

# City & Guilds Level 3 Award in the Requirements for the Design and Installation of Domestic and Small Commercial Electric Vehicle Charging Installations (2921-34)

Version 1.1 (September 2024)

## Qualification Handbook

## Qualification at a glance

<b>Subject area</b>	Building Services Industry
<b>City &amp; Guilds number</b>	2921
<b>Age group approved</b>	18+
<b>Entry requirements</b>	Please see the guidance on page 10
<b>Assessment</b>	Online multiple choice test
<b>Grading</b>	Pass/Fail
<b>Approvals</b>	Automatic approval applies in certain cases
<b>Support materials</b>	Sample assessments Smartscreen
<b>Registration and certification</b>	Consult the Walled Garden/Online Catalogue for last dates

<b>Title and level</b>	<b>City &amp; Guilds qualification number</b>	<b>Regulatory reference number</b>	<b>GLH</b>	<b>TQT</b>
City & Guilds Level 3 Award in the Requirements for the Design and Installation of Domestic and Small Commercial Electric Vehicle Charging Installations	2921-34	610/4640/1	15	19

<b>Version and date</b>	<b>Change detail</b>	<b>Section</b>
1.0 August 2024	Initial version	All
1.1 September 2024	Learner entry requirements clarification	2. Centre requirements

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# 1 Introduction

This document tells you what you need to do to deliver the qualification:

Area	Description
Who is the qualification for?	<p>This qualification serves as a supplementary short course, supporting the professional development of competent electricians who meet industry entry requirements outlined in the Electrotechnical Assessment Specification (EAS).</p> <p>It is aimed at practicing electricians interested in understanding how to design and install the range of electric vehicle supply equipment and systems available. It is specifically designed for those proficient in designing low-voltage radial power circuits, with a focus on installing small-scale electric vehicle supply equipment in domestic and small commercial settings.</p> <p>By completing this qualification, electricians can enhance their expertise in regard to EV charging infrastructure, with the aim of ensuring safe and efficient installations for the growing demand in this field.</p>
What does the qualification cover?	<p>The purpose of this qualification is to provide a comprehensive understanding of the specific and supplementary requirements related to the design, installation, and maintenance of electric vehicle (EV) supply equipment, and associated circuits, in domestic and small commercial settings. These requirements align with the current Institute of Engineering and Technology (IET) Code of Practice for Electric Vehicle Charging Equipment Installation, the most relevant Regulations in relation to EV charging infrastructure, and the latest National Occupational Standards (NOS) outcomes as follows: BSEEVCP01 Install and connect enclosures, electrical cables, conductors and wiring for EVCP systems and equipment; BSEEVCP02 Inspect, test and commission EVCP systems and equipment; BSEEVCP03 Identify and rectify faults in EVCP systems and equipment; and BSEEVCP04 Maintain EVCP systems and equipment.</p> <p>The qualification covers additional methods of protecting against open PEN conductor faults and how to assess if an installation has an issue with diverted neutral current. It also covers smart functions</p>

Area	Description
	in electrical vehicle charging installations and relevant items within the installation as a whole. Integration into prosumer's electrical installations including the option of electric vehicles reverse feeding into the installation and/or supply grid.
What opportunities for progression are there?	On successful completion of this qualification, learners can progress on to City & Guilds Level 4 Award in the Design and Verification of Electrical Installations. As well as other CPD qualifications within Electrotechnical.
Who did we develop the qualification with?	Leading Charge Point Operators e.g. BP, Shell, Connected Kerb, TESP [including Electrician Plus accreditation] and key training organisations.
Is it part of an apprenticeship framework or initiative?	No.

## Structure

To achieve the City & Guilds Level 3 Award in the Requirements for the Design and Installation of Domestic and Small Commercial Electric Vehicle Charging Installations, learners must achieve:

City & Guilds unit number	Unit title	GLH
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### Mandatory units:

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Learners must achieve the following mandatory unit.

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305	Requirements for the Design and Installation of Domestic and Small Commercial Electric Vehicle Charging Installations	15
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Eligibility for this qualification must be confirmed according to the learner entry requirements on page 10. Once eligibility is confirmed, proxy unit **2921-801** must be claimed to allow certification. Please see Walled Garden for details.

## Total Qualification Time (TQT)

Total Qualification Time (TQT) is the number of notional hours which represents an estimate of the total amount of time that could reasonably be expected for a learner to demonstrate the achievement of the level of attainment necessary for the award of a qualification.

TQT comprises of the following two elements:

- 1) the number of hours that an awarding organisation has assigned to a qualification for guided learning
- 2) an estimate of the number of hours a learner will reasonably be likely to spend in preparation, study or any other form of participation in education or training, including assessment, which takes place as directed by – but, unlike guided learning, not under the immediate guidance or supervision of – a lecturer, supervisor, tutor or other appropriate provider of education or training.

