Detailed Requirements Document (DRD)
Level 3 Electrification Context Core and Specialisms

Overview

Employers in the Rail Engineering Sector have developed this Detailed Requirements Document (DRD); the document is designed to meet the detail required for the electrification pathway within the Railway Engineering Technician Standard.

The Electrification DRD describes the context core and specialisms required for an Electrification Railway Engineering Technician to be competent; this document forms part of the Employer Occupational Brief (EOB).

Purpose

Employers, colleges and training providers should use this document to support the delivery of the Railway Engineering – Electrification pathway in the planning and delivery of the apprenticeship standard.

The detail within this document has been developed from the National Occupational Standards (NOS).

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1. Context core and specialisms for Electrification Rail Engineering Technician

Core Knowledge. Within a Rail context all Rail Engineering Technicians need to know about:
Safe and Professional working practices including legislation, regulation, industry procedures and safety requirements.
The scientific, technical, engineering, mathematical and design principles that are required to support the maintenance, renewal and construction of The Railway.

Core Skills. Within a Rail context all Rail Engineering Technicians need to be able to:
Plan a high standard of technical work: Gathering and interpreting information including drawings, plans and schedules needed for the development of rail engineering activity planning; detailed inspection and performance & condition analysis of assets; Plan work to be undertaken including the appropriate resources.
Deliver a high standard of technical work: Undertake engineering activities in relation to maintenance, construction / installation and or renewal of assets. Complete integrity & compliance checks on own work, instigate testing and identify where independent testing is required. Transfer responsibility of assets once work has been completed. Supervise their own work and that of others.
Solve problems: Identify problems and apply a structured approach and appropriate methods to problem solving and diagnosis.
Communicate effectively. Use oral, written, electronic and IT based methods and systems for the accurate communication, reporting & recording of technical and other information, using correct terms, standards, templates and certifications.
Understand, manage and maintain harmonic and power quality systems, transformer rectifiers, motor generators and transformers, DC traction breakers, protection and SCADA control systems, compressed air systems, power generation and other sub-station plant
Know how to and be able to work to high and low voltage power rules, reinstate power supplies by local, manual and remote switching, isolation and earthing of AC/DC electrical systems at different voltages and frequencies (this includes live working for TfL).

Core Knowledge

2. Safe and Professional working practices including legislation, regulation, industry procedures and safety requirements.

Safe and Professional working practices including legislation, regulation, industry procedures and safety requirements.
Health, Safety & Environment
Your organisation's methods and techniques for carrying out preventative and corrective maintenance activities relevant to your role
Your organisations methods and procedures for carrying out isolation activities
Your organisations methods and procedures for carrying out testing and earthing activities
Your organisations methods and techniques for carrying out assessment activities relevant to your role
Your organisations methods and techniques for carrying out restoration activities relevant to your role
Your organisation's methods and techniques for carrying out switching activities

Core Knowledge

3. The scientific, technical, engineering, mathematical and design principles that are required to support the maintenance, renewal and construction of The Railway.

The scientific, technical, engineering, mathematical and design principles that are required to support the maintenance, renewal and construction of The Railway
The Rail Engineering Technician knowledge qualification for the Electrification pathway is made up of the following three units: Overhead Line Infrastructure Construction and Maintenance is mandatory plus one from Overhead Line Technologies (Construction) or Overhead Line Technologies (Maintenance). For further guidance please see the knowledge qualification structure at annex A.
Features and Application of Electrical Machines
Know the electrical hazards and the legislation, regulations and standards related to working with electrical apparatus • Identify the hazards that may exist when working with different pieces of electrical apparatus • Describe the control measures that should be used to reduce the risk of harm to self and others when working electrical apparatus • Describe the aspects of legislation, regulations and standards that relate to electrical apparatus
Understand alternating current (AC) machines • Explain the features, characteristics and application of AC motors • Explain the features, characteristics and applications of AC generators • Explain the features, characteristics and applications of transformers
Understand direct current (DC) machines • Explain the features, characteristics and applications of DC motors • Explain the features, characteristics and applications of DC generators
Know how electrical machine control circuits and systems operate • Describe the operation and use of stop/start/retain relay control circuits for AC or DC machines
Rail Electrification Technologies
Understand mechanical systems • Describe the purpose and application of lubricants • Describe the operation and maintenance of lubrication systems • Describe the operation of seals, packaging and bearings. • Describe the operation of different types of cam and follower and linkage mechanisms. • Describe the arrangement and operation of transmission shaft and coupling, clutch and brakes • Describe the layout and operation of a pneumatic actuation systems, hydraulic actuation systems and manual handling systems • Describe the layout and operation of power generation plant, refrigeration and air conditioning systems applied to substations.

