

# Unit 56: Railway Infrastructure Construction and Maintenance

<b>Unit code:</b>	<b>A/600/0348</b>
<b>QCF Level 3:</b>	<b>BTEC Nationals</b>
<b>Credit value:</b>	<b>10</b>
<b>Guided learning hours:</b>	<b>60</b>

## ● Aim and purpose

This unit aims to give learners an understanding of the stages involved in the planning, construction and maintenance of railway infrastructure.

## ● Unit introduction

This unit will examine the preparatory phase of railway construction and will focus on the legal and financial frameworks. This will include primary legislation, the funding of new railways and the procedures for land acquisition.

Learners will also consider the type of earthwork activities that are required. They will gain an understanding of site preparation and the processes that follow, such as forming railway cuttings and embankments and dealing with drainage.

The design principles of different forms of railway construction (for example light and heavy rail applications) will be covered, along with the respective construction methods, materials and quality control methods.

Finally the unit will cover the processes used for track maintenance and the possible defects that can arise. This includes the issues that affect maintenance such as defects in the materials used and seasonal/ environmental problems such as leaves on the track, extremes of temperature and flooding. Learners will gain an insight into the identification of railway infrastructure defects and the effective remedial treatments to ensure an efficient operational railway.

The unit assumes no prior knowledge of the industry but learners would benefit most if they are currently working in the railway industry (such as an apprentice) or a closely related support industry. Alternatively, learners would need to gain access to suitable railway construction sites to enable them to appreciate the scale, scope and complexity of the subjects covered by this unit.

## ● Learning outcomes

### On completion of this unit a learner should:

- 1 Know the preparatory activities required for the construction of railway track infrastructure
- 2 Know the scope of earthwork activities that may be undertaken in association with railway track infrastructure
- 3 Understand the forms of construction and material specifications used in railway track infrastructure
- 4 Understand track maintenance processes used to identify and correct defects in railways.

# Unit content

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## 1 Know the preparatory activities required for the construction of railway track infrastructure

*Legal and financial framework:* primary legislation eg Railways Act, regulations; funding of new railways eg design, build, finance and operate (DBFO), private finance initiative (PFI); procedures to acquire land eg compulsory, compensatory

*New build or renewal development process:* route considerations eg need for service, number of tracks required, impact on the environment (noise, vibration, aesthetic, pollution, sustainability), stability, infrastructure integrity, associated structures (bridges, tunnels and level crossings); public consultation eg public enquiries, protests, environmental regulation, parliamentary approval; health, safety and welfare eg work force and public, legislation/regulations (Health and Safety at Work Act, Construction (Design and Maintenance) Regulations), method statements and safe methods of work, railway safety systems, industry standards (Network Rail, Railway Safety and Standards Board); contract administration eg legal process, selection of contract, contract conditions, methods of measurement

## 2 Know the scope of earthwork activities that may be undertaken in association with railway track infrastructure

*Earthworks project methodology:* site preparation eg advance fencing, geological survey, stripping topsoil, material disposal, haul road; cut and fill eg site specific problems and solutions, use of explosives, borrow pits; embankment construction eg suitable/unsuitable materials for fill, procedures and testing of soil properties as work proceeds; treatment of weak areas eg stabilisation, replacement and drainage techniques; ground water control eg methods of water table control (including vegetation), stability of slopes; forms of subsoil drainage eg patterns used, types of drainage (collector/carrier, open channel, use of interceptors, typical cross sections used); disposal of collected water eg open channel, soakaways, watercourses and drains via catchpits, discharge legislation (Environment Agency)

## 3 Understand the forms of construction and material specifications used in railway track infrastructure

*Design principles:* forms of construction eg light/heavy rail, specification selection (Network Rail (NR) Track Construction Standard SP/TRK 102); typical forms of track eg cross-sections of track types, formation specifications, sand blanket, geotextile; tunnels; walkways; track design considerations eg conventional passenger speed, enhanced passenger speed, transitions, curves, clearances, rolling stock; design standards eg Technical Specification for Interoperability, Track Design Manual (NR/SP/TRK/049), Track Construction Standard (NR/SP/TRK/102)