Title and level	GLH	TQT
City & Guilds Level Level 3 Award in the Requirements for the Design and Installation of Domestic and Small Commercial Electric Vehicle Charging Installations	15	19

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## 2 Centre requirements

### Approval

#### Automatic approval

If your centre is approved to offer City & Guilds Level 3 Award in the Design and Installation of Domestic and Small Commercial Electric Vehicle Charging Installations (2921-31) you will be automatically approved to offer the new City & Guilds Level 3 Award in the Requirements for the Design and Installation of Domestic and Small Commercial Electric Vehicle Charging Installations (2921-34).

To offer this qualification, new centres will need to gain both centre and qualification approval. Please refer to the document **Centre Approval Process: Quality Assurance Standards** for further information.

Centre staff should familiarise themselves with the structure, content and assessment requirements of the qualification before designing a course programme.

### Resource requirements

#### Centre staffing

Staff delivering these qualifications must be able to demonstrate that they meet the following occupational expertise requirements. They should:

- be occupationally competent or technically knowledgeable in the area for which they are delivering training and/or have experience of providing training (this knowledge must be to the same level as the training being delivered)
- have recent relevant experience in the specific area they will be assessing
- have credible experience of providing training.

#### Continuing professional development (CPD)

Centres are expected to support their staff in ensuring that their knowledge remains current of the occupational area and of best practice in delivery, mentoring, training, assessment and quality assurance, and that it takes account of any national or legislative developments.



## Quality assurance

Approved centres must have effective quality assurance systems to ensure optimum delivery and assessment of qualifications. Quality assurance includes initial centre approval, qualification approval and the centre's own internal procedures for monitoring quality. Centres are responsible for internal quality assurance and City & Guilds is responsible for external quality assurance. All external quality assurance processes reflect the minimum requirements for verified and moderated assessments, as detailed in the Centre Assessment Standards Scrutiny (CASS), section H2 of Ofqual's General Conditions. For more information on both CASS and City & Guilds Quality Assurance processes visit: the **What is CASS?** and **Quality Assurance Standards** documents on the City & Guilds website.

Standards and rigorous quality assurance are maintained by the use of:

- Internal quality assurance
- City & Guilds external quality assurance.

External quality assurance for the qualification will be provided by City & Guilds EQA process. EQAs are appointed by City & Guilds to approve centres, and to monitor the assessment and internal quality assurance carried out by centres. External quality assurance is carried out to ensure that assessment is valid and reliable, and that there is good assessment practice in centres.

The role of the EQA is to:

- provide advice and support to centre staff
- ensure the quality and consistency of assessments and marking/grading within and between centres by the use of systematic sampling
- provide feedback to centres and to City & Guilds.

## Learner entry requirements

This course is intended for practicing electricians. Eligibility for this qualification must be confirmed according to the learner entry requirements as outlined below.

Evidence that eligibility requirements have been met must be kept by the centre for 3 years and will be subject to external quality assurance processes.

Learners **must** hold one of the following:

- City & Guilds Level 3 NVQ Diploma in Installing Electrotechnical Systems and Equipment (Buildings, Structures and the Environment) (2357)
- City & Guilds Level 3 NVQ Diploma in Electrotechnical Services (Electrical Maintenance) (2357)
- City & Guilds Level 3 Electrotechnical qualification (5357)
- City & Guilds Level 3 NVQ in Electrotechnical Services Experienced Worker (2356)
- City & Guilds Level 3 Electrotechnical Experienced Worker Qualification (2346)
- City & Guilds Level 3 Electrotechnical in Dwellings Experienced Worker Qualification (2347)
- Other Awarding Organisations equivalences will also be acceptable
- Equivalent historical qualifications (see EAS Table 4B/4C) [EAS Qualifications guide August 2023 \(theiet.org\)](#)  
or
- ECS Gold Card (for domestic electrician), JIB Electrician or Approved Electrician Card.

For learners in Scotland:

- Any of the above or
- SVQ in Electrical Installation at SCQF level 7

For learners in Wales:

- Any of the above or
- EAL Building Services Engineering (Level 3) Electrotechnical Installation

For all learners, the qualifications above must have been achieved no more than 5 years prior to starting this qualification or there must be evidence the learner has remained current by holding the latest edition of the Wiring regulations qualification.

## Age restrictions

This qualification is approved for learners aged 18 or above.

## Access arrangements and reasonable adjustments

City & Guilds has considered the design of this qualification and its assessment in order to best support accessibility and inclusion for all learners. We understand however that individuals have diverse learning needs and may require reasonable adjustments to fully participate. Reasonable adjustments, such as additional time or alternative formats, may be provided to accommodate learners with disabilities and support fair access to assessment.

Access arrangements are adjustments that allow candidates with disabilities, special educational needs, and temporary injuries to access the assessment and demonstrate their skills and knowledge without changing the demands of the assessment. These arrangements must be made before assessment takes place.

The Equality Act 2010 requires City & Guilds to make reasonable adjustments where a disabled person would be at a substantial disadvantage in undertaking an assessment.

It is the responsibility of the centre to ensure at the start of a programme of learning that candidates will be able to access the requirements of the qualification.