Core Knowledge

The scientific, technical, engineering, mathematical and design principles that are required to support the maintenance, renewal and construction of The Railway
Rail Electrification Technologies continued
Understand materials in the rail environment • Describe mechanical, physical, thermal, electrical and magnetic properties of materials used in rail engineering • Describe the effects of processing on the properties and behaviour of materials used in rail engineering • Describe the principles of the modes of failure.
Understand the function of High Voltage and Low Voltage Switchgear • Explain the purpose, operation and application of switchgear • Explain the importance of switchgear to plant safety and the requirement to use specialist tools • Identify hazards associated with maintenance activities on switchgear • Identify switchgear component failure modes and causes
Data Analysis
Principles and theories associated with fluid power equipment (such as cascading and truth tables, logic/ladder diagrams, sequential charts/tables or functional diagrams)
Systems
The effects of pressure and flow on the performance of the system
The principles of how Heating Ventilation Air Conditioning (HVAC) units/modules function
The principles of how communication-electronic or associated systems function and interact e.g. SCADA
Assets & Equipment
The identification of different compressors (such as screw piston, rotary vane)
The identification of different hydraulic motors (such as piston, gear, vane)
The different types of pipework, fittings and manifolds, and their application
The identification, application, function and operation of different types of valves (such as poppet, spool, piston, disc and slide)
The identification, application function and operation of different types of sensors and actuators (such as rotary, linear, mechanical, electrical)
The identification and application of different types of pumps (positive, gear vane and piston)
The different types of cabling including their application and compliance (such as multi-core cables, single-core cables, steel wire armoured (SWA), data cables, screened cables, fibre cables) their fittings and their application.
The different types of electrical component (such as plugs, sockets, switches, lighting and fittings, junction boxes, relays, protection devices)

Core Skills

4. Plan a high standard of technical work

Plan a high standard of technical work: Gathering and interpreting information including drawings, plans, schedules needed for the development of rail engineering activity planning; Detailed inspection and performance & condition analysis of assets; Plan work to be undertaken including the appropriate resources.
How to identify and analyse the restoration activities to be undertaken
Identify the components and/or equipment to be restored

5. Deliver a high standard of technical work

Deliver a high standard of technical work: Undertake engineering activities in relation to maintenance, construction / installation and or renewal of assets. Complete integrity & compliance checks on own work, instigate testing and identify where independent testing is required. Transfer responsibility of assets once work has been completed. Supervise their own work and that of others.
Installation and Maintenance
Source and interpret the relevant information relating to the switches and their location
The different types and mechanisms of switches and their correct mode of operation
How to identify and analyse the sequence of switching activities to be undertaken
Carry out the switching activity within the limits of your own authority
Carry out the switching activities in the specified sequence and in an agreed timescale
Carry out the required isolation and earthing activities in the specified sequence and in agreed timescales
Establish the operational condition of the contact system
Integrity & Compliance
The types of conditions and activities that would impact on the functional integrity and safety of the operational system
How and when switching activities cannot be completed
Identify and confirm the required isolation and earthing methods and procedures
Identify and confirm the required position of the switches prior to the activity

Core Skills

Deliver a high standard of technical work: Undertake engineering activities in relation to maintenance, construction / installation and or renewal of assets. Complete integrity & compliance checks on own work, instigate testing and identify where independent testing is required. Transfer responsibility of assets once work has been completed. Supervise their own work and that of others.
Integrity & Compliance continued
Source and interpret the relevant information relating to the contact system and the location of the isolation and earthing activity
Identify where the operational condition of the assets may affect the functional integrity and safety of the operational system
Identify where the operational condition of the contact system may affect the functional integrity and safety of the operational system
How to source and interpret information relating to the contact system, including operational activity, if applicable
Testing
How to identify and analyse the sequence of testing and earthing activities to be undertaken
The types of tests and checks that can be performed upon completion of the installation
Identify any special requirements and incorporate them in the plan, for example, identifying when independent testing and additional communications equipment are required
Transfer Responsibility
Establish and confirm the correct positioning of the switches upon completion of the activity
Confirm the isolating and earthing activities have been completed within the limits of your own authority