*Construction methods:* renewal methods and plant utilisation eg high output, conventional; methods of maintaining gauge clearance and track position (conventional and absolute track geometry); component fixity; stressing of rails; consideration of associated structures

*Materials and quality control:* sampling and testing of materials and component parts; product specification and approval processes; sustainable sourcing; waste material disposal eg ballast disposal, track recycling systems

## 4 Understand track maintenance processes used to identify and correct defects in railways

*Maintenance issues:* fatigue defects eg rail defects; seasonal/environmental eg leaf fall, low/high temperature, snow, flooding; track component failure eg rail, sleeper, fastening; instability of sub-grade or ballast

*Identification of rail infrastructure defects:* inspection eg visual, vehicles; high speed testing/examination; review of outputs and application of maintenance standards; special inspections eg bridges, tunnels; rail defect classification

*Remedial treatments:* replacement of failed components; weld repair; grinding; leaf fall removal; remedial correction of defective ballast eg manual/mechanical methods to stabilise weak sub-grade

## Assessment and grading criteria

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria for a pass grade describe the level of achievement required to pass this unit.

Assessment and grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:	To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:
<b>P1</b> describe the legal and financial framework applicable to a project for a new section of railway infrastructure	<b>M1</b> evaluate the pre-production and legislative processes that may be required for a given rail infrastructure project	<b>D1</b> justify the pre-production, legislative and earthworks processes that have been used for a given rail infrastructure project
<b>P2</b> describe the development process required for a new build or renewal within a railway environment	<b>M2</b> compare two given railway track earthworks projects	<b>D2</b> analyse a given rail infrastructure failure and identify the root cause and effect of the failure.
<b>P3</b> describe the methodology used for a railway track earthworks project, including the plant and equipment required for a standard track cross section [IE4]	<b>M3</b> explain the need for overall asset inspection, management, effects of failure and the appropriate remedial actions.	
<b>P4</b> explain the essential design principles for track geometry		
<b>P5</b> describe the construction methods for initial placement and subsequent maintenance activities to ensure track position and geometry [IE2, IE4]		
<b>P6</b> describe the materials and quality control processes required to ensure the provision of suitable and sustainable track construction material and waste material disposal		
<b>P7</b> describe the maintenance issues that need to be considered to determine rail infrastructure integrity		

Assessment and grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:	To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:
<b>P8</b> explain how rail infrastructure defects are identified and the prescribed remedial action for each.		

**PLTS:** This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills applicable in the pass criteria. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

<b>Key</b>	IE – independent enquirers CT – creative thinkers	RL – reflective learners TW – team workers	SM – self-managers EP – effective participators
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## Essential guidance for tutors

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### Delivery

It is likely that centres will deliver the learning outcomes in sequence. This will ensure that learners gain an understanding of the preparatory activities required for the construction of a railway track before going on to consider the scope of the earthworks required, the design principles of railway track infrastructure and track maintenance processes.

It is recommended that traditional teaching methods are combined with more learner-centred investigations to encourage exploration of the subject. For example, a case study/project might be used to explore the construction of a new section of track from its initial preparation through to its commissioning and use. If possible, case studies should be based on a site where learners are working, as this can add significant vocational reality and relevance. In such cases, learners may need to formulate and agree with their tutor the scenario and the terms of reference for the case study/project.

Whatever delivery method is used, it is critical that learners gain an understanding of the scale and scope of railway infrastructure, its construction and maintenance. Although the use of video footage might help learners gain an appreciation of the scale and complexity of such works, it is strongly recommended that each learner gains at least some first hand experience on a working site. This may be achieved through the learner's work-based experience (eg apprenticeship) or through organised site visits arranged by the centre. Such visits can be of great value and will enable learners to appreciate the range and scale of typical tasks undertaken during a railway new build, renewal or during maintenance operations.

## Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan demonstrates one way in planning the delivery and assessment of this unit.