Please refer to the JCQ access arrangements and reasonable adjustments and Access arrangements - when and how applications need to be made to City & Guilds for more information. Both are available on the **[City & Guilds website](#)**

## 3 Delivering the qualification

### Initial assessment and induction

An initial assessment of each learner should be made before the start of their programme to identify:

- if the learner has any specific training needs
- support and guidance they may need when working towards their qualification
- any units they have already completed or credit they have accumulated which is relevant to the qualification
- the appropriate type and level of qualification.

We recommend that centres provide an induction programme so the learner fully understands the requirements of the qualification, their responsibilities as a learner and the responsibilities of the centre. This information can be recorded on a learning contract.

### Inclusion and diversity

City & Guilds is committed to improving inclusion and diversity within the way we work and how we deliver our purpose which is to help people and organisations develop the skills they need for growth.

More information and guidance to support centres in supporting inclusion and diversity through the delivery of City & Guilds qualifications can be found here:

**[Inclusion and diversity | City & Guilds \(cityandguilds.com\)](#)**

### Sustainability

City & Guilds are committed to net zero. Our ambition is to reduce our carbon emissions by at least 50% before 2030 and develop environmentally responsible operations to achieve net zero by 2040 or sooner if we can. City & Guilds is committed to supporting qualifications that support our customers to consider sustainability and their environmental footprint.

More information and guidance to support centres in developing sustainable practices through the delivery of City & Guilds qualifications can be found here:

**[Our Pathway to Net Zero | City & Guilds \(cityandguilds.com\)](#)**

Centres should consider their own carbon footprint when delivering this qualification and consider reasonable and practical ways of delivering this qualification with sustainability in mind. This could include:

- reviewing purchasing and procurement processes (such as buying in bulk to reduce the amount of travel time and energy, considering and investing in the use of components that can be reused, instead of the use of disposable or single use consumables)
- reusing components wherever possible
- waste procedures (ensuring that waste is minimised, recycling of components is in place wherever possible)
- minimising water use and considering options for reuse/salvage as part of plumbing activities wherever possible.

## Support materials

The following resources are available for this qualification:

Description	How to access
Sample assessments	<a href="http://www.cityandguilds.com">www.cityandguilds.com</a>
SmartScreen	<a href="http://www.smartscreen.co.uk">www.smartscreen.co.uk</a>

## 4 Assessment

### Assessment of the qualification

Candidates must:

- successfully complete one online multiple choice test.

Assessment types			
Unit	Title	Assessment method	Where to obtain assessment materials
305	Requirements for the Design and Installation of Domestic and Small Commercial Electric Vehicle Charging Installations	Online multiple choice test	City & Guilds Evolve test system

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### Assessment strategy

City & Guilds has written the following assessment to use with this qualification

- Online multiple choice test.

### Time constraints

Qualification registration is valid for one year.

### Recognition of prior learning (RPL)

RPL is not allowed for this qualification.

## Test specifications

The way the knowledge is covered by each test is laid out in the table below:

### Permitted materials:

IET Code of Practice for Electric Vehicle Charging Equipment Installation (5th edition)  
IET Wiring Regulations 18<sup>th</sup> Edition: BS 7671:2018 (2022) Requirements for Electrical Installations

**Graded:** Pass/Fail

**Pass mark:** the pass mark for this examination is set at approx. 75%

Test: 2921- 305	Duration: 60 minutes		
Unit	Outcome	Number of questions	Percentage %
305	01 Know the key documentation and legislation in relation to electric vehicle supply equipment (EVSE)	2	7%
	02 Know different types and features of EVSE	8	27%
	03 Understand design considerations for EVSE installations	12	40%
	04 Understand testing, commissioning and handover requirements specific to the installation of electric vehicle charging equipment and circuits in domestic and small commercial settings	4	13%
	05 Understand the use of vehicles as electrical energy storage systems as part of prosumer's installations	4	13%
	<b>Total</b>	<b>30</b>	<b>100%</b>

## 5 Units

### Structure of the units

These units each have the following:

- City & Guilds reference number
- title
- level
- guided learning hours (GLH)
- assessment type
- learning outcomes, which are comprised of a number of topics and content elements

### Guidance for delivery of the units

This qualification comprises of a one **units**. A unit describes what is expected of a competent person in particular aspects of their job.

Each **unit** is divided into **learning outcomes** which describe in further detail the skills and knowledge that a candidate should possess.

Each **learning outcome** has a set of **topics** that are simple and concise statements that indicates to a learner something specific they will be learning in relation to the learning outcome. It should provide clarity to a learner at a high level on what they should be expecting to learn or be able to do about a specific area of the learning outcome.

**Content**, the content sections define the 'depth and breadth' to which the teaching/learning must be delivered.

It is important that these sections define all the essential content that must be covered for learners to achieve the learning outcome. It is the information in this section that learners will be assessed on.



