

Unit 59: Railway Infrastructure Construction and Maintenance

NQF Level 3: BTEC National

Guided learning hours: 60

Unit abstract

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

Learners 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 (eg 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 must:

- 1 Understand the preparatory activities required for the construction of railway track infrastructure
- 2 Understand 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

1 Understand 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 Understand 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

Grading grid

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

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:
P1 describe the legal and financial framework applicable to a project for a new section of railway infrastructure	M1 evaluate the pre-production and legislative processes that may be required for a given rail infrastructure project	D1 justify the pre-production, legislative and earthworks processes that have been used for a given rail infrastructure project
P2 describe the development process required for a new build or renewal within a railway environment	M2 compare two given railway track earthworks projects	D2 analyse a given rail infrastructure failure and identify the root cause and effect of the failure.
P3 describe the methodology used for a railway track earthworks project, including the plant and equipment required for a standard track cross section	M3 explain the need for overall asset inspection, management, effects of failure and the appropriate remedial actions.	
P4 explain the essential design principles for track geometry		

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:
<p>P5 describe the construction methods for initial placement and subsequent maintenance activities to ensure track position and geometry</p> <p>P6 describe the materials and quality control processes required to ensure the provision of suitable and sustainable track construction material and waste material disposal</p> <p>P7 describe the maintenance issues that need to be considered to determine rail infrastructure integrity</p> <p>P8 explain how rail infrastructure defects are identified and the prescribed remedial action for each.</p>		

Essential guidance for tutors

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.

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.

Learning outcome 2 has only one related pass criterion, P3. To achieve this learners must describe the methodology used for a railway track earthworks project including the plant and equipment required for a standard track cross section. Although only a single criterion, the range of content to be covered will make this a substantial piece of work. The description will need to refer to site preparation, cut and fill operations, embankment construction, treatment of weak areas, ground water control, forms of subsoil drainage and disposal of collected water. For each of these, learners must also consider the plant and equipment required. Linking this criterion with M2 (comparison of two railway track earthworks) may provide more scope to cover all the content by examining two earthwork projects rather than trying to do this through the investigation of just one.

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).

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

This unit can be linked with *Unit 49: Function and Characteristics of Railway Signalling Systems* and *Unit 56: Installing, Commissioning, Testing and Maintenance of Railway Signalling Systems*.

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.

Indicative reading for learners

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

Key skills

Achievement of key skills is not a requirement of this qualification but it is encouraged. Suggestions of opportunities for the generation of Level 3 key skill evidence are given here. Tutors should check that learners have produced all the evidence required by part B of the key skills specifications when assessing this evidence. Learners may need to develop additional evidence elsewhere to fully meet the requirements of the key skills specifications.

Communication level 3	
When learners are:	They should be able to develop the following key skills evidence:
<ul style="list-style-type: none"> gathering information on railway infrastructure construction and maintenance procedures and practice describing the legal and financial frameworks, development processes and methodology, etc. of railway infrastructure construction and maintenance. 	<p>C3.2 Read and synthesise information from at least two documents about the same subject. Each document must be a minimum of 1000 words long.</p> <p>C3.3 Write two different types of documents each one giving different information about complex subjects. One document must be at least 1000 words long.</p>
Information and communication technology Level 3	
When learners are:	They should be able to develop the following key skills evidence:
<ul style="list-style-type: none"> searching for information on railway infrastructure construction and maintenance procedures and practice preparing and presenting information on the legal and financial frameworks, development processes and methods of railway infrastructure construction and maintenance. 	<p>ICT3.1 Search for information, using different sources, and multiple search criteria in at least one case.</p> <p>ICT3.2 Enter and develop the information and derive new information.</p> <p>ICT3.3 Present combined information such as text with image, text with number, image with number.</p>