Topic and suggested assignments/activities and/assessment
<p><i>Whole-class teaching:</i></p> <ul style="list-style-type: none"><li>• identify and describe primary legislation relating to railway construction</li><li>• describe the funding of railways and procedures to acquire land</li><li>• describe the development process required for the building of new sections of rail and renewal of existing railways.</li></ul> <p><i>Group research activity:</i></p> <ul style="list-style-type: none"><li>• using case study material identify the different considerations that needed to be taken into account before a new railway could be built.</li></ul>
<p>Preparation for and carrying out <b>Assignment 1: Preparing for Railway Infrastructure Construction</b> (P1, P2, P3, M1, D1)</p>
<p><i>Whole-class teaching:</i></p> <ul style="list-style-type: none"><li>• explain the preparation and construction processes required in order to build earthworks for a rail construction project.</li></ul> <p><i>Site visit/case study:</i></p> <ul style="list-style-type: none"><li>• identify and view the main aspects of earthwork construction.</li></ul>
<p>Preparation for and carrying out <b>Assignment 2: Railway Track Earthwork Activities</b> (P3, M2)</p>
<p><i>Whole-class teaching:</i></p> <ul style="list-style-type: none"><li>• explain the forms of construction, forms of track, tunnels and walkways that form track infrastructure</li><li>• explain and discuss track design considerations</li><li>• identify and explain the standards used in railway track infrastructure</li><li>• explain different construction methods used</li><li>• identify and discuss the materials and quality control for railway infrastructure.</li></ul> <p><i>Group research activity:</i></p> <ul style="list-style-type: none"><li>• using case study material identify the main forms of construction used for a particular rail infrastructure project.</li></ul>
<p>Preparation for and carrying out <b>Assignment 3: Track Design and Sustainability</b> (P4, P5, P6)</p>
<p><i>Whole-class teaching:</i></p> <ul style="list-style-type: none"><li>• explain and discuss the main maintenance issues that can affect railway track</li><li>• explain the methods use to inspect and identify rail infrastructure defects</li><li>• explain the different remedial treatments that can be used to repair track defects.</li></ul>
<p>Preparation for and carrying out <b>Assignment 4: Track Maintenance</b> (P7, P8, M3, D2)</p>
<p>Unit evaluation and feedback.</p>

## Assessment

The approach to assessment will be very much dependent on the degree of access that learners have to actual railway infrastructure construction and maintenance activities. Where learners have access to 'live' sites, evidence could be generated through work-based activities. Where this is not practicable a case-study, developed through project style investigations could be used. Although it may be possible to construct suitable test/examination type questions to meet the requirements of the assessment criteria, this is not considered to be the best approach.

For P1, learners must describe the legal and financial framework applicable to a project for a new section of railway infrastructure. This needs to include reference to the primary legislation that must be followed, the relevant funding required for a new section of railway infrastructure and the procedures used to acquire land. Learners must also describe the development process required for a new build or renewal within a railway environment (P2). The choice of either new build or renewal can be decided either by the learner or the tutor. If a new build is chosen, P2 could be linked with P1. Otherwise, if the learner considers a renewal, a separate piece of work would be needed for P2. The work associated with P1 and P2 should be linked, where possible, with that for M1 and D1. The respective evaluation and justification should be based on the legal, financial and development processes considered at pass level.

P4, P5 and P6 cover learning outcome 3. Centres may choose to design a single assessment activity based on a given section of railway track to cover all three criteria. To achieve P4, learners must explain the essential design principles for track geometry including the form of construction, form of track, track design consideration and use of relevant design standards. For P5, they must describe the construction methods for initial placement and subsequent maintenance activities to ensure track position and geometry. Finally, for P6, learners must describe the materials and quality control processes required to ensure the provision of suitable and sustainable track construction material and waste material disposal.

