SEMPEO233

Wiring and testing electrical equipment and circuits

Overview

This standard covers a broad range of basic competences that you need to wire up and test electrical equipment and circuits. It will prepare you for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or it will provide a basis for the development of additional skills and occupational competences in the working environment.

The activities will include the wiring and termination of a range of cables, such as single and multicore cables, screened cables, fire resistant and armoured cables. You will be required to make a variety of terminations and to connect a range of electrical components, such as switches/switchgear, distribution panels, motors and starters, control systems, sensors and actuators, safety devices, and luminaires.

You will be required to select the appropriate tools, materials and equipment to use, based on the operations to be performed and the components to be connected. You will be expected to use appropriate tools and techniques for the wiring of the various electrical components and connectors that make up the electrical system/circuit. In addition, you will be expected to make all necessary electrical connections to the switches, relays, sensors/actuators and other devices, as appropriate to the equipment and circuit being produced. The wiring and testing activities will include making all necessary checks and adjustments to the circuit, including continuity, polarity, insulation resistance values, and ensuring that the equipment functions to the specification.

Your responsibilities will require you to comply with health and safety requirements and organisational policy and procedures for the wiring and testing activities undertaken. You will need to take account of any potential difficulties or problems that may arise with the wiring and testing activities, or with the tools and equipment used, and to seek appropriate help and advice in determining and implementing a suitable solution. You will work under a high level of supervision, whilst taking responsibility for your own actions and for the quality and accuracy of the work that you carry out.

Your underpinning knowledge will provide an understanding of your work, and will enable you to apply appropriate electrical wiring and testing procedures and techniques safely. You will understand the wiring and testing methods and procedures used, and their application, and will know about the various cables and components used to produce the circuits, to the required depth to provide a sound basis for carrying

out the activities to the required specification.

You will understand the safety precautions required when carrying out the wiring and testing activities, especially those for ensuring the safe isolation of the equipment and circuits produced. You will be required to demonstrate safe working practices throughout, and will understand the responsibility you owe to yourself and others in the workplace.

Specific Standard Requirements

In order to prove your ability to combine different electrical assembly and wiring activities, at least one of the electrical assemblies produced must be of a significant nature, and must contain a minimum of **five** of the components listed in scope 3 **plusfive** of the activities listed in scope 5.

Performance criteria

You must be able to:

1. work safely at all times, complying with health and safety legislation, regulations, directives and other relevant guidelines
2. plan the wiring and testing activities before you start them
3. use appropriate sources to obtain the required specifications, circuit diagrams and test information
4. obtain the correct tools and equipment for the wiring and testing operations, and check that they are in a safe and usable condition
5. mount and secure the electrical components safely and correctly, to meet specification requirements
6. install and terminate the cables to the appropriate connections on the components
7. use appropriate test methods and equipment to check that the completed circuit is safe and meets all aspects of the specification
8. deal promptly and effectively with problems within your control, and seek help and guidance from the relevant people if you have problems that you cannot resolve
9. leave the work area in a safe and tidy condition on completion of the wiring and testing activities

Knowledge and understanding

You need to know and understand:

1. the specific safety practices and procedures that you need to observe when wiring and testing electrical equipment (including any specific legislation, regulations or codes of practice for the activities, equipment or materials)
2. the hazards associated with wiring and testing electrical equipment, and with the tools and equipment used, (such as using sharp instruments for stripping cable insulation), and how they can be minimised
3. the importance of wearing appropriate protective clothing and equipment (PPE), and keeping the work area safe and tidy
4. what constitutes a hazardous voltage and how to recognise victims of electric shock
5. how to reduce the risks of a phase to earth shock (such as insulated tools, rubber matting and isolating transformers)
6. the interpretation of circuit diagrams, wiring diagrams, and other relevant specifications (including BS and ISO schematics, wiring regulations, symbols and terminology)
7. the basic principles of operation of the equipment/circuits being produced, and the purpose of the individual modules/components used
8. the different types of cabling and their application (such as multicore cables, single core cables, solid and multi- stranded cables, steel wire armoured (SWA), mineral insulated (MI), screened cables, data/communications cables, fibre-optics)
9. the application and use of a range of electrical components (such as plugs, switches, sockets, lighting and fittings, junction boxes, consumer units, relays, solenoids, transformers, sensors and actuators)
10. the application and use of circuit protection equipment (such as fuses and other overload protection devices, trips, residual current device (RCD))
11. how to check that components meet the required specification/operating conditions (such as values, tolerance, current carrying capacity, voltage rating, power rating, working temperature range)
12. methods of mounting and securing electrical equipment/components to various surfaces (such as the use of nuts and bolts, screws and masonry fixing devices)
13. checking that the positions selected for mounting the components do not interfere with or damage existing services (such as cable harnesses, pipework or electricity supplies)

