactured to Network Rail Standards
(b) Sited in accordance with Network Rail practice.
(c) May be used only where main line trains operate.

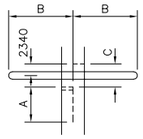
TABLE 1 Mounting heights of signs (to underside of lowest sign)

Combination of signs	H	
	a	b
TSR&GD 774, TSR&GD602, TSR&GD 778, TSR&GD 775, RIR 056/142045	900	2100
TSR&GD 774, TSR&GD 775, RIR 056/142045	900	2100
TSR&GD 771 or TSR&GD 770	1500	2100
TSR&GD 771, TSR&GD 572, TSR&GD 789	300	–
TSR&GD 770, TSR&GD 572, TSR&GD 789	300	–

a = height above highest point of road
b = height above highest point of footway (if sign overhangs)

TABLE 2 Recommended visibility at open crossings

Dist. A (metres) from Give Way line	Dist. B (metres) for crossing length C of		
	7m	14m	21m
2	140	45	55
10	40	14m	21m
20	25	30	35
40	20	25	30



Viewing zones defined by A and B to be unobstructed apart from minor objects

TABLE 3 Centre line road markings for open crossings

Carriageway width (metres)	Road markings (see note 4)	Length of marking on each side of crossing (metres)	Description of marking
< 5.0	None	—	—
5.0 to under 5.5	1004	15	Broken lines 4000 x 100
5.5 to 7.3	1013.1 See note	30	Double solid lines between Give Way markings and Solid/broken lines beyond
> 7.3	1013.1 See note	45	

NOTE

(1013.1 markings) The double solid lines may be extended beyond the Give Way markings if visibility is restricted on an approach. Otherwise the markings on each side of the crossing (third column) shall be the alternative 1013.1. ie solid line with broken line on it's iffside.

DRAWING INFORMATION TAKEN FROM PSA STANDARD DRAWING DCES/RLY/17 (ISSUE A)

ISSUE	CHANGES	DATE	SIG
1	INITIAL ISSUE	24:05:10	D.C.B.

DRCS FILE NUMBER 4615001S01 | SCALE 1 : 20 | DRAWN BY D.C.Belringer

MOD UK RAILWAYS PERMANENT WAY DESIGN AND MAINTENANCE ANNEX 'J' STANDARD DRAWINGS

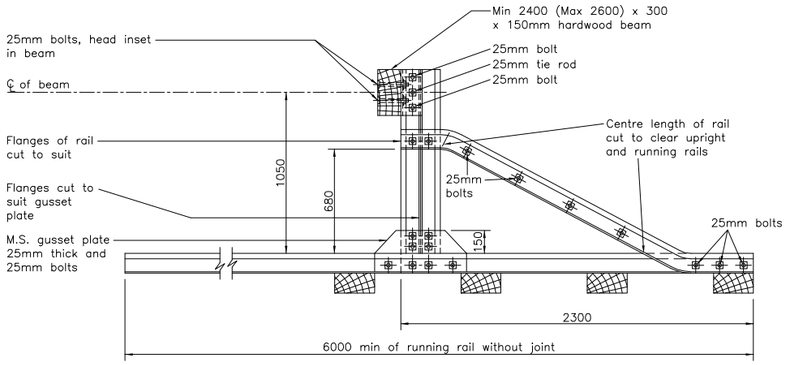
DRAWING TITLE

ROAD SIGNS FOR RAILWAY LEVEL CROSSINGS

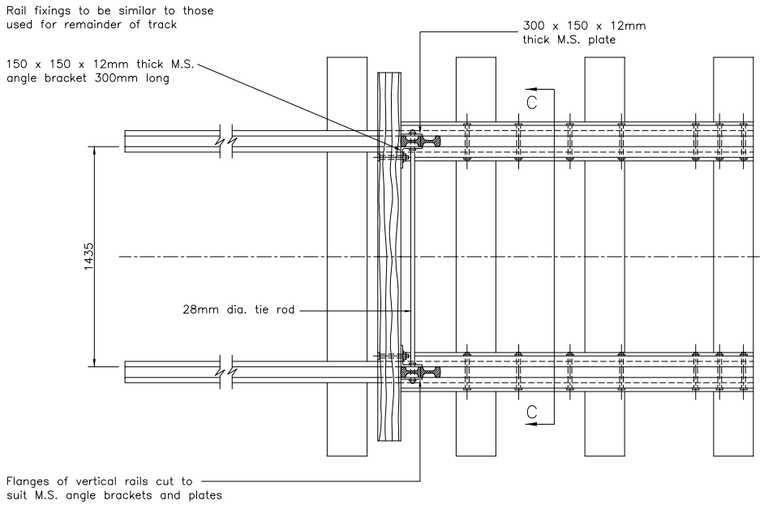
DRAWING NUMBER 4615 | A3

ALL FB RAIL BUFFER STOP

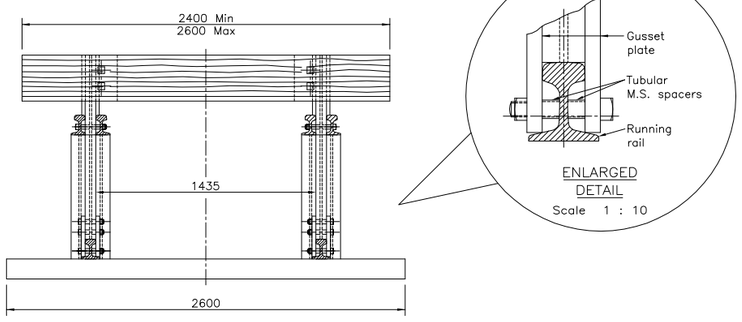
Scale 1 : 40



SIDE ELEVATION



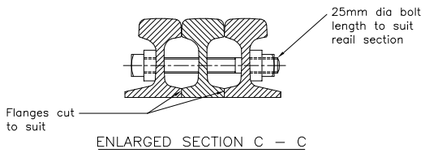
PLAN



FRONT ELEVATION

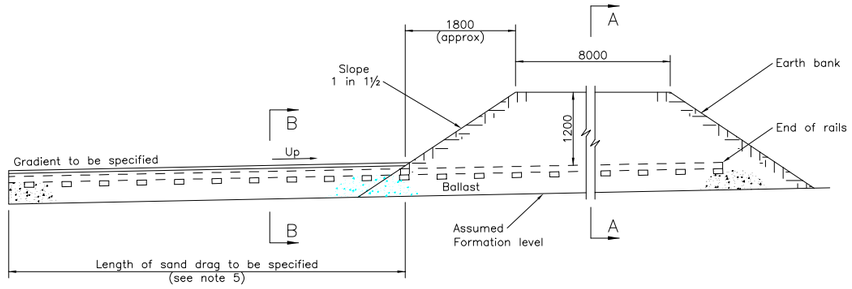
ENLARGED DETAIL

Scale 1 : 10



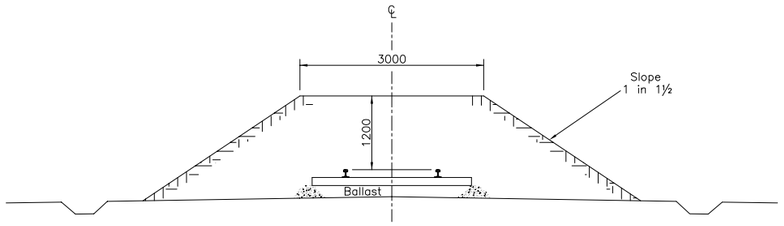
ENLARGED SECTION C – C

Scale 1 : 10



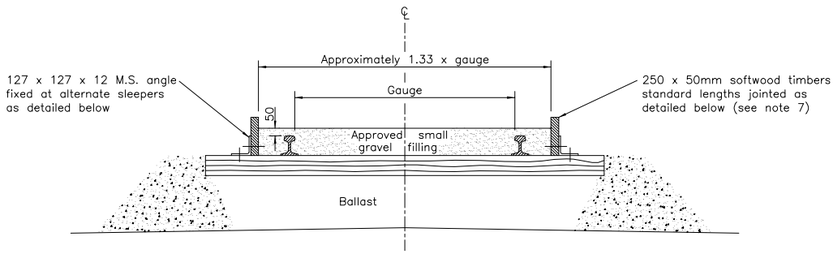
LONGITUDINAL SECTION

Scale 1 : 100



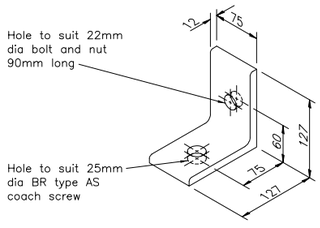
CROSS SECTION A – A

Scale 1 : 100



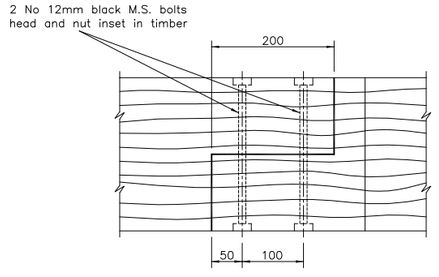
ENLARGED CROSS SECTION B – B

Scale 1 : 40



M.S. ANGLE DETAIL

Scale 1 : 10



TIMBER JOINT DETAIL

Scale 1 : 10

DRAWING INFORMATION TAKEN FROM PSA STANDARD DRAWING DCES/RLY/18 (ISSUE A)

NOTES

1. All dimensions are in millimetres.
2. The buffer stop has been shown as constructed from flat bottom rail. Other rail sections may be used with appropriate adjustments to detail.
3. (a) Material for filling a sand drag track shall be an approved coarse sand or fine gravel about 2 – 6mm particle size, heavy enough to resist become airborne.
   (b) The filling material shall be compacted in position by light rolling and both this and the earth bank maintained at the depths shown.
4. The retaining timbers shall be impregnated with coal tar creosote to BS 144 applied in accordance with BS 913.
5. The site for a 'sand drag' shall be carefully selected, it should preferably be constructed with a rising gradient and with a length appropriate to the circumstances. 12 metres is a usual length.
6. 'Sand drags' can only be authorised and sited by the Ministry of Defence Railway Engineer (MOD RE).
7. As an alternative to softwood retaining timbers, rail sections of appropriate size may be used, if the running line is light enough to result in 50mm cover of sand over the rail head.
8. Enquiries concerning this drawing or requests for additional specifications should be addressed to the MOD RE.

