



National Unit Specification: general information

UNIT: Installation of A.C. Induction Motors (SCQF level 6)

CODE F5DA 12

SUMMARY

This Unit is designed to allow candidates to develop knowledge and understanding and skills of electrical motor installation. The candidate will be able to identify the constructional features of alternating current (ac) induction motors, types of enclosure, starting methods and types of protection devices for ac induction motors. The Unit will develop the candidate's skills in wiring, connecting, testing, mounting, aligning and coupling ac induction motors. The candidate will also develop the skills to interpret the relevant requirements of the Wiring Regulations BS7671 for the installation and control of ac motors.

The Unit is suitable for candidates wishing to gain employment in the electrical installation industry or progress to more advanced studies in electrical engineering.

This Unit may form part of a National Qualification Group Award or may be offered on a free-standing basis.

OUTCOMES

- 1 Identify constructional features of ac induction motors and types of enclosures.
- 2 Describe the starting methods and protection devices used for ac induction motors.
- 3 Carry out the installation and testing of an ac induction motor.
- 4 Identify and interpret the requirements of the Wiring Regulations BS7671 for the installation and control of ac motors.

Administrative Information

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National Unit Specification: general information (cont)

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RECOMMENDED ENTRY

While entry is at the discretion of the centre, candidates would normally be expected to have attained one of the following, or equivalent:

- ◆ Standard Grade Maths and Standard Grade Physics or Technological studies at credit level
- ◆ NC Unit: *Electrical Plant Safety and Maintenance* (SCQF level 5)
- ◆ NC Unit: *Rotating Electrical Plant* (SCQF level 5)

CREDIT VALUE

1 credit at SCQF level 6 (6 SCQF credit points at SCQF level 6*).

**SCQF credit points are used to allocate credit to qualifications in the Scottish Credit and Qualifications Framework (SCQF). Each qualification in the Framework is allocated a number of SCQF credit points at an SCQF level. There are 12 SCQF levels, ranging from Access 1 to Doctorates.*

CORE SKILLS

There is no automatic certification of Core Skills in this Unit.

The Unit provides opportunities for candidates to develop aspects of the following Core Skill:

- ◆ Problem Solving (SCQF level 6)

These opportunities are highlighted in the Support Notes of this Unit Specification.

National Unit Specification: statement of standards

UNIT Installation of A.C. Induction Motors (SCQF level 6)

Acceptable performance in this Unit will be the satisfactory achievement of the standards set out in this part of the Unit Specification. All sections of the statement of standards are mandatory and cannot be altered without reference to SQA.

OUTCOME 1

Identify constructional features of ac induction motors and types of enclosures.

Performance Criteria

- (a) Identify correctly component parts of an ac induction motor.
- (b) Identify correctly types of enclosure for an ac induction motor.
- (c) Identify correctly terminal markings for an ac induction motor.

OUTCOME 2

Describe the starting methods and protection devices used for ac induction motors.

Performance Criteria

- (a) Describe clearly types of starting methods for ac induction motors.
- (b) Identify correctly protection devices for ac induction motors.

OUTCOME 3

Carry out the installation and testing of an ac induction motor.

Performance Criteria

- (a) Complete correctly a wiring diagram for a starter, motor and associated controls.
- (b) Carry out correctly the mounting of an ac induction motor.
- (c) Carry out correctly the wiring of the starter, motor and associated controls.
- (d) Carry out correctly the testing of an ac induction motor and starter circuit.
- (e) Carry out correctly the alignment and coupling of an ac induction motor to a mechanical load.

OUTCOME 4

Identify and interpret the requirements of the Wiring Regulations BS7671 for the installation and control of ac motors.

Performance Criteria

- (a) Identify and interpret correctly the BS7671 requirements for the installation of ac induction motors.
- (b) Identify and interpret correctly the BS7671 requirements for the control of ac induction motors.