## Unit 305

# Requirements for the Design and Installation of Domestic and Small Commercial Electric Vehicle Charging Installations

<b>Level:</b>	3
<b>GLH:</b>	15
<b>Assessment type:</b>	Online multiple choice test

### Learning outcomes

1. Know the key documentation and legislation in relation to electric vehicle supply equipment (EVSE)
2. Know different types and features of EVSE
3. Understand design considerations for EVSE installations
4. Understand testing, commissioning and handover requirements specific to the installation of electric vehicle charging equipment and circuits in domestic and small commercial settings
5. Understand the use of vehicles as electrical energy storage systems as part of prosumer's installations

### Learning outcome 1

Know the key documentation and legislation in relation to electric vehicle supply equipment (EVSE)

Topics	Content elements
1.1 Statutory and non-statutory documents relating to the selection, installation and commissioning of EVSE	<p>1.1.1 Scope of statutory and non-statutory documents relating to the selection, installation and commissioning of EVSE</p> <p>a) Statutory documents:</p> <ol style="list-style-type: none"><li>i. Electricity at Work Regulations (EAWR)</li><li>ii. Health and Safety at Work etc. Act (HASAWA)</li><li>iii. Electricity Safety, Quality and Continuity Regulations (ESQCR)</li><li>iv. Road Traffic Regulation Act in relation to Traffic Regulation Order (TRO)</li></ol>

- v. Building Regulations (England)
  - Part M – access to and use of buildings
  - Part P – electrical safety-dwellings
  - Part S – infrastructure for the charging of electric vehicles
- vi. Building Regulations (Wales)
  - Part M – access to and use of buildings
  - Part P – electrical safety-dwellings
- vii. Building (Scotland) Act
- viii. Building Regulations (Northern Ireland)
  - Part R – access to and use of buildings
- ix. The Electric Vehicles (Smart Charge Points) Regulations
- x. Planning permission
- b) Non-statutory documents
  - i. Building regulation approved documents
  - ii. IET Code of Practice for Electric Vehicle Charging Equipment Installation
  - iii. BS 7671 Requirements for Electrical Installations
  - iv. IET Guidance Notes
    - GN1 Selection & Erection
    - GN3 Inspection & Testing
    - GN7 Special Locations
    - GN8 Earthing & Bonding
  - v. IET On-Site Guide
  - vi. RC59: Recommendations for fire safety when charging electric vehicles
  - vii. Manufacturer's instructions

## Learning outcome 2

Know different types and features of EVSE

Topics	Content elements
2.1 Modes of charging equipment	2.1.1 Features and intended use of Modes of charging <ul style="list-style-type: none"> <li>a) Mode 1               <ul style="list-style-type: none"> <li>i. features:                   <ul style="list-style-type: none"> <li>• use of a plug and socket-outlet conforming to BS 1363 or BS EN 60309</li> <li>• charging cable assembly does not contain a control box</li> </ul> </li> </ul> </li> </ul>

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- ii. intended use:
    - only recommended for emergency use
    - no longer permitted on new vehicles on the UK market
    - only to be used with a socket-outlet rated for continuous use, such as BS 1363/EV
  - b) Mode 2
    - i. features:
      - use of a plug and socket-outlet conforming to BS 1363 or BS EN 60309
      - charging cable assembly contains a control box
    - ii. intended use:
      - minimal charging solution
      - only to be used with a socket-outlet rated for continuous use, such as BS 1363/EV
      - maximum 3 kW (13 A) in domestic or residential installations
      - maximum 22 kW (32 A) in three-phase non-domestic installations
      - maximum 7.4 kW (32 A) in single-phase non-domestic installations
  - c) Mode 3
    - i. features:
      - dedicated AC charging equipment
      - use of vehicle inlets and vehicle connectors conforming to BS EN 62196
      - interlock arrangement to prevent connection and disconnection on-load
      - range of power ratings, both single-phase and three-phase between 3 kW to 22 kW
    - ii. intended use:
      - dedicated vehicle connection points, not to be used for other purposes
  - d) Mode 4
    - i. features:
      - dedicated DC charging equipment
      - interlock arrangement to prevent connection or disconnection on-load
      - conversion from single-phase or three-phase LV AC is typically carried out in the EVSE at the charging point
-

	<ul style="list-style-type: none"> <li>• larger power systems can utilise DC from external power conversion equipment</li> </ul> <p>ii. intended use:</p> <ul style="list-style-type: none"> <li>• rapid charging, not typically used in domestic installations</li> </ul>
<p>2.2 Connectors and connection arrangements</p>	<p>2.2.1 Identification of types of vehicle inlet and vehicle connectors used in Mode 3 EVSE domestic and small commercial installations and their alternative names</p> <p>a) BS EN 62196-2 Type 1</p> <ul style="list-style-type: none"> <li>i. SAE J1772 connector</li> <li>ii. Yazaki connector</li> </ul> <p>b) BS EN 62196-2 Type 2 (considered universal in the UK)</p> <ul style="list-style-type: none"> <li>i. Mennekes connector</li> </ul> <p>c) BS EN 62196-2 Type 3</p> <ul style="list-style-type: none"> <li>i. EV Plug Alliance connector</li> </ul> <p>2.2.2 Types of charging connection used in Mode 3 EVSE domestic and small commercial installations</p> <p>a) Case A – charging cable and plug permanently attached to the EV</p> <p>b) Case B – detachable charging cable assembly with a vehicle connector and plug</p> <p>c) Case C – charging cable permanently attached to the charging equipment (tethered cable)</p>
<p>2.3 EVSE specification and features</p>	<p>2.3.1 Variations in electric vehicle charging equipment features and their uses</p> <p>a) multiple socket-outlets</p> <ul style="list-style-type: none"> <li>ii. variation of connector types</li> <li>iii. ability to charge multiple EVs simultaneously</li> </ul> <p>b) feeder pillars</p> <ul style="list-style-type: none"> <li>i. common internal components</li> <li>ii. typically used when multiple EV charging points are installed</li> </ul> <p>c) protective devices incorporated within the EVSE</p> <ul style="list-style-type: none"> <li>i. RCD/RCBO</li> <li>ii. overcurrent protection</li> <li>iii. RDC-DD</li> </ul>