ISSUE	CHANGES	DATE	SIG
1	INITIAL ISSUE	24:05:10	D.C.B.

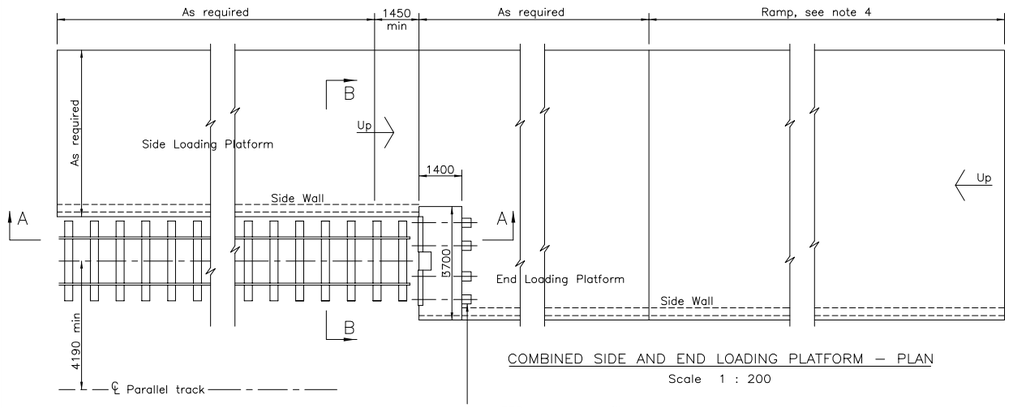
DRCS FILE NUMBER	SCALE	DRAWN BY
4616001S01	As shown	D.C.Belringer

MOD UK RAILWAYS PERMANENT WAY DESIGN AND MAINTENANCE ANNEX 'J' STANDARD DRAWINGS

DRAWING TITLE

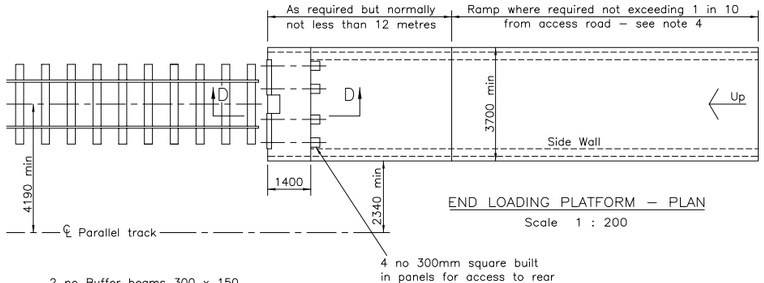
DETAILS OF RAIL BUFFER STOP AND SAND DRAG

DRAWING NUMBER 4616 — A3



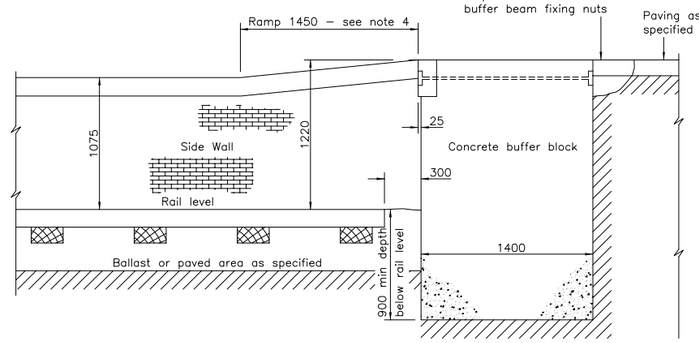
COMBINED SIDE AND END LOADING PLATFORM – PLAN

Scale 1 : 200



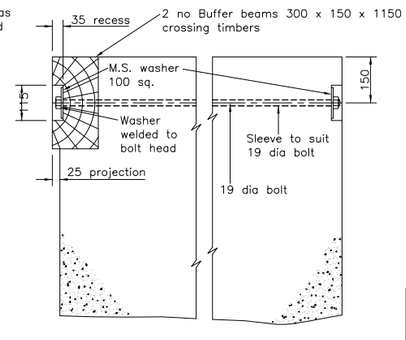
END LOADING PLATFORM – PLAN

Scale 1 : 200



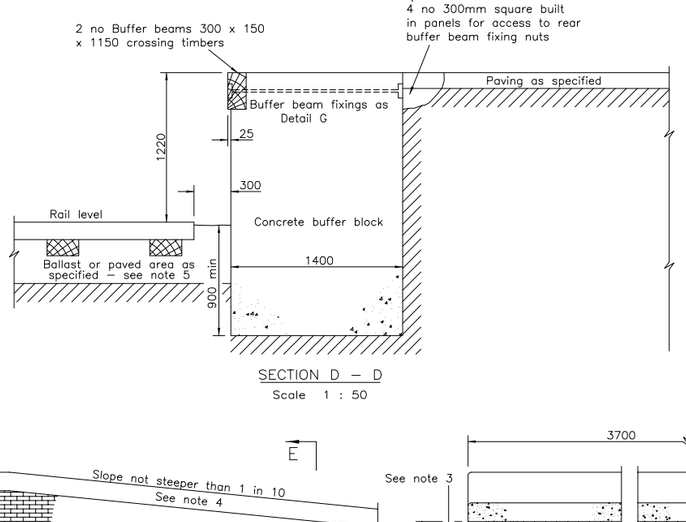
SECTION A – A

Scale 1 : 50



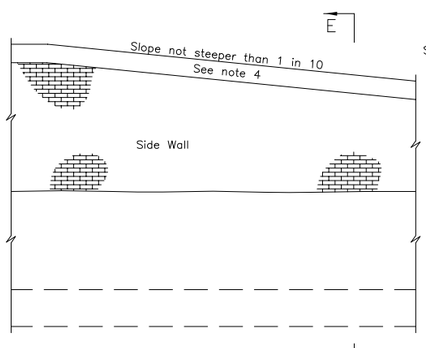
BUFFER BEAM DETAIL G

Scale 1 : 20



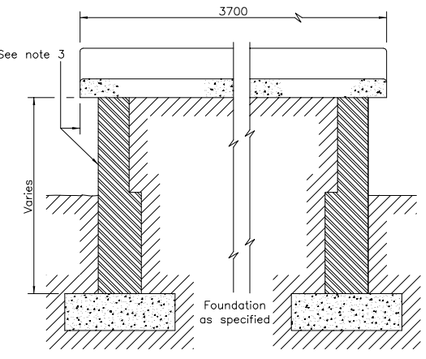
SECTION D – D

Scale 1 : 50



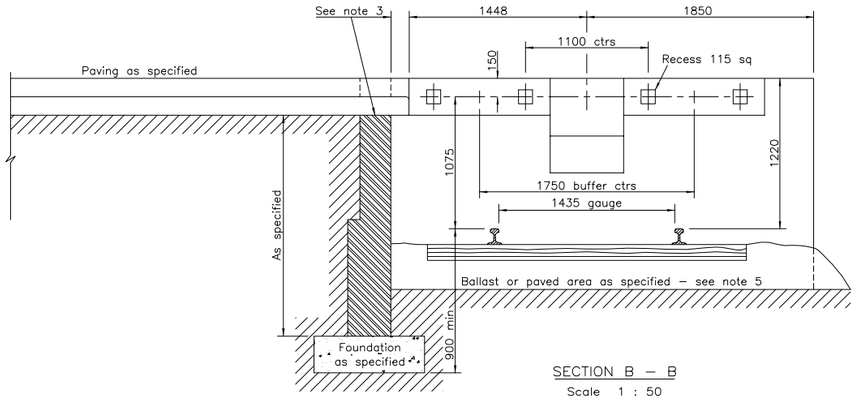
ELEVATION RAMP TO PLATFORM

Scale 1 : 50



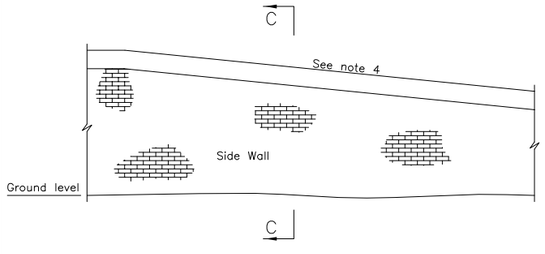
SECTION E – E

Scale 1 : 50



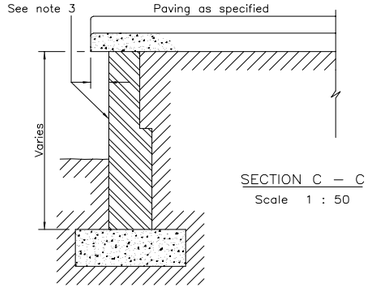
SECTION B – B

Scale 1 : 50



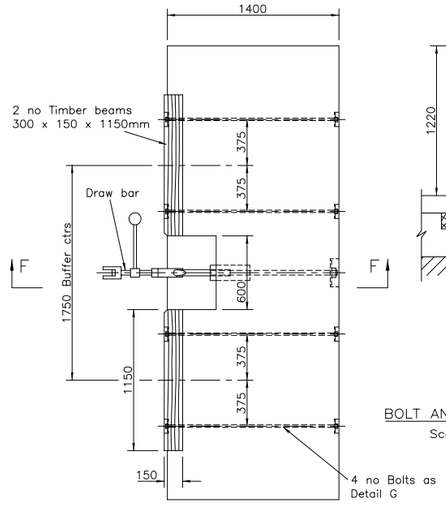
ELEVATION RAMP TO END LOADING PLATFORM

Scale 1 : 50

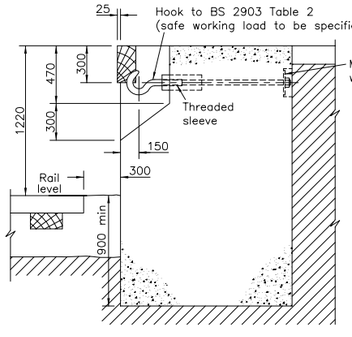


SECTION C – C

Scale 1 : 50



PLAN



SECTION F – F

Scale 1 : 50

BOLT AND HOOK DETAIL

Scale 1 : 50

DRAWING INFORMATION TAKEN FROM PSA STANDARD DRAWING DCES/RLY/19 (ISSUE A)