National Unit Specification: statement of standards (cont)

UNIT Installation of A.C. Induction Motors (SCQF level 6)

EVIDENCE REQUIREMENTS FOR THIS UNIT

Evidence is required to demonstrate that candidates have achieved all Outcomes and Performance Criteria.

Outcomes 1, 2 and 4:

Written and/or recorded oral evidence is required which demonstrates that the candidate has achieved Outcomes 1, 2 and 4 to the standards specified in the Outcomes and Performance Criteria. This evidence should be obtained under controlled, supervised conditions.

Outcomes 1, 2 and 4 may be assessed on an individual basis or as a single assessment covering all three Outcomes. The total assessment time for Outcomes 1, 2 and 4 should be no longer than one hour. Assessment/s should be conducted under controlled, supervised, closed-book conditions in which candidates should be provided with the Wiring Regulations BS7671 but not be allowed to bring any notes, handout, text books or any other relevant materials into the assessment.

Outcome 3:

Performance evidence supplemented with an assessor observation checklist, and written and/or recorded oral evidence is required which demonstrates that the candidate has achieved Outcome 3 to the standards specified in the Outcome and Performance Criteria. This evidence should be obtained under supervised conditions.

Outcome 3 may be assessed on an individual basis. The assessment for Outcome 3 should be no longer than two hours and conducted under closed-book conditions.

The practical assessment exercise for Outcome 3 should be undertaken by candidates individually and be conducted over the duration of Outcome 4 delivery.

With regard to Outcome 1:

- ◆ candidates should state SIX component parts from either a Cage Rotor or a Wound Rotor AC Induction Motor including parts from the following: Winding, Laminations, Cage Conductors, Terminals and Terminal Box, End Shield, Shaft, Bearings, Fan, Slip rings (Wound Rotor), Brushes (Wound Rotor), Insulation, Foot Mount, Flange Mount, Lifting Ring and Rating plate
- ◆ candidates should identify THREE Enclosure types from the following: Flameproof, Drip Proof, Pipe Ventilated, Totally Enclosed and Screen Protected
- ◆ candidates should identify terminal markings for a Star connected circuit and a Delta connected circuit

National Unit Specification: statement of standards (cont)

UNIT Installation of A.C. Induction Motors (SCQF level 6)

With regard to Outcome 2:

- ◆ candidates should describe TWO starting methods from the following: Direct-on-Line, Star-Delta, Electronic Soft Start, Wound Rotor and Auto-Transformers starters
- ◆ candidates should state ONE protection device for EACH of the following methods of protection for AC induction motors: Overload, Short Circuit and protection against overheating

With regard to Outcome 3:

- ◆ candidates should complete a motor-starter wiring diagram and a control line diagram for a Three Phase ac Induction Motor
- ◆ candidates to mount an ac induction motor using either horizontal or vertical installation
- ◆ candidates should demonstrate skills for the wiring and connection from the terminals of a Three Phase ac Induction Motor to a motor starter and associated controls using either direct-on-line or star delta or rotor resistance or electronic soft start starting methods
- ◆ candidates should demonstrate TWO of the following tests: motor winding resistance test, a motor insulation resistance test, and functional testing including start/stop buttons, starting sequence and reverse rotation
- ◆ candidates should demonstrate the alignment and coupling using either direct drives or belt drives

With regard to Outcome 4:

- ◆ candidates should identify and interpret TWO BS7671 requirements for the installation of AC induction motors
- ◆ candidates should identify and interpret TWO BS7671 requirements for the control of ac induction motors

National Unit Specification: support notes

UNIT Installation of A.C. Induction Motors (SCQF level 6)

This part of the Unit Specification is offered as guidance. The support notes are not mandatory.

While the exact time allocated to this Unit is at the discretion of the centre, the notional design length is 40 hours.

GUIDANCE ON THE CONTENT AND CONTEXT FOR THIS UNIT

The Unit is contained with the options section of the National Certificate Group Awards in Electrical Engineering at SCQF level 6 and may also be offered on a free-standing basis.