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- d) open PEN detection devices
    - i. Voltage monitoring to earth (exceeding 70 V rms)
    - ii. Voltage monitoring between line and neutral (<207 V rms >253 V rms)
  - e) timers
    - i. allow for off-peak charging
    - ii. allow for multiple EV charging where the supply is insufficient for simultaneous EV charging
    - iii. allow charging to be restricted to a fixed time period
  - f) built-in energy meters
    - i. usage monitoring for energy management
    - ii. monetising/billing for use of the charging point
  - g) security features
    - i. prevention of unauthorised charging of EVs
    - ii. prevention of unauthorised remote access to equipment settings
    - iii. protection against vandalism
    - iv. prevention of unauthorised disconnection of charging cable
    - v. anti-tampering alarm systems
  - h) communication features
    - i. charge station utilisation
    - ii. energy usage
    - iii. faults (to be communicated to the owner/operator of the charging equipment)
    - iv. EEMS integration within prosumers' electrical installations
  - i) network integration
    - i. GPRS connectivity
    - ii. Wi-Fi connectivity
    - iii. ethernet connectivity
    - iv. smart meter integration
  - j) load curtailment and load shedding
    - i. local load management
    - ii. smart grid integration
-

## Learning outcome 3

Understand design considerations for EVSE installations

Topics	Content elements
3.1 Considerations prior to installation of EV charging equipment	<p>3.1.1. Considerations in respect of different locations when planning an installation of EV supply equipment</p> <ul style="list-style-type: none"><li>a) locations:<ul style="list-style-type: none"><li>i. vehicle location</li><li>ii. control device location</li><li>iii. socket-outlet location</li></ul></li><li>b) considerations:<ul style="list-style-type: none"><li>i. potentially flammable or explosive atmospheres</li><li>ii. potential fire hazards (where materials are stored in close proximity)</li><li>iii. ventilation and cooling</li><li>iv. lighting</li><li>v. relative to parking space</li><li>vi. individual vehicle charging</li><li>vii. simultaneous multiple vehicle charging</li><li>viii. vehicle impact protection ratings</li><li>ix. ingress protection in relation to external influences</li><li>x. space around EV charging equipment to allow for maintenance</li><li>xi. avoidance of creating potential trip hazards or obstructions</li><li>xii. GPRS coverage</li><li>xiii. height of controls and socket-outlets</li></ul></li></ul> <p>3.1.2 Electrical considerations when planning an installation of EV supply equipment</p> <ul style="list-style-type: none"><li>a) maximum demand:<ul style="list-style-type: none"><li>i. pre EVSE-installation demand</li><li>ii. application of diversity in relation to EVSE</li><li>iii. post EVSE-installation demand</li></ul></li><li>b) supply metering:<ul style="list-style-type: none"><li>i. landlord's supply</li><li>ii. unmetered supply</li></ul></li><li>c) adequacy of supply<ul style="list-style-type: none"><li>i. supply capacity, taking account of additional load</li><li>ii. additional DNO/DSO requirements</li><li>iii. looped supply limitations</li></ul></li></ul>

	<p>d) identifying existing earthing arrangement</p> <ol style="list-style-type: none"> <li>i. TN-C-S (PME) or TN-S (treated as PME)</li> <li>ii. guaranteed TN-S</li> <li>iii. TT</li> </ol> <p>e) requirement for DNO/DSO notification</p> <ol style="list-style-type: none"> <li>i. timing of notification</li> <li>ii. notification for generation (ENA Engineering Recommendations G98, G99 and G100)</li> </ol> <p>3.1.3 Additional considerations when planning an installation of EV supply equipment</p> <ol style="list-style-type: none"> <li>a) client's requirements</li> <li>b) manufacturer's instructions and requirements</li> <li>c) planning permission requirements <ol style="list-style-type: none"> <li>i. listed buildings</li> <li>ii. conservation areas</li> </ol> </li> <li>d) traffic management <ol style="list-style-type: none"> <li>i. Traffic Management Order (TMO)</li> </ol> </li> </ol>
<p>3.2 Design and installation considerations for the EVSE</p>	<p>3.2.1 Considerations for system earthing and supply arrangements</p> <ol style="list-style-type: none"> <li>a) potential hazards associated with PME earthing arrangements in the event of an open-circuit fault within the PEN conductor of a PME earthing system (TN-C-S or non-guaranteed TN-S) <ol style="list-style-type: none"> <li>i. all conductive-parts, connected to the earthing system, can rise to a dangerous voltage above earth potential</li> <li>ii. open-circuit PEN conductors can cause currents to flow in exposed and extraneous metalwork, not intended to carry these currents: <ul style="list-style-type: none"> <li>• excessive heat may be generated</li> <li>• increased shock risk where a difference of potential exists</li> </ul> </li> </ol> </li> <li>b) potential hazards of separate earthing arrangements <ol style="list-style-type: none"> <li>i. simultaneous contact, between separate earthing systems, where a dangerous difference in potential could exist</li> </ol> </li> <li>c) requirement to consult with DNO/DSO <ol style="list-style-type: none"> <li>i. unless the DNO/DSO can guarantee the integrity of the TN-S system and ensure that it will not be converted to PME, TN-S should be treated as TN-C-S (PME)</li> </ol> </li> </ol>