NOTES

1. All dimensions are in millimetres.
2. All the essential dimensions shown are in accordance with current railway operating requirements.
3. The construction of the side walls, platforms and roads shall be shown on the relevant civil engineering drawings for the particular project. The form of construction eg platform edge detail and materials shown on this drawing are for the purpose of illustration only.
4. The gradient of the approach ramp shall be determined by the limitation imposed by the vehicles to be used but in no case shall it exceed 1 in 10.
5. In the case of side loading platforms not associated with end loading platforms an extra 85mm of ballast should be added under the track when working to standard height of 1075mm. This will permit later lowering of the rails to provide a platform height of 1160mm if and when new wagons with sliding doors are introduced.
6. Where vehicles and heavy equipment are loaded the buffer draw bar and hook must be incorporated.

ISSUE	CHANGES	DATE	SIG
1	INITIAL ISSUE	24:05:10	D.C.B.

DRCS FILE NUMBER	SCALE	DRAWN BY
4617001S01	As shown	D.C.Belringer

MOD UK RAILWAYS PERMANENT WAY DESIGN AND MAINTENANCE ANNEX 'J' STANDARD DRAWINGS

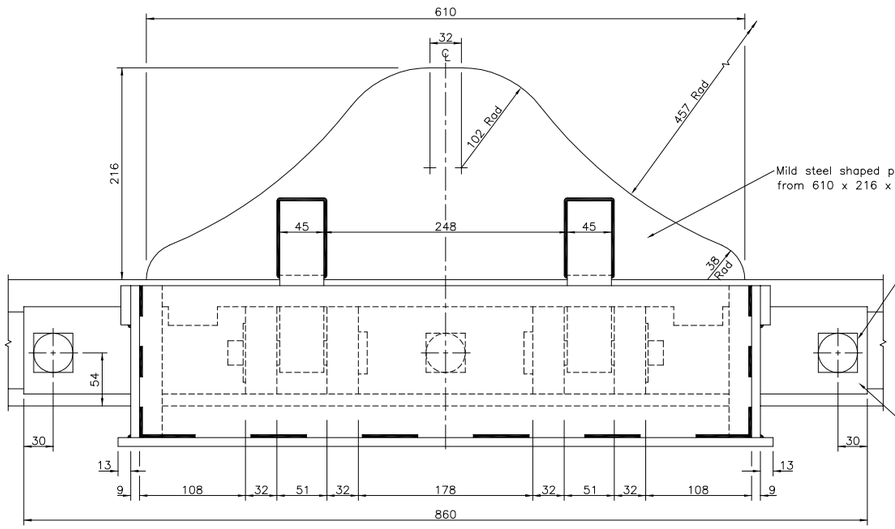
DRAWING TITLE

END AND SIDE LOADING PLATFORMS (RAILWAYS)

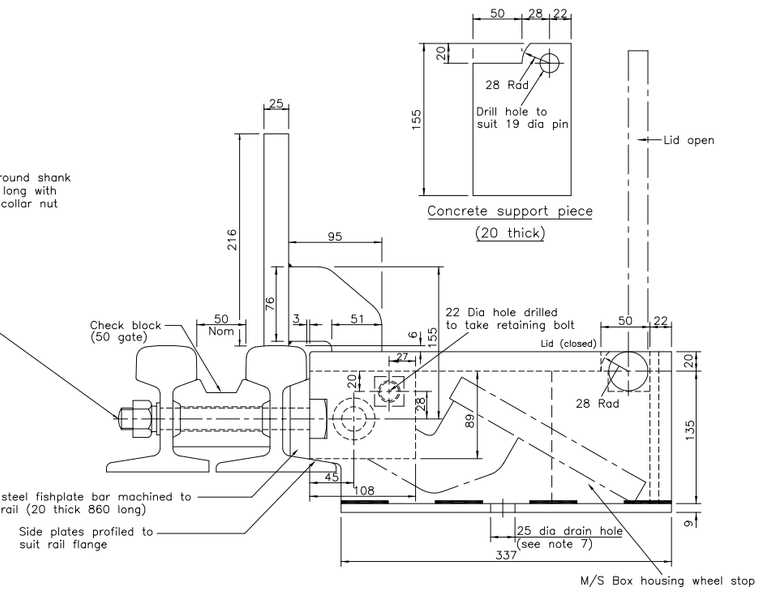
DRAWING NUMBER

4617

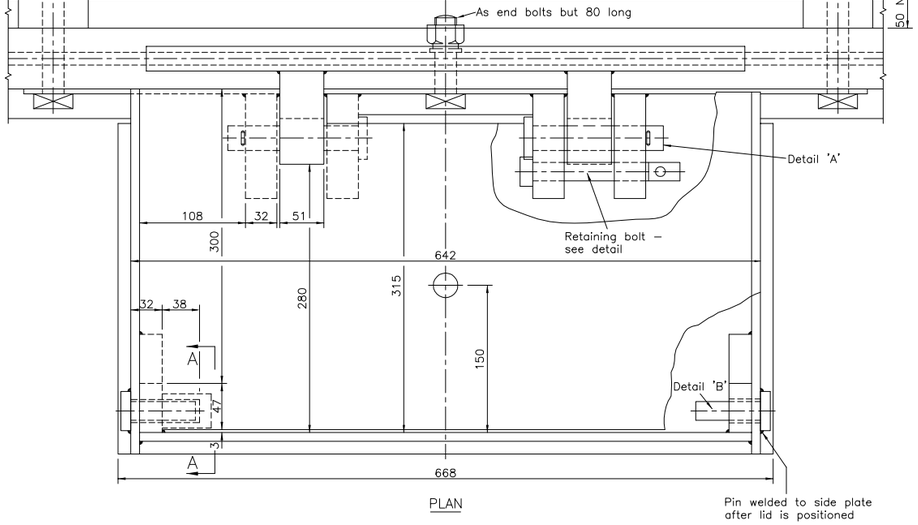
A 3



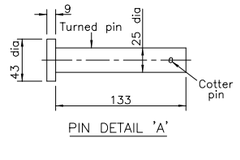
FRONT ELEVATION



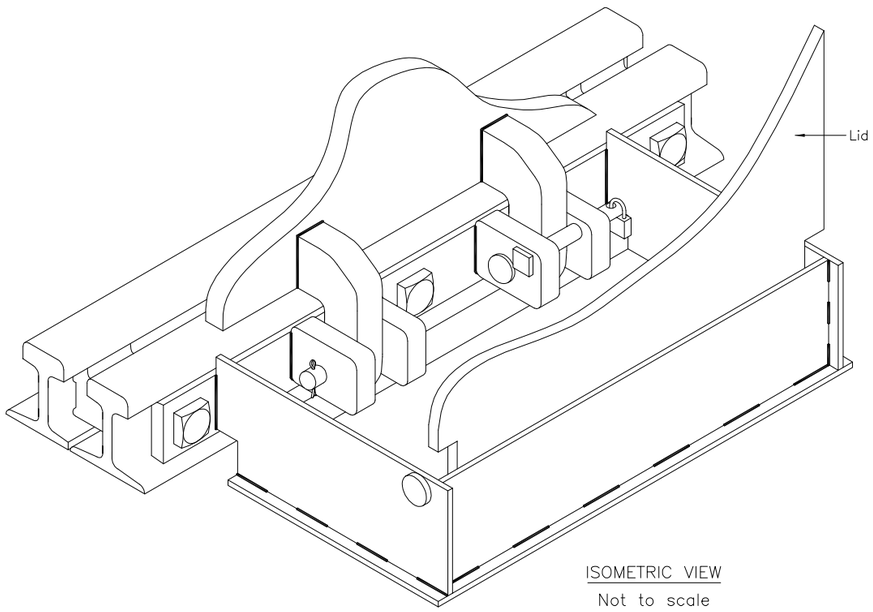
SIDE ELEVATION



PLAN

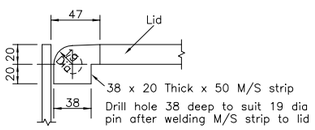


PIN DETAIL 'A'

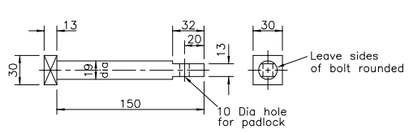


ISOMETRIC VIEW

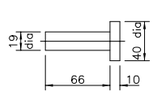
Not to scale



SECTION A – A



RETAINING BOLT



PIN DETAIL 'B'

NOTES

1. All dimensions are in millimetres.
2. Wheel stops are not suitable for use in areas normally subjected to vehicular traffic. They can only be authorised and sited by the Ministry of Defence Railway Engineer.
3. This wheel stop is intended for use on BS 75R rail. For heavier rail amend as necessary but retain profile of wheel stop. Not suitable for narrow gauge.
4. For details of rail wheel stops in unpaved areas see Standard drawing 4511.
5. Open space at back of M/S box to be blocked prior to filling paved area surrounding box.
6. Allowance to be made from U/S of drain hole in box for drainage through the paved area.
7. When ordering wheel stops, accurate rail dimensions must be provided of the particular rails where the stops are to be fitted.
8. Compliance with this drawing is mandatory for all MOD standard gauge railways where wheel stops are required in paved areas.

