

City & Guilds Level 2 NVQ Diploma in Refrigeration and Air Conditioning (6187-01/02)

Version 2.3 (June 2026)

Qualification handbook

Qualification at a glance

Subject area	05.2 Building and construction
City & Guilds number	6187
Age group approved	16-18, 18+, 19+
Entry requirements	N/A
Assessment	Multiple choice examination, portfolio of evidence
Grading	Pass/Fail
Approvals	Fast track approval/full approval required
Registration and certification	Consult Walled Garden for last dates

Title and level	City & Guilds qualification number	Regulatory reference number	GLH	TQT
City & Guilds Level 2 NVQ Diploma in Installing, Testing and Maintaining Air Conditioning and Heat Pump Systems	6187-01	600/0912/3	540	660
City & Guilds Level 2 NVQ Diploma in Installing and Maintaining Refrigeration Systems	6187-02	600/0913/5	540	660

Version and date	Change detail	Section
1.2 Nov 2011	Amend assessment type – Unit 501	Units
1.3 March 2012	Range included against Unit 230/530	Units
2.0 July 2012	Optional Unit 330 added and ROC amended	Qualification structure Summary of assessment methods Units
2.1 February 2016	URN Corrected for Unit 330	Units
2.2 October 2017	Added TQT and GLH details	Introduction
	Deleted QCF	Throughout
2.3 June 2026	Updated to new template	Throughout
	Amendment to Unit 203, AC2.1 – removal of 'Hydroelectric' and 'Solar photovoltaic' from the 'Low Carbon' bulleted list	Units

1 Introduction

These qualifications are intended for those involved in the commissioning, installation, servicing and maintenance of refrigeration, air-conditioning and heat pump systems and support the skills necessary for employment/progression in this sector.

This document contains the information that centres need to offer the following qualifications:

Qualification title and level	GLH	TQT	City & Guilds qualification number	Qualification accreditation number	Registration and certification
City & Guilds Level 2 NVQ Diploma in Installing, Testing and Maintaining Air Conditioning and Heat Pump Systems	540	660	6187-01	600/0912/3	See Walled Garden/Online Catalogue for last dates
City & Guilds Level 2 NVQ Diploma in Installing and Maintaining Refrigeration Systems	540	660	6187-02	600/0913/5	

1.1 Qualification structure

To achieve the **City & Guilds Level 2 NVQ Diploma in Installing, Testing and Maintaining Air Conditioning and Heat Pump Systems (6187-01)**, learners must achieve a total of **66** credits:

- **54** credits must come from the **9** mandatory units, and
 - **12** credits from the **2** optional units
- listed in the table below.

Unit accreditation number	City & Guilds unit	Unit title	Assessment method	Credit value
Mandatory units				
J/602/2479	201/501	Understand and carry out safe working practices in Building Services Engineering	Online multiple choice / Assignment	10
J/602/2482	202	Understand how to communicate with others within Building Services Engineering	Online multiple choice	3
D/602/2486	203	Understand how to apply environmental protection measures within Building Services Engineering	Online multiple choice	4
J/602/2496	204	Understand how to apply scientific principles within MES	Online multiple choice	7
A/602/4987	210	Understand air conditioning and heat pump system installation, testing and maintenance techniques	On-line multiple choice	7
D/602/5002	211	Install, test and maintain air conditioning and heat pump systems	Portfolio	4
T/602/2493	219	Apply safe working practices in building services engineering working environment	Portfolio	2
R/602/4994	228/528	Understand and carry out site preparation and pipework fabrication techniques for RAC systems	Online multiple choice / Assignment	14
D/502/0629	230/530	Handling fluorinated gases and ozone-depleting substances _category I personnel	Online multiple choice / Assignment	3
Optional units				
K/602/4998	302/602	Understand and carry out electrical work on RAC systems and components	Online multiple choice / Assignment	12
T/504/0305	330/630	Understand and carry out electrical work on RAC systems and components	Online multiple choice / Assignment	12

To achieve the **City & Guilds Level 2 NVQ Diploma in Installing and Maintaining Refrigeration Systems (6187-02)**, learners must achieve a total of **66** credits:

- **54** credits must come from the **9** mandatory units, and
- **12** credits from the **2** optional units listed in the table below.

Unit accreditation number	City & Guilds unit	Unit title	Assessment method	Credit value
Mandatory units				
J/602/2479	201/501	Understand and carry out safe working practices in Building Services Engineering	Online multiple choice / Assignment	10
J/602/2482	202	Understand how to communicate with others within Building Services Engineering	Online multiple choice	3
D/602/2486	203	Understand how to apply environmental protection measures within Building Services Engineering	Online multiple choice	4
J/602/2496	204	Understand how to apply scientific principles within MES	Online multiple choice	7
T/602/2493	219	Apply safe working practices in building services engineering working environment	Portfolio	2
R/602/4994	228/528	Understand and carry out site preparation and pipework fabrication techniques for RAC systems	Online multiple choice / Assignment	14
D/502/0629	230/530	Handling fluorinated gases and ozone-depleting substances category I personnel	Online multiple choice / Assignment	3
M/602/4999	233	Understand refrigeration system installation, testing and maintenance techniques	Online multiple choice	7
J/502/7932	234	Install, test and maintain refrigeration systems	Portfolio	4
Optional units				
K/602/4998	302/602	Understand and carry out electrical work on RAC systems and components	Online multiple choice / Assignment	12
T/504/0305	330/630	Understand and carry out electrical work on RAC systems and components	Online multiple choice / Assignment	12