6. Solve problems

Solve problems: Identify problems and apply a structured approach and appropriate methods to problem solving and diagnosis.
Identify and assess and defects or variations to the switching mechanisms

Core Skills

7. Communicate effectively

Communicate effectively. Use oral, written, electronic and IT based methods and systems for the accurate communication, reporting & recording of technical and other information, using correct terms, standards, templates and certifications.
Communicate Effectively
How to source and interpret information relating to the switches, including maintenance reports, if applicable
Report any instances where the switching activities cannot be fully met or where there are identified defects outside the planned activities
The implications of not reporting instances of where the switching activities cannot be fully met

Electrification Specific Detail

8. Understand, manage and maintain harmonic and power quality systems, transformer rectifiers, motor generators and transformers, DC traction breakers, protection and SCADA control systems, compressed air systems, power generation and other sub-station plant

Understand, manage and maintain harmonic and power quality systems, transformer rectifiers, motor generators and transformers, DC traction breakers, protection and SCADA control systems, compressed air systems, power generation and other sub-station plant
Prepare for Engineering Activities
Assist in preparing resources for electrification and plant engineering activities **Points 1 and 2 -** Conduct Maintenance, installation and Repairs from first principles, following Work Instructions, Risk Assessments, Method Statements and or direct instruction. Identify electromechanical load flows before conducting switching so as to maintain supply to the railway via alternative feeds (where applicable). Arrange to switch Plant ON/OFF by remote, Local or manual control via the correct authority. Identify any safety hazards present at the location of the work. Identify individual competencies needed for the task. 1. Work to a plan and identify what resources are required and source information regarding those resources. 2. Ensure that there are sufficient resources available for the activities to be undertaken and that the resources are used safely, appropriately and in a timely manner. 3. Work to a plan and ensure the required resources are available and fit for purpose, including obtaining all the necessary documentation and reporting to your line manager/supervisor. Activities may include: 1. Maintenance 2. Fault finding and/or installation work on electrification and plant equipment, assets and components

Electrification Specific Detail

Understand, manage and maintain harmonic and power quality systems, transformer rectifiers, motor generators and transformers, DC traction breakers, protection and SCADA control systems, compressed air systems, power generation and other sub-station plant
Prepare for Engineering Activities continued
Allocate and monitor resources for electrification and plant engineering activities 1. Work to a plan, identify and allocate the resources required and source information regarding those resources. Procuring drawings, work instructions / method statements, tools, parts and testing equipment / other equipment necessary for the task. Identify correct level of staffing, for the task, to maintain a safe environment. 2. Monitor the use of resources and ensure that there are sufficient resources available for the activities to be undertaken and that resources are used safe, appropriate and timely manner. Compile a report of any anomalies or unsafe practices so that improvements can be put in place. 3. Where changes in resources or activities occur the individual will be able to challenge when a plan or resource allocation may need amending. Following Change Control Policy where needed liaising with Line Managers at all times.
Assist in preventative and corrective maintenance of traction cabling systems 1. The maintenance may be routine and could involve replacing, locating, diagnosing, restoring and testing earthing and bonding equipment. 2. This element may also include working on one or more electrical components associated with power supply systems. 3. The types of activities will be both planned and unplanned but will generally be single stage processes The types of systems may include: 1. Contact Systems (OLE, Conductor rails) 2. Power Supply Equipment (Switchgear AC and DC, Transformers) Types of maintenance activities may include: 1. Routine and preventative maintenance 2. Replacement 3. Faultfinding 4. Restoration 5. Testing
Carry out technical assessment of electrification and plant 1. Carry out technical assessments of contact systems (OHLE, Conductor rails) in the rail engineering industry. i.e. Switchgear both AC and DC, Auto Transformers, Rectifiers and protection systems for both intrusive and Non-intrusive. 2. This could include intrusive or non-intrusive inspection or other methods appropriate for the asset type, which may be routine. 3. At all times the inspection or other methods must be approved by your organisation. 4. Contact systems could include all aspects of overhead line electrification equipment and conductor rails, such as substation electrification equipment. 5. Assets are mainly electrical but the activity could include one or more structural and/or mechanical components.