ISSUE	CHANGES	DATE	SIG
1	INITIAL ISSUE	24:05:10	D.C.B.

DRCS FILE NUMBER	SCALE	DRAWN BY
4618001S01	1 : 5 or as shown	*D.C.Belringer*

MOD UK RAILWAYS PERMANENT WAY
DESIGN AND MAINTENANCE
ANNEX 'J' STANDARD DRAWINGS

DRAWING TITLE

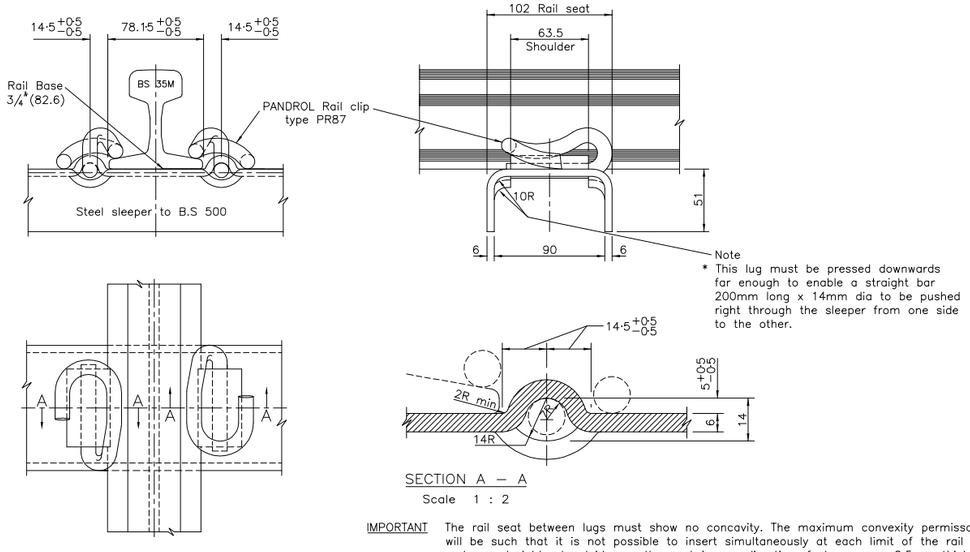
RAIL WHEEL STOP FOR
USE IN PAVED AREAS

DRAWING NUMBER

4618

A
3

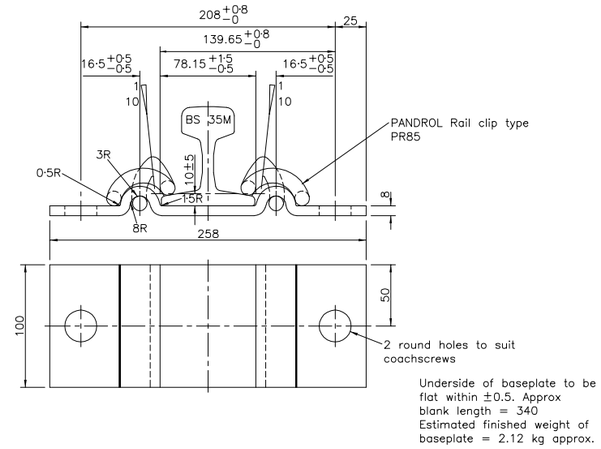
DRAWING INFORMATION TAKEN FROM PSA
STANDARD DRAWING DCES/RLY/20 (ISSUE A)



SECTION A — A
Scale 1 : 2

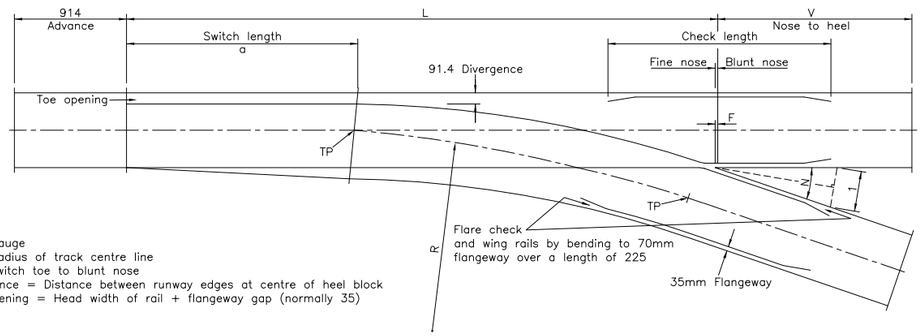
IMPORTANT The rail seat between lugs must show no concavity. The maximum convexity permissable will be such that it is not possible to insert simultaneously at each limit of the rail seat, under a straight edge laid over the seat in any direction, feeler gauges 0.5mm thick.

STEEL SLEEPER TO SUIT BS 35M RAIL AND PANDROL CLIP TYPE PR87
Scale 1 : 5 Unless shown otherwise



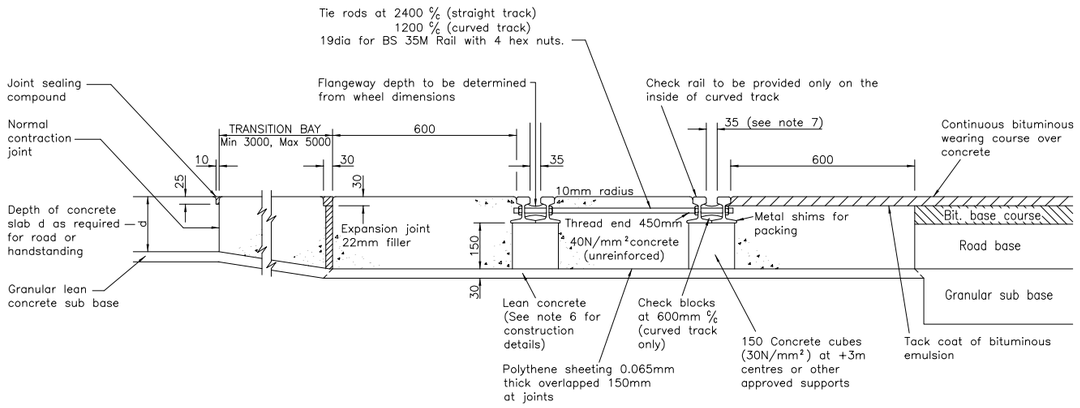
Underside of baseplate to be flat within ±0.5. Approx blank length = 340
Estimated finished weight of baseplate = 2.12 kg approx.

PRESSED STEEL BASEPLATE ASSEMBLY FOR BS 35M RAIL AND PANDROL CLIP TYPE PR85 FOR USE WITH WOOD SLEEPERS
Scale 1 : 5



G = Gauge
R = Radius of track centre line
L = Switch toe to blunt nose
Divergence = Distance between runway edges at centre of heel block
Toe opening = Head width of rail + flangeway gap (normally 35)

NARROW GAUGE TRACK TURNOUTS
Scale 1 : 50



DETAIL WHERE ADJACENT HARDSTANDING IS CONCRETE

DETAIL WHERE ADJACENT HARDSTANDING IS BITUMINOUS MATERIAL

NARROW GAUGE TRACK IN HARDSTANDING
Scale Not to scale

DEPTHS OF BALLAST (Sleepered track)	
TYPE OF SUBGRADE	MIN. DEPTH OF BALLAST BELOW SLEEPERS (mm) FOR ALL TRACK
GOOD eg. sand or sandy gravel, CBR not less than 10%	100
AVERAGE eg. sandy clay, or sandy silt, chalk, CBR not less than 3%	100 With fabric
POOR eg. silt or heavy clay, CBR less than 3%	150 membrane

DRAWING INFORMATION TAKEN FROM PSA STANDARD DRAWING DCES/RLY/21 (ISSUE A)

NOTES

1. All dimensions are in millimetres, except where stated otherwise.
2. The turnout details are intended to be a basis for inviting quotations from manufacturers and the manufacturer's working drawings will be used for construction.
   Turnouts with curved switches ie. where the turnout radius extends beyond the toe of the switch will be acceptable provided the minimum width of the toe is maintained (see below).
3. Switches to be heel type straight planed under cut head with notch in foot of the stockrail.
   Length of switch planing = $\frac{\text{Length of switch}}{\text{Divergence}}$ x Head width of rail
   Minimum width of switch rail at toe = 6
4. Maximum timber spacing in turnouts to be 750. Width of blunt nose to be 9·5. Fastenings throughout turnouts to be Pandrol clips with pressed or welded on shoulder to baseplate. Stockrails at switches to be bolted to brackets being welded to slide baseplates with two holes for coachscrews in baseplates.
5. Assemblies illustrated have been reproduced frpm Pandrol Ltd's copyright drawings with their permission. Approved assemblies for other weights of rail are available from the Ministry of Defence Railway Engineer (MOD RE).
6. Where track is in hardstanding the concrete is to be placed in one lift above the lean concrete. Placing is to be carried out under both rails simultaneously and alignment checked on completion. Contraction joints shall be installed in the concrete at a spacing not greater than 5m with expansion joints not greater than 60m spacing.
   No slab is to exceed 4·5m in width. Specification details of concrete slabs, lean concrete, bituminous materials, joint sealing compounds and joint filler to be determined by the designer.
7. Widen gauge by 7mm when the radius of curvature is less than 20 times the maximum rigid wheelbase of the rolling stock. Increase flangeway gap by the amount of any gauge widening in hardstandings only.
8. Structure gauge clearances and track spacing depend on the maximum load gauge (M.L.G.) in a stationary condition and certain minimum clearances. The MOD RE should be consulted and the following criteria observed :—

Lateral clearances			
From edge of M.L.G. to structure	Structure > 2m length 870	Structure < 2m length 610	Platform Edge 75
Multiple track between edges of M.L.G.	Running lines 460	Sidings 760	Fouling point 460
Vertical clearances			
From top of M.L.G. to structure	All tracks 300		
Platform level below unloaded wagon floor	75		

The above criteria apply to straight and level track only. Allowance must be made for track curvature and superelevation where appropriate. The clearances from track to platforms must be compiled with the other dimensions given are minimum requirements. Where point levers or other obstructions are to be sited between sidings consult with the MOD RE for additional widths.