P7 and P8 relate to learning outcome 4, and require learners to examine the maintenance processes used for railway infrastructure. These also link to M3 and D2 and centres should consider the design of the assessment instrument used to ensure that all four criteria are achieved through a single assessment activity. To achieve P7, learners must describe the maintenance issues that need to be considered to determine rail infrastructure integrity. This must cover all the maintenance issues included in the respective content section – fatigue defects, seasonal/environmental issues and track component failure. This can be done as part of the learner's explanation of how rail infrastructure defects are identified and the prescribed remedial action for each (P8). This should include inspection methods, high speed testing/examination, review of outputs and applications of maintenance plus the related remedial treatments. This work can be further developed to achieve M3 through an explanation of the need for overall asset inspection and management that recognises the effects of failure and remedial actions. Finally, a 'what if' type scenario could be used for analysis of a given rail infrastructure failure and identification of the root cause and effect of the failure (D2).

## Programme of suggested assignments

The table below shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the assessment and grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Edexcel assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1, P2, P3, M1, D1	Preparing for Railway Infrastructure Construction	A railway design and construction company has been asked to produce a report for a new build development.	A written assignment based on a case study or work-based report detailing activities required to prepare for construction.
P3, M2	Railway Track Earthwork Activities	A contractor is asked to prepare a proposal for the construction of earthworks for a new section of track.	A written assignment based on a case study or work-based report.
P4, P5, P6	Track Design and Sustainability	A railway design and construction company has been asked to design a section of railway track for a new build development.	A design proposal.
P7, P8, M3, D2	Track Maintenance	A rail construction contractor has been asked to produce a self evaluation form for quality control.	A written report on track maintenance.

## Links to National Occupational Standards, other BTEC units, other BTEC qualifications and other relevant units and qualifications

This unit forms part of the BTEC Engineering sector suite. This unit has particular links with the following unit titles in the Engineering suite:

Level 1	Level 2	Level 3
		Function and Characteristics of Railway Signalling Systems
		Railway Signalling Systems Testing and Maintenance

## Essential resources

There are no major essential resources for this unit, however, centres will find it difficult to deliver this unit without access to either 'live' construction and maintenance sites or at least suitable video footage. Centres will need to provide access to relevant legislation/regulations and design standards for reference.

## Employer engagement and vocational contexts

Much of the work for this unit can be set in the context of learners' work placements or be based on case studies of local employers. Further information on employer engagement is available from the organisations listed below:

- Work Experience/Workplace learning frameworks – Centre for Education and Industry (CEI, University of Warwick) – [www.warwick.ac.uk/wie/cei](http://www.warwick.ac.uk/wie/cei)
- Learning and Skills Network – [www.vocationallearning.org.uk](http://www.vocationallearning.org.uk)
- Network for Science, Technology, Engineering and Maths Network Ambassadors Scheme – [www.stemnet.org.uk](http://www.stemnet.org.uk)
- National Education and Business Partnership Network – [www.nebpn.org](http://www.nebpn.org)
- Local, regional Business links – [www.businesslink.gov.uk](http://www.businesslink.gov.uk)
- Work-based learning guidance – [www.aimhighersw.ac.uk/wbl.htm](http://www.aimhighersw.ac.uk/wbl.htm)

## Indicative reading for learners

### Textbooks

Bonnett C – *Practical Railway Engineering* (Imperial College Press, 2005) ISBN 1 860945 1 55

Selig E and Waters J – *Track Geotechnology and Substructure Management* (Thomas Telford Ltd, 1994) ISBN 0727720139

## Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the pass assessment criteria of this unit.

Skill	When learners are ...
<b>Independent enquirers</b>	planning and carrying out researching when investigating railway track and earthwork construction analysing and evaluating information on rail infrastructure, judging its relevance and value.

Although PLTS are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are ...
<b>Creative thinkers</b>	asking questions in relation to railway infrastructure to extend their thinking
<b>Reflective learners</b>	reviewing progress and acting on the outcomes.

## ● Functional Skills – Level 2

Skill	When learners are ...
<b>English</b>	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	explaining and describing the processes and methodologies involved in the construction and maintenance of rail infrastructure
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	researching the processes and methodologies involved in the construction and maintenance of rail infrastructure
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	explaining and describing the processes and methodologies involved in the construction and maintenance of rail infrastructure.