9. Know how to and be able to work to high and low voltage power rules, reinstate power supplies by local, manual and remote switching, isolation and earthing of AC/DC electrical systems at different voltages and frequencies (this includes live working for TfL).

Know how to and be able to work to high and low voltage power rules, reinstate power supplies by local, manual and remote switching, isolation and earthing of AC/DC electrical systems at different voltages and frequencies (this includes live working for TfL).
Plan Electrification and Plant Activities
Plan electrification and plant engineering activities 1. This element is about planning electrification and plant engineering activities, which may include considering the availability of: a. technical documentation b. equipment c. tools d. materials e. components f. personnel 2. At all times you must take into account the time the system will be available for the task when planning activities and considering resources. The type of activities to be planned may relate to: 1. Contact systems (OLE, Conductor rails) 2. Power supply equipment
Isolate and earth contact systems to meet defined isolation requirements in the rail engineering industry 1. Confirm the requirements for isolating and earthing prior to undertaking the activity. 2. The types of isolations may include: pre-arranged, urgent, short notice. 3. This unit is for those individuals who are required to isolate and earth contact systems to meet defined isolation requirements.
Establish the operational condition of electrification and plant assets 1. This could include intrusive or non-intrusive inspection or other methods appropriate for the asset. 2. At all times the inspection or other methods must be approved by your organisation. 3. The types activities could vary and will generally be multi stage processes. 4. Operational Control - Remote, Local and Manual Switching (Contacts OPEN & CLOSED) The assets may include: 1. Contact systems (OLE, Conductor rails) 2. Power supply equipment The assets may also include one or more components in the following areas: 1. Structural 2. Mechanical 3. Electrical

Electrification Specific Detail

Know how to and be able to work to high and low voltage power rules, reinstate power supplies by local, manual and remote switching, isolation and earthing of AC/DC electrical systems at different voltages and frequencies (this includes live working for TfL).

Plan Electrification and Plant Activities continued

Carry out installation of electrification and plant equipment and components

1. Install, position and secure electrification and plant equipment and components correctly and making the necessary connections in accordance with policies and procedures.

The types of equipment and components may include:
- Contact and catenary wire
- Insulators
- Droppers
- Switchgear AC and DC
- Auto Transformers protection
- Rectifiers

These may also be in one or more of the following areas:
- Structural
- Mechanical
- Electrical

The equipment and components will be sub-sets of the following assets
- Contact Systems (OLE, Conductor rails)
- Power Supply Equipment

Types of installation activities may include:
- Replacing insulators
- Replacing droppers

Carry out installation of electrification and plant assets

1. Perform multistage processes ensuring any interference with other systems and assets is kept to a minimum.
2. Where interference with other systems and assets has to take place, the correct approvals will be obtained.

The types of assets may include:
1. Contact systems (OLE, Conductor rails)
2. Power supply equipment

These may also be in one or more of the following areas:
1. Structural
2. Mechanical
3. Electrical

Electrification Specific Detail

Know how to and be able to work to high and low voltage power rules, reinstate power supplies by local, manual and remote switching, isolation and earthing of AC/DC electrical systems at different voltages and frequencies (this includes live working for TfL).
Plan Electrification and Plant Activities continued
Carry out preventative and corrective maintenance of traction cabling systems 1. The maintenance may be routine and could involve replacing, locating, diagnosing, restoring and testing earthing and bonding equipment. 2. This element may also include working on one or more electrical components associated with power supply systems. 3. The types of activities will be both planned and unplanned but will generally be multi stage processes and any interference with other systems must be kept to a minimum. 4. Where interference with other systems has to take place, correct approvals will be obtained. The types of systems may include: 1. Contact Systems (OLE, Conductor rails) 2. Power Supply Equipment Types of maintenance activities may include: 1. Routine and preventative maintenance 2. Replacement 3. Faultfinding 4. Restoration 5. Testing 6. Use of varying Electrical and Mechanical Test Equipment
Carry out maintenance on electrification and plant assets 1. Undertake preventative and corrective maintenance on electrification and plant assets. The maintenance may be routine and could involve adjusting, replacing and dismantling/reassembling electrification and plant assets. 2. The types of maintenance activities will be both planned and unplanned but will generally be multi stage processes and any interference with other systems and assets must be kept to a minimum. 3. Where interference with other systems and assets has to take place, you will ensure the correct approvals are obtained. Undertake preventative and corrective maintenance on electrification and plant assets. The types of assets may include: 1. Contact systems (OLE, Conductor rails) 2. Power supply equipment These may also be in one or more of the following areas: 1. Structural 2. Mechanical 3. Electrical