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- d) separation of earth electrode zones
    - i. minimum required separation distances between underground earthed metalwork and earth electrodes for EVSE
    - ii. ground potential rise (GPR) due to earth potential rise (EPR)

### 3.2.2 Circuit requirements within EVSE circuit design:

- a) a separate, dedicated final or distribution circuit, protected individually by overcurrent and RCD protective devices
- b) a distribution circuit may be used to supply more than one charging point where RCD and further overcurrent protection is provided for each charging point
  - i. sub current must be able to carry the full load current
  - ii. the distribution circuit must be sized to carry all the load current(s) simultaneously, without applying diversity, unless suitable provision is made for load curtailment or shedding

### 3.2.3 Consideration of protective devices within EVSE circuit design

- a) type of RCD protecting the charging point
  - i. Type A with RDC-DD, where the DC component of the residual current is limited to 6 mA
  - ii. Type F with RDC-DD, where the DC component of the residual current is limited to 10 mA
  - iii. Type B, where the DC component of the residual current is limited to  $0.4 \times I_{\Delta n}$
- b) short-circuit thermal constraints
  - i. application of BS 7671, Regulations 435.1
  - ii. installation of overload protection at the origin of the supply circuit to avoid calculation of short circuit thermal constraints
- c) locations requiring use of Arc Fault Detection Devices (AFDDs)
  - i. higher risk residential buildings
  - ii. houses in multiple occupation
  - iii. purpose-built student accommodation
  - iv. care homes
- d) surge protection in electrical installations
  - i. to be provided against transient overvoltage unless the client agrees that any loss or damage is tolerable, and they accept the risk
- e) considerations:



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- i. use of bidirectional power-flow
  - ii. risk of overheating of protective devices due to long duration
  - iii. adherence to manufacturer's instructions
  - iv. placement of heavily loaded circuits in the distribution board

#### 3.2.4 Considerations for cable selection within EVSE circuit design

- a) application of rating factors in relation to cable installation, method and circumstance
    - i. thermal insulation
    - ii. proximity of additional circuits
    - iii. burial in ground
    - iv. ambient temperature (air/ground)
  - b) calculation of circuit voltage drop to ensure this remains within required parameters
    - i. BS 7671 requirements
    - ii. manufacturer's instructions
    - iii. maximum 5% where an Open-PEN voltage monitoring device is not provided
    - iv. maximum 4% where an Open-PEN voltage monitoring device is used (to minimise the risk of unwanted tripping)
  - c) use of non-standard cables
    - i. where a constructional standard is not available for combined LV power and data cables shall be considered as non-standard, and manufacturer's instructions should be adhered to
    - ii. use of such cables is a departure from BS 7671 and should be documented accordingly
  - d) considerations
    - i. long duration loading of EVSE circuits
    - ii. large currents in relation to cross-sectional area of cables and length of run.
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### 3.2.5 Considerations for specification and positioning of EVSE

#### a) external influences

##### i. buried cables

- protection against mechanical damage when burying cables directly in the ground
  - cables buried directly to incorporate earthed metallic armour, metal sheath, conduit or duct
  - depth required to avoid damage
  - requirements for cable covers or marker tape

##### ii. equipment, including EVSE

- degree of protection of at least IP44 when outdoors
- degree of protection of at least IP2X/IP4X when indoors
- containment systems
- installed to avoid damage by any reasonably foreseeable impact
- a means of protection against mechanical impact to a minimum of IK08

#### b) accessibility

##### i. mounting heights

- controls
- displays
- electrical outlets
- socket-outlets

#### c) fire safety considerations

- i. charging points for electric road-vehicles should normally be located outdoors
  - ii. flammable or combustible material storage should not be located in or near a designated charging area
  - iii. internal EVSE installations should be protected by an automatic fire detection installation, complying with BS 5839-6
  - iv. considerations for sprinkler/suppression systems based on risk assessments, or relevant national building regulations requirements
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<p>3.3 Labelling requirements on circuits and equipment intended for electric vehicle charging</p>	<p>3.3.1 Labelling requirements on circuits and equipment for EVSE, including the content and location of labels and notices</p> <ul style="list-style-type: none"> <li>a) labelling of BS 1363-2 (EV) socket-outlets</li> <li>b) notices regarding connection to TT earthing systems</li> <li>c) multiple supplies, if applicable</li> <li>d) RCD functional test notice</li> <li>e) earth electrode(s)</li> <li>f) bonding</li> </ul>
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## Learning outcome 4