Successful completion of this Unit enhances the employability skills for candidates to gain employment in the electrical installation industry.

This Unit provides the opportunity for candidates to develop their knowledge and understanding of AC induction motors, practical exercises to wire a motor starter circuit and also to fix, align and install electrical plant.

This Unit could be taught in conjunction with other NC Units such as *Electrical Plant Maintenance* SCQF level 6 or *Single and Three Phase Induction Motors* SCQF level 6.

GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

This Unit may be delivered by a combination of lectures, tutorials, investigations (including Internet) and demonstrations. An organised visit to an electrical plant installation accompanied by a responsible person would be beneficial to the candidates in achieving the above Outcomes of this Unit. Visual and physical examination of component parts of ac induction motors, wiring diagrams, control line diagrams and the different types of ac induction motor is recommended. Examination of protection devices such as magnetic overload devices, thermal overloads, temperature sensing devices such as thermistors and their electronic equivalents are useful to assist in the learning of the operational characteristics of these devices.

For Outcome 3, the practical wiring exercise, preassembled starters on boards can be used with suitable terminals and an incoming supply. The Tutor MUST ensure that the candidate works safely at all times and that the wiring arrangements have been checked prior to the circuit being energised.

It is recommended that a suitable safe voltage level be used to energise the motor circuits.

Also, for Outcome 3 the installation of the ac induction motor could be fixed or mounted on concrete plinths or bed plates or slide rails for horizontal installation. Alternatively, vertical installation can be used. A range of couplings can be used from flexible, rigid to universal.

National Unit Specification: support notes (cont)

UNIT Installation of A.C. Induction Motors (SCQF level 6)

OPPORTUNITIES FOR CORE SKILL DEVELOPMENT

Problem Solving Skills will be naturally developed and enhanced as candidates install and test induction motors. Knowledge and understanding of starting methods and protection devices must be applied as they identify requirements, tools and techniques to be used, and plan the practical work. Regulations and safety requirements must be adhered to as candidates complete all stages in wiring, connecting, testing, mounting, aligning and coupling to meet current industry standards. Group discussion could encourage review and evaluation of achievement.

GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT

Opportunities for the use of e-assessment

E-assessment may be appropriate for some assessments in this Unit. By e-assessment we mean assessment which is supported by information and communications technology (ICT), such as e-testing or the use of e-portfolios or e-checklists. Centres which wish to use e-assessment must ensure that the national standard is applied to all candidate evidence and that conditions of assessment as specified in the Evidence Requirements are met, regardless of the mode of gathering evidence. Further advice is available in *SQA Guidelines on Online Assessment for Further Education (AA1641, March 2003)*, *SQA Guidelines on e-assessment for Schools (BD2625, June 2005)*.

Outcomes 1, 2 and 4 require written and/or recorded oral evidence and can be combined in the form of a short answer/ restricted response assessment to give the candidate an opportunity to display knowledge of the constructional features of AC induction motors, their starting methods, forms of protection and the requirements of the appropriate BS7671 requirements for the installation and control of AC induction motors.

Outcome 3 requires performance, written and/or recorded oral evidence and should in the form of a practical exercise to demonstrate the safe mounting, wiring, testing, alignment and coupling of an ac induction motor to a mechanical load.

It is recommended that the assessment of Outcomes 1, 2 and 4 be combined in a single assessment exercise.

It is recommended that the practical assignment of Outcome 3 be given a significant division of the time (two hours) of the total maximum assessment time of three hours.

Work-place evidence, verified by certificated assessors, may be considered as being valid for the assessment of Outcome 3.

CANDIDATES WITH DISABILITIES AND/OR ADDITIONAL SUPPORT NEEDS

The additional support needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments, or considering alternative Outcomes for Units. Further advice can be found in the SQA document *Guidance on Assessment Arrangements for Candidates with Disabilities and/or Additional Support Needs* (www.sqa.org.uk).