Electrification Specific Detail

Know how to and be able to work to high and low voltage power rules, reinstate power supplies by local, manual and remote switching, isolation and earthing of AC/DC electrical systems at different voltages and frequencies (this includes live working for TfL).
Plan Electrification and Plant Activities continued
Carry out maintenance on electrification and plant assets continued
The types of maintenance activities may include: 1. Locating and diagnosing defects 2. Fault finding 3. Adjustments 4. Replacements 5. Renewals 6. Restorations 7. Removals
Carry out maintenance on electrification and plant equipment and components 1. The activities may be routine and include preventative and corrective maintenance activities 2. Could also involve adjusting, replacing and dismantling electrification and plant equipment and components 3. This element is about carrying out maintenance on electrification and plant equipment and components and may also include inter-connections, which may include preventative and corrective maintenance activities 4. The activities will be routine and may involve adjusting, replacing and dismantling electrification and plant equipment and components 5. The types of maintenance activities will be both planned and unplanned but will generally be single stage processes. The types of equipment, components and inter-connections may include: - conductors (overhead wires and rails) - support and registration assemblies - in span equipment such as section insulators and neutral section - contact and catenary wire - earthing and bonding cables and connectors - insulators - foundations - support structures such as masts and portals - droppers - Emergency Lighting - Maintenance Lighting These may also be in one or more of the following areas: 1. Structural 2. Mechanical 3. Electrical The equipment, components and interconnections will be sub-sets of the following assets: 1. Contact Systems (OLE, Conductor rails) 2. Power supply equipment

Electrification Specific Detail

Know how to and be able to work to high and low voltage power rules, reinstate power supplies by local, manual and remote switching, isolation and earthing of AC/DC electrical systems at different voltages and frequencies (this includes live working for TfL).
Plan Electrification and Plant Activities continued
Carry out maintenance on electrification and plant equipment and components continued
Examples of maintenance activities may include: 1. Lubrication 2. Cleaning and security of equipment such as, insulation, signage, guarding Examples of replacement techniques may include: 1. Crimping 2. Fastening 3. Rail drilling 4. Using tensioning rigs
Restore the contact systems to operational condition in the rail engineering industry 1. Assess the condition of the contact system and mode of failure following a de-wirement and undertaking re-construction work to restore the contact system to full operational capability. 2. The contact systems could include all aspects of overhead line electrification equipment and conductor rails. 3. The assets are mainly electrical but the restoration activity could include one or more structural and/or mechanical components.
Transfer responsibility of electrification and plant equipment and components Follow Low and High Voltage Rules and Permitting systems. Declare and Record Plant Equipment 'Fit' or 'Unfit' for Service and follow local procedures associated with these processes. Place Status Documentation on equipment that must be energised into service due to technical inefficiency or defect. Provide suitable and sufficient evidence to confirm the operational status of the equipment and/or components including recommending whether the: 1. Carry out Test and Commissioning of the system 2. System is fit for entry into service 3. System is fit for entry into restricted service 4. System is not fit for entry into service Ensure that the equipment and/or components are transferred back only after sufficient evidence exists to ensure safe working and the information supplied accurately and clearly identifies the operational status of the equipment and/or components.

Electrification Specific Detail

Know how to and be able to work to high and low voltage power rules, reinstate power supplies by local, manual and remote switching, isolation and earthing of AC/DC electrical systems at different voltages and frequencies (this includes live working for TfL).
Plan Electrification and Plant Activities continued
Manually switch the electrical supply to contact systems to meet defined requirements in the rail engineering industry 1. Confirm the requirements for switching prior to undertaking the switching on and off of the electrical supply. 2. This unit if for those individuals who are required to manually switch the electrical supply to contact systems to meet defined requirements. 3. Follow local Low Voltage and High Voltage procedures for Switching. 4. Record and document all activities and agree any switching activities beforehand. 5. Follow verbal communication procedures.