9. Transition slabs to be provided for narrow gauge level crossings appropriate to gauge of track (see standard drawing 4605).

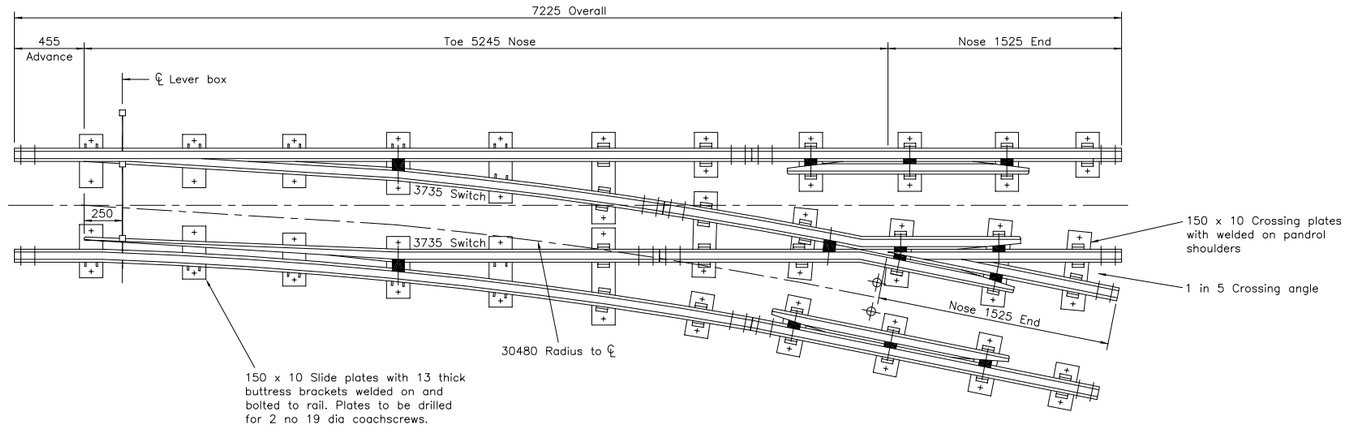
ISSUE	CHANGES	DATE	SIG
1	INITIAL ISSUE	24:05:10	D.C.B.

DRCS FILE NUMBER 4619001S01 | SCALE As shown | DRAWN BY D.C.Belringer

MOD UK RAILWAYS PERMANENT WAY DESIGN AND MAINTENANCE ANNEX 'J' STANDARD DRAWINGS

DRAWING TITLE
NARROW GAUGE RAILWAYS

DRAWING NUMBER 4619 A3

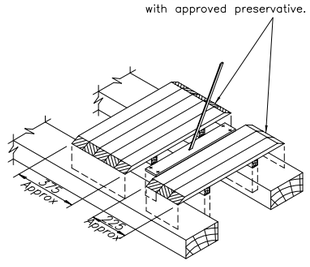


Gauge 610
Clearance 35

GENERAL ARRANGEMENT

Scale 1 : 20

75 x 20 Sawn SWD boards bevelled at each end and galv. nailed to 50 x 50mm sawn battens. Boards to be approx 1.0m long and battens spaced to suit timber spacing. Boards not to be nailed to turnout timbers. Boards and battens to be treated with approved preservative.



TURNOUT LEVER PLATFORM
FOR NARROW GAUGE TURNOUT

Scale Not to scale

NOTES

1. All dimensions are given in millimetres.
2. All plates are 10 thick.
3. All bolts are 20 diameter.
4. All bolts other than fishbolts to be fitted with locknuts.
5. All rails shown on this drawing are BS 35M.

MATERIALS FOR 1 IN 5 TURNOUT BS 35M RAIL		
1	4 Prs.	Fishplates BS 35M
2	16 Prs.	Fishbolts 13 x 89 C.P.
3	8 Prs.	Bracketed switch slide plates and bolts.
4	2 Prs.	Back heel plates with welded lugs to suit pandrol clips.
5	4 Prs.	Common plates with welded lugs to suit pandrol clips.
6	6 Prs.	Pressed check plates (or welded)
7	5 Prs.	Crossing plates with welded lugs to suit pandrol clips.
8	4 Prs.	Switch stud blocks C.I. with bolts.
9	2 Prs.	Bracketed back heel plates.
10	6 Prs.	Check blocks C.I. with bolts.
11	5 Prs.	Crossing blocks C.I. with bolts.
12	42 Prs.	Pandrol clips to suit BS 35M rail.
13	56 Prs.	Coachscrews.
14	1	Mk 1 Lever box.
15	1	Stretcher Bar.
16	1	Connecting rod.

DRAWING INFORMATION TAKEN FROM PSA STANDARD DRAWING DCES/RLY/24 (ISSUE A)

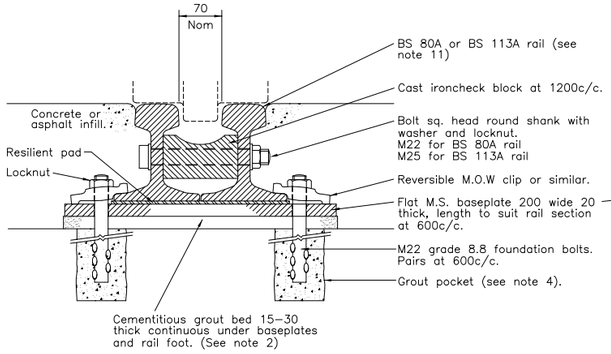
ISSUE	CHANGES	DATE	SIG
1	INITIAL ISSUE	24:05:10	D.C.B.

DRCS FILE NUMBER 4620001S01 | SCALE As shown | DRAWN BY D.C.Belringer

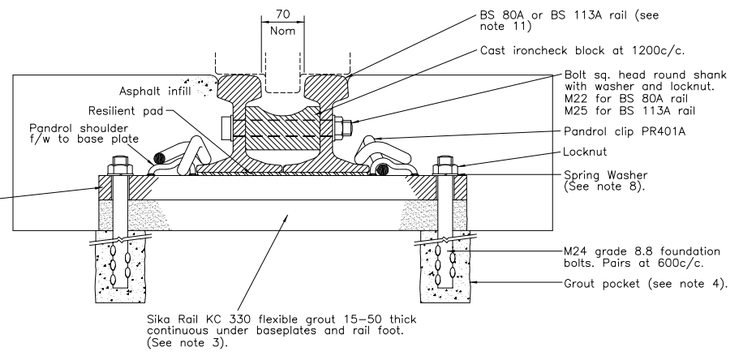
MOD UK RAILWAYS PERMANENT WAY
DESIGN AND MAINTENANCE
ANNEX 'J' STANDARD DRAWINGS

DRAWING TITLE
1 IN 5 SPRING SWITCH TURNOUT BS 35M RAIL, TRACK GAUGE 610mm

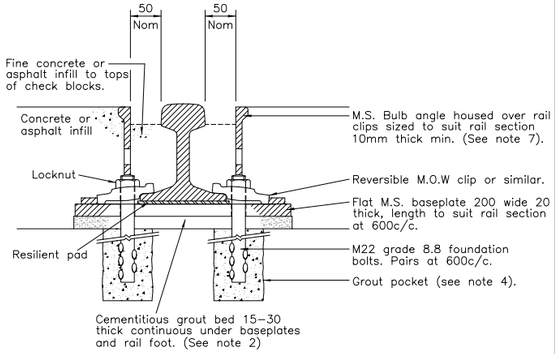
DRAWING NUMBER 4620 | A3



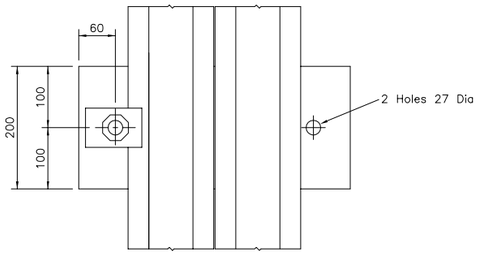
DETAIL 1A
TWIN RAIL (DUPLEX)
FOR CENTRE FLANGED CRANE WHEELS
Scale 1 : 5



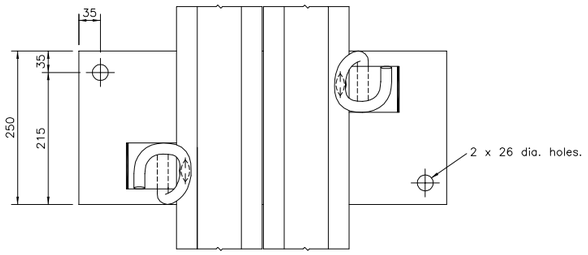
DETAIL 2A
TWIN RAILWAY RAIL (DUPLEX)
FOR CENTRE FLANGED CRANE WHEELS
Scale 1 : 5