Understand testing, commissioning and handover requirements specific to the installation of electric vehicle charging equipment and circuits in domestic and small commercial settings

Topics	Content elements
<p>4.1 Particular considerations in addition to general requirements whilst testing EVSE circuits in line with Part 6 of BS 7671</p>	<p>4.1.1 Methods of earth electrode resistance testing, and their advantages and disadvantages</p> <ul style="list-style-type: none"> <li>a) Test Method E1 – Dedicated earth electrode tester, fall of potential method <ul style="list-style-type: none"> <li>i. advantages: <ul style="list-style-type: none"> <li>• no supply required</li> <li>• can be used for testing a supply electrode, for example within a prosumer’s installation</li> </ul> </li> <li>ii. disadvantages: <ul style="list-style-type: none"> <li>• a large distance is required between test electrodes to undertake the test</li> <li>• the earth electrode must be disconnected from parallel paths, necessitating isolation of entire installation</li> </ul> </li> </ul> </li> <li>b) Test Method E2 – Dedicated earth electrode tester, stakeless or clamp-based <ul style="list-style-type: none"> <li>i. advantages: <ul style="list-style-type: none"> <li>• no supply required</li> <li>• can be used for testing a supply electrode, for example within a prosumer’s installation</li> <li>• can be performed whilst the installation is live</li> <li>• can be performed in small curtilage properties</li> </ul> </li> <li>ii. disadvantage:</li> </ul> </li> </ul>

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- multiple parallel paths required for accurate test readings
- c) Test method E3 – Measurement using an earth fault loop impedance (EFLI) tester
- i. advantage:
    - easy to carry out whilst testing the earth fault loop impedance of circuits
  - ii. disadvantages:
    - supply is required
    - the earth electrode must be disconnected from parallel paths, necessitating isolation of entire installation
    - cannot be used to test the resistance of a supply electrode, for example within a prosumer's installation

#### 4.1.2 Consideration for live testing at Mode 3 EV outlets

- a) a vehicle simulator will be required to complete the handshaking using the pilot connectors

#### 4.1.3 Consideration for Earth fault loop impedance testing

- a) earth fault loop impedance readings could be distorted by the presence of local inverters, eg V2G

#### 4.1.4 Consideration for RCD testing

- a) considerations where there is insufficient, or no, selectivity between RCDs, use of 'upstream/downstream' method

4.2 Requirements for commissioning and handover specific to EVSE in domestic and small commercial settings

#### 4.2.1 Information and documentation given to the client on completion and handover of EVSE

- a) information to give the client:
  - i. how to identify normal operation
  - ii. how to identify the charge status of the vehicle
  - iii. how to safely shut the system down
- b) documentation to give to the client:
  - i. drawings:
    - electrical
    - communication
    - control systems
  - ii. manufacturer's documentation and information:
    - operating instructions
    - routine maintenance requirements
    - warranty information
    - instructions on how to update firmware and software
    - meaning of alarms and error messages
  - iii. written instructions on how to safely isolate the charging installation:
    - when the vehicle is not connected
    - When the vehicle is connected
  - iv. requirements describing disposal of the EVSE at the end of its life
  - v. certification
    - Electrical Installation Certificate (EIC)
    - Schedule of Circuit Details
    - Schedule of Test Results
  - vi. DNO/DSO notification form
  - vii. building regulation notification
  - viii. completed risk assessment (regarding PME supply)
    - Form B1 (domestic)
    - Form D1 (commercial and industrial).

#### 4.2.2 Purpose of EVSE firmware and software and the importance of keeping it updated

- a) purpose:
  - i. to allow recovery following software failure
- b) importance of keeping firmware and software updated:
  - i. to maintain functionality
  - ii. to address security flaws

## Learning outcome 5

Understand the use of vehicles as electrical energy storage systems as part of prosumer's installations

Topics	Content elements
5.1 How electric vehicle charging installations and vehicles can be utilised as energy storage systems	<p>5.1.1 Definitions and explanations of key terms and acronyms relating to the use of vehicles as electrical energy storage systems</p> <ul style="list-style-type: none"><li>a) key terms:<ul style="list-style-type: none"><li>i. prosumer</li><li>ii. prosumer's electrical installations (PEIs)</li><li>iii. electrical energy management system (EEMS)</li><li>iv. island-mode operation</li></ul></li><li>b) acronyms:<ul style="list-style-type: none"><li>i. V2G (Vehicle to Grid)</li><li>ii. V2H (Vehicle to Home)</li><li>iii. V2X (Generic term for vehicle as storage)</li></ul></li></ul> <p>5.1.2 Uses of V2X arrangements:</p> <ul style="list-style-type: none"><li>a) ancillary services</li><li>b) energy matching/trading</li><li>c) behind the meter service</li><li>d) network services</li></ul> <p>5.1.3 Requirements for enabling vehicles to be used as electrical energy storage:</p> <ul style="list-style-type: none"><li>a) functionality must be enabled by vehicle manufacturer</li><li>b) state of charge of vehicle battery</li><li>c) choice by vehicle user</li><li>d) suitability of charging infrastructure</li><li>e) ensuring sufficient charge remains in the vehicle battery to meet day-to-day travel needs</li><li>f) in a dwelling or similar, there should ideally be a single point of isolation that removes power from all final circuits in the installation</li></ul>