14. methods of laying in or drawing cables into conduit, trunking and traywork systems, and the need to ensure the cables are not twisted or plaited
15. the techniques used to terminate electrical equipment (such as plugs and sockets; soldering; screwed, clamped and crimped connections, glands and sealed connectors)
16. the use of BS7671/IET wiring regulations when selecting wires and cables and when carrying out tests on systems
17. methods of attaching markers/labels to components or cables to assist with identification (such as colour coding conductors, using coded tabs)
18. the tools and equipment used in the wiring and testing activities (including the use of cable stripping tools, crimping tools, soldering irons and torches, gland connecting tools)
19. how to check that tools and equipment are free from damage or defects, and are in a safe, tested, calibrated and usable condition
20. the importance of conducting inspections and checks before connecting to the supply (such as visual examination for loose or exposed conductors, excessive solder or solder spikes which may allow short circuits to occur, strain on terminations, insufficient slack cable at terminations, continuity and polarity checks, insulation checks)
21. the care, handling and application of electrical test and measuring instruments (such as multimeter, insulation resistance tester, loop impedance test instruments)
22. applying approved test procedures; the safe working practices and procedures required when carrying out the various tests, and the need to use suitably fused test probes and clips
23. how to identify suitable test points within the circuit, and how to position the test instruments into the circuit whilst ensuring the correct polarity and without damaging the circuit components and the test equipment
24. how to set the instrument's zero readings; obtaining instrument readings and comparing them with circuit parameters
25. why electrical bonding/earthing is critical, and why it must be both mechanically and electrically secure
26. the problems that can occur with the wiring and testing operations, and how these can be overcome
27. the fault-finding techniques to be used if the equipment fails to operate correctly (such as half split, unit substitution and input/output)
28. when to act on your own initiative and when to seek help and advice from others

29. the importance of leaving the work area in a safe and clean condition on completion of the wiring and testing activities (such as returning hand tools and test equipment to is designated location, cleaning the work area, and removing and disposing of waste)

Scope/range related to performance criteria

1.

Carry out **all** of the following activities during the wiring and testing activities:

1.1 adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
1.2 ensure the safe isolation of services during the wiring and testing activities
1.3 follow job instructions, circuit drawings and test procedures at all times
1.4 check that tools and test instruments to be used are within calibration date, and are in a safe, tested and usable condition
1.5 ensure that the electrical system is kept free from foreign objects, dirt or other contamination
1.6 where appropriate, apply procedures and precautions to eliminate electrostatic discharge (ESD) hazards
1.7 return all tools and equipment to the correct location on completion of the wiring and testing activities

2.

Wire circuits using **three** of the following types of cables:

2.1 single core
2.2 data/communication
2.3 ribbon cables
2.4 multicore
2.5 fibre-optics
2.6 mineral insulated
2.7 PVC twin and earth
2.8 screened
2.9 armoured
2.10 flexible (such as cotton or rubber covered)
2.11 coaxial
2.12 wiring loom/harness

3.