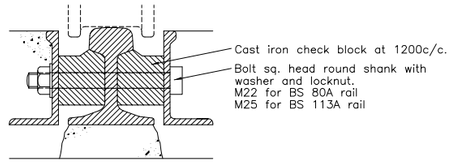
DETAIL 3A
SINGLE RAILWAY RAIL FOR
DOUBLE FLANGED CRANE WHEELS
Scale 1 : 5



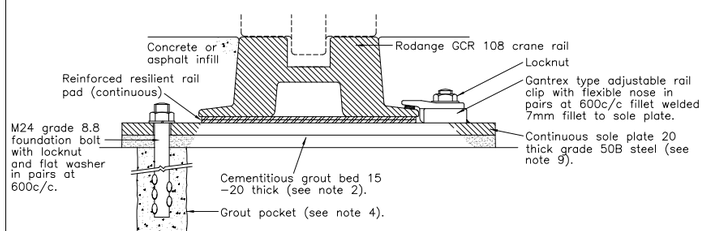
DETAIL 1B
PLAN
Scale 1 : 5



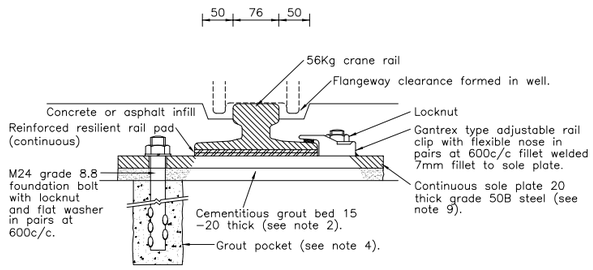
DETAIL 2B
PLAN
Scale 1 : 5



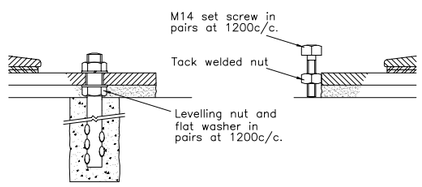
DETAIL 3B
AS DETAIL 3A SHOWING CHECK BLOCKS
Scale 1 : 5



DETAIL 4
DOUBLE HEADED CRANE RAIL (RODANGE)
FOR CENTRE FLANGED WHEELS
Scale N.T.S.



DETAIL 5
PURPOSE MADE CRANE RAIL
FOR DOUBLE FLANGED WHEELS
Scale N.T.S.



DETAIL 6
SUGGESTED METHODS OF LEVELLING
Scale N.T.S.

NOTES

1. All dimensions are in millimetres.
2. Cementitious grout to be Fosroc Conbextra or similar approved. Thicknesses between 30 and 75mm bulk out grout with pea gravel as manufacturers instructions. Voids in excess of 75mm should be first reduced with C25P concrete.
3. Flexible grout and Pandrol clip fastenings should only be used when a flexible infill around rails is permitted.
4. Pockets to foundation bolts to be filled with either cementitious grout or epoxy resin.
5. 'Rebar' shall not be permitted as an alternative to indented foundation bolts without S.O. approval.
6. Rail joints shall be avoided. Thermit weld all rail joints.
7. Alternatively use M.S. channel (min. 10mm thick).
8. Spring washers, which may require a flat backing washer, should not be fully compressed by the locknut.
9. Continuous sole plates to be laid in lengths with 10mm joints.
10. WHEEL LOAD TABLE

Detail	Rail Section	Suggested max. wheel load
1A & 1B	BS 80A BS 113A	20 Tonne 30 Tonne
2A & 2B	BS 80A BS 113A	10 Tonne 30 Tonne
3A & 3B	BS 80A BS 113A	10 Tonne 15 Tonne
4	Rodange GCR 108	80 Tonne With continuous sole plate and reinforced pad
5	S 56 Crane rail	60 Tonne With continuous sole plate and reinforced pad

Note
Wheel load may be increased 50% by the use of continuous sole plate and reinforced pad.

ISSUE	CHANGES	DATE	SIG
D.C.B.			
1	INITIAL ISSUE	24:05:10	

DRCS FILE NUMBER 4621001S01 | SCALE Not to scale | DRAWN BY D.C.Belringer

MOD UK RAILWAYS PERMANENT WAY
DESIGN AND MAINTENANCE
ANNEX 'J' STANDARD DRAWINGS

DRAWING TITLE
CRANE TRACK DETAILS

DRAWING NUMBER 4621 A 3

DRAWING INFORMATION TAKEN FROM PSA STANDARD DRAWING DCES/RLY/25 (ISSUE A)

Annex K
Example of a Depot Track Layout Diagram

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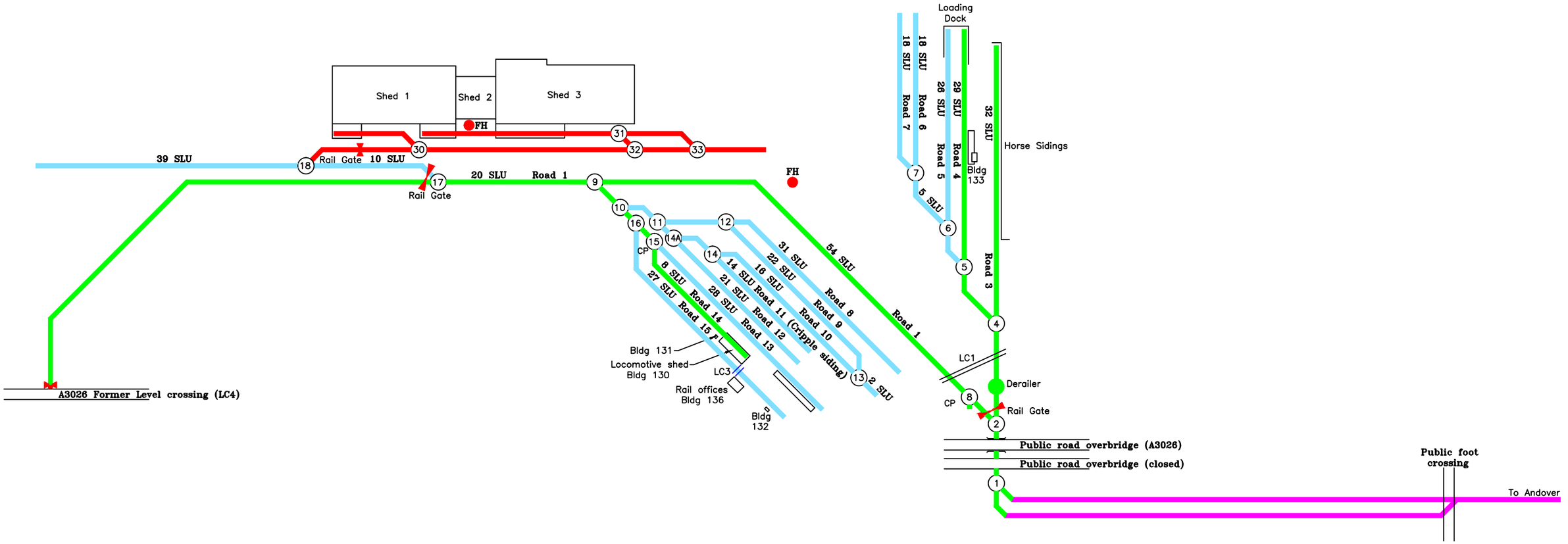

KEY

- MoD running line (main) / turnout number
- MoD running line (secondary) / turnout number
- MoD running line (care & maintenance) / turnout number
- MoD running line (closed – disused) / turnout number
- Network Rail track
- Building
- A48 Road
- 27 SLU SLU quantities per section
- CP1 Catch point
- LC12 Rail crossing (Vehicular / Pedestrian)
- WS Wheel stop
- RG Rail Gate
- FH Fire Hydrant
- Security fence
- 9 Block Post number
- 'D' Branch limits

ISSUE	TITLE	DATE	SIG
4	MINOR AMENDMENTS	31.03.16	SC
3	CORUNNA BARRACKS TRACK REMOVED	28.05.15	SC
2	PRESENTATIONAL FORMAT CHANGES	05.12.12	LBT

AMENDMENTS

MINISTRY OF DEFENCE

DEPOT RAILWAY DIAGRAM
MOD HOLDFAST DEPOT

DRAWING NO.
DRCS–3–2509–1

SCALE	DATE
NTS	DEC 2012

DRAWN BY	SIG.
D.C BELRINGER	

MOD RAILWAY ENGINEER	SIG.
S.CHEETHAM	

A3

Annex L
Railway Signs - Photographs

Block section sign

Limit of shunt sign

Red target stop signal on shed door

Limited clearance warning sign

Open level crossing road signs

5 mph permanent speed restriction

Open level crossing rail sign

Whistle sign

Maintenance Limit or Boundary Marker plate

Annex M
Bibliography and Useful References

MOD Publications

Royal Engineers Military Engineering Vol VIII
Railways and Ports Part 1 Railway Construction, Maintenance and Repair 2013 (AC 71593)

Royal Logistic Corps Rail Transport – Railway Operating (AC71680A)

JSP 790 Defence Rail Regulations

MOD General Railway Rules Book (Annex to JSP 790)

Other Publications

HSE Railway Safety Principles and Guidance Part 1

HSE Railway Safety Principles and Guidance Part 2:

- Section A - The Infrastructure
- Section B - Stations
- Section C - Signalling
- Section D - Level Crossings

Railway Group Standards – provisioned by Railway Safety and Standards Board

British Railway Track 7th edition – The Permanent Way Institution

The Traffic Signs Regulations and General Directives 2016

Personal Track Safety Handbook – Network Rail (frequently reissued)