<p>5.2 Design considerations for overcurrent protection in island-mode operation</p>	<p>5.2.1 Considerations, which must be made by the designer, for overcurrent protection in island-mode operation</p> <ul style="list-style-type: none"> <li>a) changes to conditions and provisions for fault protection and overcurrent protection as the prospective fault current drops</li> <li>b) requirement for additional means of overcurrent protection, where existing circuit protective devices may not operate due to reduced prospective fault currents</li> </ul>
<p>5.3 Requirements for handover and commissioning of EVSE where this incorporates V2X functionality, in addition to requirements for handover and commissioning of EVSE where this does not incorporate V2X functionality</p>	<p>5.3.1 Specific information and documentation given to the client on completion and handover of EVSE incorporating V2X</p> <ul style="list-style-type: none"> <li>a) documentation to give the client: <ul style="list-style-type: none"> <li>i. details on whether the charging equipment is installed in a manner appropriate for island operation</li> <li>ii. details on the design features that enable island operation</li> <li>iii. drawings of the control system</li> </ul> </li> <li>b) information to be given to the client <ul style="list-style-type: none"> <li>i. power and capacity limitations in island mode</li> <li>ii. how to prevent the battery from discharging where the capacity is required to power the vehicle</li> </ul> </li> </ul>
<p>5.4 Smart charging integration into electrical installations</p>	<p>5.4.1 Purpose of smart charging applications</p> <ul style="list-style-type: none"> <li>a) timed charging control</li> <li>b) managed charging</li> <li>c) demand-limiting (or load curtailment) charging</li> <li>d) smart meter integration</li> <li>e) optimisation for self-use</li> </ul> <p>5.4.2 Purpose of exclusively bi-directional applications (current may flow to or from the car)</p> <ul style="list-style-type: none"> <li>a) V2H used to avoid import of energy from the grid during peak hours/peak rates</li> <li>b) V2G: export from the car storage at peak demand, with car recharged more cheaply later</li> <li>c) off-grid systems: the vehicle may be used as storage in an overall off-grid system</li> </ul>

## **Supporting information**

### **Suggested learning resources**

IET Code of Practice for Electric Vehicle Charging Equipment Installation (5th edition)

IET On-Site Guide to BS 7671

IET Guidance Note 3 Inspection and Testing

BS 7430 Code of practice for protective earthing of electrical installations



## Appendix 1 Sources of general information

The following documents contain essential information for centres delivering City & Guilds qualifications. They should be referred to in conjunction with this handbook. To download the documents and to find other useful documents, go to the **Centre document library** on **www.cityandguilds.com** or click on the links below:

### **Centre Handbook: Quality Assurance Standards**

This document is for all approved centres and provides guidance to support their delivery of our qualifications. It includes information on:

- centre quality assurance criteria and monitoring activities
- administration and assessment systems
- centre-facing support teams at City & Guilds/ILM
- centre quality assurance roles and responsibilities.

The Centre Handbook should be used to ensure compliance with the terms and conditions of the centre contract.

### **Centre Assessment: Quality Assurance Standards**

This document sets out the minimum common quality assurance requirements for our regulated and non-regulated qualifications that feature centre-assessed components. Specific guidance will also be included in relevant qualification handbooks and/or assessment documentation.

It incorporates our expectations for centre internal quality assurance and the external quality assurance methods we use to ensure that assessment standards are met and upheld. It also details the range of sanctions that may be put in place when centres do not comply with our requirements or actions that will be taken to align centre marking/assessment to required standards. Additionally, it provides detailed guidance on the secure and valid administration of centre assessments.

### **Access arrangements: When and how applications need to be made to City & Guilds**

provides full details of the arrangements that may be made to facilitate access to assessments and qualifications for candidates who are eligible for adjustments in assessment.

The **Centre document library** also contains useful information on such things as:

- conducting examinations
- registering learners
- appeals and malpractice.

### **Useful contacts**

Please visit the **Contact us** section of the City & Guilds website.

## City & Guilds

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We partner with our customers to deliver work-based learning programmes that build competency to support better prospects for people, organisations and wider society. We create flexible learning pathways that support lifelong employability because we believe that people deserve the opportunity to (re)train and (re)learn again and again – gaining new skills at every stage of life, regardless of where they start.

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City & Guilds  
Giltspur House  
5 – 6 Giltspur Street  
London  
EC1A 9DE

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