Connect up **ten** of the following electrical modules/components to produce circuits:

3.1 isolators
3.2 blowers
3.3 cable connectors
3.4 switches
3.5 lamp holders
3.6 fuses
3.7 sockets
3.8 panel lamps
3.9 circuit breakers
3.10 contactors
3.11 luminaires

3.12 sensors
3.13 motor starters
3.14 ballast chokes
3.15 actuators
3.16 solenoids
3.17 consumer units
3.18 junction boxes
3.19 relays
3.20 residual current device (RCD)
3.21 terminal blocks
3.22 alarm devices
3.23 instruments
3.24 electronic modules/units
3.25 motors
3.26 transformers
3.27 control devices
3.28 pumps
3.29 panels or sub-assemblies
3.30 heaters
3.31 other specific electrical components

4.

Apply wiring methods and techniques to include **six** of the following:

4.1 positioning and securing of equipment and components
4.2 levelling and alignment of components
4.3 determining current rating and lengths of cables required
4.4 securing by using mechanical fixings (such as screws, nuts and bolts)
4.5 laying in cables without twisting or plaiting
4.6 feeding cables into conduit without twisting or plaiting
4.7 leaving sufficient slack for termination and movement

5.

Carry out **eight** of the following cable termination activities:

5.1 stripping cable sheaths without damage to conductor insulation
5.2 terminating mineral insulated cables
5.3 removing cable insulation
5.4 sealing/protecting cable connections
5.5 connecting accessories (such as plugs, sockets multi-way connectors)
5.6 attaching suitable cable identification
5.7 making mechanical/screwed/clamped connections
5.8 crimping (such as spade end, loops, tags and pins)
5.9 soldering and de-soldering
5.10 securing wires and cables (such as clips, plastic strapping, lacing, harnessing)
5.11 terminating armoured cables
5.12 heat shrinking (devices and boots)
5.13 earth bonding
5.14 cable glands and grips

6.

Wire up **three** of the following electrical system circuits:

6.1 domestic lighting circuits
6.2 air conditioning control circuits
6.3 domestic power circuits
6.4 refrigeration control circuits
6.5 motor start and control
6.6 heating/boiler control circuits
6.7 vehicle heating or ventilating
6.8 aircraft lighting circuits
6.9 vehicle lighting
6.10 power generation and control circuits
6.11 vehicle starting and ignition
6.12 avionic circuits and systems
6.13 instrumentation and control circuits
6.14 emergency lighting systems
6.15 alarm systems (such as fire, intruder, process control)
6.16 communication systems
6.17 electro-pneumatic or electro-hydraulic control circuits
6.18 computer systems
6.19 other control circuits (such as pumps, fans, blowers, extractors)
6.20 other specific electrical circuits

7.

Use **two** of the following test instruments during the wiring and testing activities:

7.1 multimeter
7.2 earth-loop impedance tester
7.3 insulation resistance tester
7.4 polarity tester/indicator
7.5 RCD tester
7.6 other specific test equipment

8.

Carry out checks and adjustments, appropriate to the equipment and circuits being wired, to include **three** of the following:

8.1 making visual checks (such as completeness, signs of damage, incorrect termination)
8.2 movement checks (such as loose fittings and connections)
8.3 testing that the equipment operates to the circuit specification
8.4 carrying out fault finding techniques (such as half-split, input/output, unit substitution)

Plus **three** more from the following:

5. protective conductor resistance values
6. load current
7. power rating

8. insulation resistance values
9. polarity
10. frequency values
11. continuity
12. resistance
13. inductance
14. voltage levels
15. capacitance
16. RCD disconnection time
17. specialised tests (such as speed, sound, light, temperature)

1.

Produce electrical circuits in accordance with **one** of the following standards:

1.1 BS 7671/IET wiring regulations
1.2 other BS and/or ISO standards
1.3 company standards and procedures

Behaviours

Additional Information

You will be able to apply the appropriate behaviours required in the workplace to meet the job profile and overall company objectives, such as:

- strong work ethic
- positive attitude
- team player
- dependability
- responsibility
- honesty
- integrity
- motivation
- commitment

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