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Annex N
Glossary of Terms

accommodation crossing	a private level crossing provided for the use of a land owner or his tenants to provide access to property or land when this has been severed by the construction of a railway.
adjustment switch	a device installed either between CWR and jointed track, or between CWR and switch & crossing units to permit thermal movement of the end of the CWR.
adze	a cutting tool used for shaping timber, consisting of a long handle with a broad blade set at right angles, used in an underarm manner by a standing man.
AHB level crossing	Automatic Half Barrier level crossing: a level crossing where barriers are provided only to the nearside of the road to either side of the crossing, whose opening and closing sequences are initiated automatically by the passage of trains.
alignment	(1) right of way of railway. (2) longitudinal direction of track in horizontal and/or vertical plane, either as designed or as a result of traffic effects.
alumino-thermic weld	a butt weld used to join rails, using a process causing a thermo-chemical reaction, normally undertaken in-situ.
AMS	austenitic manganese steel.
anchor	fitting attached to the foot of a rail, in contact with a sleeper or chair, to prevent longitudinal movement (creep) of the rail.
AOCL level crossing	Automatic Open Crossing, Locally monitored: a level crossing without barriers, protected by automatic warning lights and sounds for road traffic activated by the approach of trains, the function of the automatic warnings being monitored by train drivers.
austenite	a type of steel consisting of a solid solution of carbon and iron with a smooth grain structure.
ballast	stone layer used to support and restrain sleepers, timbers and rail bearers; commonly graded, crushed, angular limestone or granite (see also bottom ballast and top ballast).
ballast cleaner	a machine for ballast cleaning, with the track in-situ.
ballast cleaning	the process of removing fines (which clog drainage) from ballast.
ballast fines	small particles of ballast broken off through ballast abrasion.
ballast shoulder	ballast heaped at sleeper ends to provide lateral restraint to the track.
baseplate	a cast iron, cast steel or pressed steel bearing plate used to support flat bottomed rail, fastened to the top of the sleeper.

baseplate pad	a piece of resilient material between sleeper and baseplate.
batter	(1) the slope of earthworks or retaining structures. (2) the rounding off of rail ends at joints and of crossing noses caused by the passage of trains (a track defect).
bay	see bed.
bearer	concrete beam, supporting and connecting the rails of switch and crossing units.
bed	the space between adjacent sleepers, timbers or bearers.
blanketing	a porous layer placed between the earthworks of the railway formation and the bottom ballast, with the aim of drainage, usually formed of sand and/or a special synthetic membrane.
block section	section of track that can be protected by signals to prevent more than one train occupying that section.
bond wire	an electrical connection between two rails to provide electrical continuity.
bottom ballast	ballast beneath the underside of sleepers, timbers and rail bearers, used for vertical support, placed levelled and compacted before track laying.
boxing in	filling beds with ballast and reforming ballast shoulder.
breather switch	see adjustment switch.
buckle	a severe local distortion in rail alignment, frequently encountered in conjunction with severe increase in local ambient temperature with CWR.
buffer stop	a structure at the termination of a track or siding with a beam or buffers in line with rolling stock buffers to prevent running off the end of the track.
bullhead rail	a form of rail once used extensively in Britain in which the head and foot were of equal width. Now largely superseded by flat bottom rail.
cant	superelevation of outer rail above inner rail on a curve.
cant deficiency	shortfall of cant required for balanced traverse of a curve.
cant gradient	the rate of change of cant with respect to distance along the track.
care and maintenance	track which has been put out of use for traffic purposes but which is to remain in situ, capable of being used at short notice.
catch pit	a chamber (normally covered) connected to track drains, to trap fines and other deleterious material for periodic removal.

catch point	a set of spring switches acting as a derailing device in the facing position, unless held open for planned train movements. Used to protect runaways or unauthorised movements at rail gates or the bottom of gradients.
cess	a strip of ground between edge of ballast shoulder and bottom of cutting, top of embankment, bridge abutment or other structure, etc; providing a place of safety or safe walking route for railway staff.
chair	a cast iron fitting fastened to a sleeper which supports bullhead rail secured in it by a wood or sprung steel key.
check rail	an additional rail placed inside and parallel to the inner running rail on a severe curve to guide wheel flanges.
chord line	a short line linking two other lines.
clamp (emergency clamp)	a screw clamp used to hold and secure a pair of fishplates without fishbolts in order to make a temporary connection between 2 rails, or as support for a rail break.
closure rail	a length of unmachined rail connecting switches and crossings in turnouts, crossings in diamonds, or new plain line with existing track.
clothoid spiral	a type of curve where the curvature (ie the reciprocal of the instantaneous radius) is proportional to the distance along the curve from its tangent point with the straight.
cold expanded holes	fishbolt holes that have been mechanically expanded by a pressure tool to prevent development of radial cracks.
compensated gradient	actual gradient plus the gradient equivalent of train curving resistance.
connecting rod	mechanical connection between operating lever box and switches in a turnout.
corrugation	a rail defect: a regular series of peaks and troughs on the running surface of a rail.
creep	progressive longitudinal migration of a rail relative to other elements of the track structure or of the entire track structure.
crib	see bed.
cripple road	siding allocated for holding temporarily unserviceable rolling stock.
crossing	(1) a piece of trackwork: enabling one track to cross another at an angle. (2) a component of a turnout: the element forming the "V" where the tracks leading out of the turnout diverge. (3) a right of way crossing a railway line at grade.
cross level	the difference in level between a pair of rails, when compared normally to the rail centreline. Also an instrument used for measuring this difference.

crossover	on parallel or twin tracks; a track diverging from one and converging on the other via a turnout at each end to allow trains to cross from one track to the other.
CWR	continuously Welded Rail: rails joined by a series of butt welds, forming a length greater than 36.5 metres (120'), with adjacent lengths of plain line rail joined by expansion switches rather than fishplated joints.
diamond	see crossing (1).
derailer	a shaped device, hinging over one rail, to channel wheel flanges up to the top of the rail and over the outside edge, causing the train to derail. Used to protect from runaway vehicles or unauthorised train movements.
dog spike	a simple spike with a shaped head, hammered in to wood sleepers to catch on the foot of the rail, forming a secure holding down and lateral restraint system.
exchange siding	a siding used to exchange rolling stock between two different railway networks, the exchange siding being connected to both networks.
expansion gap	the gap between rail ends at a fishplated joint, allowing rails to move under thermal expansion.
expansion switch	see adjustment switch.
facing	facing the direction from which trains normally approach.
facing crossover	a crossover which faces the normal direction of movement on the lines connected by the crossover, ie used by trains travelling in the normal line direction.
facing point lock	a mechanical device preventing the movement of points which face the direction of travel, activated when the signal for a train or route is placed in 'off' indication.
facing turnout	a turnout in which the switches face the normal direction of travel.
fastening	a device for securing a rail, either directly to a sleeper or track slab, or to a chair or baseplate.
ferrule	a plastic or resilient insert used in the holes of baseplates to prevent securing screws from causing damage due to high point loads or vibration.
fishbolt	a bolt used in conjunction with fishplates to form a joint between two rail ends.
fishplate	a plate used for making a bolted butt connection between two rails.
flangeway	a clear way adjacent to the rail along which the wheel flange travels.
flat bottom rail	a form of rail with a wide foot incorporating a flat bottom enabling it to be fastened direct to the sleeper or baseplate.
foot crossing	an at-grade crossing of a footpath or other pedestrian route of a railway.

formation	the earthworks and trackbed of a railway.
fouling point	the position on either of two or more converging tracks beyond which the necessary clearances for trains to safely pass each other is not available.
fourfoot	the area between a pair of rails forming a track.
frog	a crossing unit (see crossing (2)).
gall	a defect where the rail has eroded in contact with a chair or baseplate, and/or a baseplate or chair has eroded in contact with rail.
gauge	the distance between the gauge faces of a pair of rails.
gauge corner cracking	a rail defect: repetitive surface cracking on the rail running edges.
gauge envelope	the cross sectional load gauge profile or structure gauge profile, as applicable.
gauge face (of rail)	the running edge of a rail (the inside face between a pair of rails), from which the gauge is measured.
geogrid reinforcement	extruded plastic mesh laid horizontally at the bottom of the bottom ballast layer to as a reinforcement over poor or low strength formations.
geotextile	filter membrane laid horizontally to separate formation from bottom ballast, and prevent pumping of fines and clay upwards into the ballast whilst allowing free drainage of surface water.
ground frame	a small mechanical frame set apart from a signal box, often in the open, to operate turnouts and signals. On running lines this is frequently unlocked electrically from the nearest signal box, or by a release key.
guard rail	an additional rail placed inside or outside running rails and parallel to them, to restrain derailed rail vehicles.
gut rail	closure rail between switches and crossing units within a turnout.
Hallade	a mathematical technique for designing track realignment.
hunting	lateral oscillations of a wheelset, bogie or vehicle.
IBJ	Insulated Block Joint: an insulated rail joint used for separating adjacent track circuits. Sometimes called an IRJ.
inclined rail	rail set at 1:20 angle to its cross sectional vertical centre line, inwards to the centre of track. This is normal for plain line but not for S&C.
insulator	plastic insert to separate the fastening and the base plate or sleeper, forming electrical insulation between the metal parts.
interlocking	either a mechanical or electrical device, or a piece of computer software which prevents signals and turnouts being set in such a manner so as they conflict with the potential to cause accidents.
intersection bridge	a bridge carrying one railway line over another.

interval	the gap between the adjacent outer rails of two parallel tracks.
jim crow	a device for forming or removing sharp bends in rails, shaped somewhat like an archery bow, consisting of clamps to hook round the rail at either end and a plunger on a screw thread in the centre.
jointed rail/track	rail or track using fishplates for butt connections between rails.
key (as track component)	wooden wedge or spring steel component used to retain bullhead rail in a chair.
level crossing	an at grade crossing of a road or other vehicular traffic of a railway line, frequently protected by special equipment and signalling.
lever box	the mechanism operated by a hand pulled lever and connected to the switches, to change a turnout direction.
line	horizontal alignment of a rail or track.
line speed	the maximum speed at which the fastest type of train is normally permitted to use the line, subject to PSRs.
Link-up	the national railway industry system for approving suppliers of specialist railway materials, services and contractors.
load (or loading) gauge	the cross sectional profile within which the rolling stock (including any loads) must be contained, to prevent collision with lineside/overhead structures.
lookout	a railwayman acting as part of a safe system of work, whose duties are to observe the approach of trains and to warn other authorised persons present on the track of the approach of these trains.
longitudinal timbers	timber rail bearers laid longitudinally to the rails, with chairs or baseplates attached to their upper face.
LWR	Long Welded Rail: rails joined by a series of butt welds to reduce the number of rail joints, generally forming a length less than 36.5 metres (120'), although this may be exceeded. This is not to be confused with CWR.
marker board	a temporary board placed at the trackside to delineate a particular feature, eg limits of possession or TSR.
MCB level crossing	Manually Controlled Barrier level crossings: a level crossing provided with full barriers controlled and monitored by a signalman or crossing keeper.
narrow gauge	track of less than standard gauge, commonly employed for minor railways, as the normal gauge in Southern Africa, The Far East, and for secondary networks in parts of Europe and India. Used on distribution railways within some UK munitions depots.
nose	the point at which the running edge of two rails forming a crossing, meet.

occupation crossing	a private level crossing provided for the use of the land owner or his tenants when access to a piece of land or property has been severed by the construction of a railway.
open area	concrete paved track within a wider paved area forming a road/rail transfer area or loading yard.
open crossing	a level crossing where no barriers or warning lights etc are provided, generally confined to lightly used railways and roads.
outside edge (of rail)	the opposite face to the gauge face or running edge of a rail.
overbridge	a bridge carrying a road, canal etc over the railway.
packing	the process of filling and compacting voids under the bearing areas of sleepers with ballast, to achieve the correct rail level.
pad	a piece of resilient non-conductive material between baseplate and rail.
pandrol clip	a form of rail fastening consisting of a spring steel shaped bar. The standard form of fastening for MOD railways.
pearlite	a form of steel made up of alternate laths of ferrite and cementite.
permanent way	all elements of railway trackwork.
plain line	straight or curved track unencumbered by turnouts or crossings.
point machine	an electric motor providing power worked turnout actuation.
point rail	one of a pair of rails forming a crossing nose.
possession	a safe system of work process whereby train service by the operator is suspended and control of the line is temporarily handed over to an occupying person, department or contractor. Usually used to protect staff and trains whilst engineering work is carried out.
prime contracting	the MOD system of estate and works management.
PSR	Permanent Speed Restriction: applied to particular locations on a track (eg curves) where the speed restriction required for safety, comfort, etc is less than the line speed.
pumping	a track defect whereby the sleepers, timbers or bearers depress into voids or soft ground under the passage of trains.
rail bonding	electrical interconnection of running rails to provide a minimum of resistance for traction return current.
rail lubricator	a device fixed to the track that provides lubrication to the rail running edge at sharp curves, lubricating the contact between wheel flanges and running edge.
rail seat	the area of a baseplate, chair, sleeper, timber or bearer which directly supports a rail.

reception siding	a siding into which an arriving non-passenger train arrives and is held clear of the running times.
reverse curve	a curve of one hand immediately following on from a curve of the opposite hand.
running edge	the inside edge of a rail (gauge face).
running-on slab	a concrete slab under the ballast butting up to fixed infrastructure such as underbridges or concrete paved track, to provide a transition in resilience from the conventional ballasted track.
runround	the process of releasing a locomotive from the front of a train at the completion of a journey and moving it to the other end of the train ready for the return run, or a track provided to facilitate this movement.
sabot	rail mounted friction wheel stop. Also known as a hemshoe.
S&C	switches and crossings: all elements of the turnouts and crossings under consideration.
S&C unit	one complete item of S&C, eg a turnout.
sand drag	a length of track buried in a contained area of sand to form a retarder for runaways or unauthorised movements.
side wear	wear on the side of the rail head caused by friction from wheel flanges on sharp curves.
sixfoot	the gap between the adjacent outer rails of two parallel tracks.
sleeper	softwood, hardwood, concrete or steel beams supporting and connecting a pair of rails to form plain line track.
slewing	moving track horizontally to form/adjust a new alignment.
slide baseplate	a baseplate used to support the moving part of the switch rails in a turnout.
slide chair	a chair used to support the moving part of the switch rails in a turnout.
slip (as trackwork item)	a type of S&C unit: resembling a crossing but fitted with switches which enable the unit to function additionally as a turnout, single slips permit this function from one end only, double slips permit it from both ends.
soleplate	steel plate across full gauge under both switch toes to hold gauge and resist track deflection caused by switch operating mechanism.
sorting siding	a siding used to marshal train formations ready for onward dispersal or movement.
splice rail	one of a pair of rails forming the crossing nose.
spot re-sleepering	the replacement of individual sleepers as and when failure occurs.
squat	a rail defect: fatigue crack seen at the rail head.

standard gauge	the normal gauge used in Britain, Europe, North America, China, most of Australia and many other parts of the world. In Britain is defined as 1435mm normal for most plain line, with 1432 mm for S&C and some plain line.
stock rail	the fixed rail in a turnout, against which a switch rail bears.
stretcher bar	a connecting bar between a pair of switches, to ensure the switches move in tandem.
structure gauge	the cross sectional profile within which lineside/overhead structures must be built and maintained, to prevent collision from rolling stock and to provide a safety clearance distance.
switch (switch rail)	one of a pair of moving blades in a turnout.
switch toe	the tips of switches, or the position of the switch tips relative to the longitudinal position of the track.
tamping	the process of repacking the ballast under the bearing areas of sleepers, using a track mounted machine fitted with vibrating tines which penetrate the ballast.
tenfoot	the gap between the adjacent outer rails of the two parallel tracks, either side of the centre, in a four track railway.
tie rod	a steel tie running between the bottom flanges of a pair of rails, used to prevent rails spreading apart and to maintain the correct gauge.
timber	softwood or hardwood baulk, supporting and connecting the rails of switch and crossing units.
top	accuracy of vertical alignment of a rail or track.
top ballast	ballast above the level of the underside of sleepers, timbers and bearers, providing lateral support for these elements, placed after track laying.
track category	determined by the usage or importance of the track to the operators, this determines the required standard of specification, condition and maintenance.
track circuit	an electrical device which reveals the presence of a train on the piece of track connected to the track circuit, to a signalman or to the signalling system.
track geometry	the dimensional standards/measurements that determine the position of the running edges of the rails: gauge, cross level, longitudinal level, alignment.
trailable switch or turnout	switches or turnouts which are set by the wheelsets of trains passing in the trailing direction.
trailing crossover	a crossover that does not face the normal direction of movement on the lines connected by the crossover, ie they are used by trains reversing or travelling against the normal line direction.

trailing turnout	a turnout that does not face the normal direction of movement on the line, ie it is used by trains reversing or travelling against the normal line direction.
transition curve	a curve of gradually increasing/decreasing radius providing a smooth change in alignment from straight to circular curved track.
trespass guards	a floor level structure presenting sharp edges, often in timber, to deter people and livestock from straying or trespassing off a crossing and onto the track.
TSR	Temporary Speed Restriction: a speed limit imposed, generally for poor track condition, safety of lineside staff, or during engineering work, to a particular length of track, delineated by marker boards.
turnout	the total assembly of trackwork involved in 'turning out' one line from another by means of a pair of switches and a crossing.
turntable	a track supporting bridge centrally pivoted and set in a circular pit, allowing rolling stock to be turned end to end.
twist	a track defect: an unintended difference in cross levels causing a vehicle to twist whilst traversing the defect.
twist rail	a special rail with a twist about a longitudinal axis, to marry inclined plain line rail to vertical rail eg at connections to S&C.
UIC	Union International des Chemins de Fer: the international railway standards organisation.
underbridge	a bridge carrying the railway over a defile, gap, road, river or another railway.
vertical rail	rail set vertically in line with its cross sectional vertical centre line. This is normal for S&C but in most plain line, the rail is inclined inwards.
wet spot	an area where pumping has caused fines to clog drainage through the ballast.
wheel burn	a rail defect in the surface of the rail head caused by wheel slip or loss of traction in locomotives.
wheel stop	a device bolted to rails, in a shape to mate up to rolling stock wheels, to prevent rolling stock moving past that position. Stops may be fixed, or hinged to allow planned movements.
wing rail	rails forming part of a crossing section in a turnout.

Annex O
Abbreviations

ACDS Log Ops	Assistant Chief Defence Staff Logistic Operations
BH	bull head (rail)
C&M	care and maintenance
CAD	computer aided design
CWR	continuously welded rail
DE&S	Defence Equipment and Support
DfT	Department for Transport
DIO	Defence Infrastructure Organisation
DSA	Defence Safety Authority
EOD	explosive ordnance disposal
FB	flat bottom (rail)
h	hour
HMRI	Her Majesty's Railway Inspectorate
HSE	Health and Safety Executive
HTS	high tensile steel
JSP	joint service publication
km	kilometre
lb	pound weight
Nm	newton metre
MHE	mechanical handling equipment
m	metre
mm	millimetre
MOD	Ministry of Defence
mph	miles per hour
NR	Network Rail
ORR	Office of Rail and Road (DfT)
PPE	personal protective equipment
PRE	Principal Railway Engineer (DIO)
PTS	personal track safety
PW	permanent way
RAIB	Railway Accident Investigation Branch
RES	rail end straightening
ROM	railway operating manager
RPC	regional prime contract
s	second
S&C	switches and crossings
SIT	sleeper integrity tester
SMS	Safety management system
170 (Infra Sp) Engr Gp RE	170 (Infrastructure Support) Engineer Group Royal Engineers
507 STRE(Rly Infra)	507 Specialist Team Royal Engineers (Railway Infrastructure)

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