1.2 Opportunities for progression

On completion of this qualification candidates may progress into employment or to the following City & Guilds qualifications:

- 6187-04 Level 3 NVQ Certificate in Servicing and Maintaining Air Conditioning and Heat Pump Systems
- 6187-06 Level 3 NVQ Diploma in Servicing and Maintaining Refrigeration Systems
- ILM Level 2 Qualifications in Team Leading
- ILM Level 2 Qualifications in Innovation in the Workplace
- ILM Level 3 Qualifications in Management

Total Qualification Time

Total Qualification Time (TQT) is the total amount of time, in hours, expected to be spent by a Learner to achieve a qualification. It includes both guided learning hours (which are listed separately) and hours spent in preparation, study and assessment.

Title and level	GLH	TQT
City & Guilds Level 2 NVQ Diploma in Installing, Testing and Maintaining Air Conditioning and Heat Pump Systems	540	660
City & Guilds Level 2 NVQ Diploma in Installing and Maintaining Refrigeration Systems	540	660

2 Centre requirements

This section outlines the approval processes for Centres to offer these qualifications and any resources that Centres will need in place to offer the qualifications including qualification-specific requirements for Centre staff.

2.1 Approval process

Centres who are currently approved to offer the following qualifications:

- 6087-02 City & Guilds Level 2 NVQ in Refrigeration and air-conditioning (small commercial refrigeration and air-conditioning systems)
- 6127-01 City & Guilds Level 2 Certificate in small commercial refrigeration and air-conditioning systems

are eligible for automatic approval for the following qualifications:

- 6187-01 City & Guilds Level 2 NVQ Diploma in Installing, Testing and Maintaining Air Conditioning and Heat Pump Systems
- 6187-02 City & Guilds Level 2 NVQ Diploma in Installing and Maintaining Refrigeration Systems

Centres who are not approved to offer the existing qualifications must use the standard Qualification Approval Process (refer to *Centre Manual - Supporting Customer Excellence* in Appendix 2). This also applies to new centres wishing to offer any of these qualifications.

City & Guilds reserves the right to insist on full qualification approval if there have been quality issues within a centre or if there have been substantial staff changes at the centre.

2.2 Physical resources and site agreements

It is acceptable for centres to use specially designated areas within a centre to teach practical skills and to assess the simulated practical assignments within the knowledge units. The equipment, systems and machinery must meet current industrial standards and be capable of being used under normal working conditions, and must fully meet the requirements set in each City & Guilds practical assignment guide.

2.3 Human resources

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

- be technically competent in the areas for which they are delivering training and/or have experience of providing training. This knowledge must be at least to the same level as the training being delivered
- hold the appropriate qualifications detailed in this handbook
- have recent relevant experience in the specific area they will be assessing
- be occupationally knowledgeable in the area for which they are delivering training. This knowledge must be at least to the same level as the training being

delivered and must include up-to-date knowledge of each industry (for which the assessment is taking place), its settings, legislative and regulatory requirements, codes of practice and guidance.

- have credible experience of providing training.

Centre staff may undertake more than one role, e.g. a tutor and assessor or internal verifier, but they must never internally verify their own assessments.

Assessors must

- be working towards or have achieved A1 or A2 Standards and continue to practice to those standards or;
- have achieved D32 or D33 or TQFE/TQSE and possess CPD evidence of practicing to A1 or A2 Standards or;
- have other suitable 'equivalent assessor qualifications' endorsed by SummitSkills, which apply the principles of the A1/A2 Standards.

Assessor occupational competence

Have verifiable relevant industry experience and current knowledge of industry working practices and techniques relevant to the occupational working area. This verifiable evidence must be at or above the level being assessed and include one or more of the following:

- A relevant qualification. Assessors must either be able to demonstrate that they are registered and up-to-date with their registration with an appropriate approved industry registration body or have one or more of a relevant occupational qualification to ensure that they can be regarded as occupationally competent in terms of assessing or verifying the relevant qualifications, and units therein.

For particular units/qualifications the verifiable evidence may need to be above the level of the unit/qualification being assessed. This requirement will be detailed in the "Additional Information" pertaining to specific units/qualifications.

Assessment of competence-based units/qualifications for mechanical services occupations will require assessors to have the relevant qualification that certifies their competence in key technical areas pertinent to the completion of the unit/qualification.

This occupational competence must include up-to-date knowledge of each industry (for which the assessment is taking place), its settings, legislative and regulatory requirements, codes of practice and guidance.

Assessor Continuing Professional Development

The occupational competence of assessors must be updated on a regular basis and be periodically reconfirmed via Continuing Professional Development (CPD) via the assessment centres and quality assured by City & Guilds.

It is the responsibility of each assessor to identify and make use of opportunities for CPD, such as industry conferences, access to trade journals, and SSC and Professional Body/Trade Association events, at least on an annual basis to enhance and upgrade their professional development and technical knowledge. It is imperative that records are kept of all such CPD opportunities/occasions and that they provide evidence of cascading such technical knowledge and industry intelligence to all relevant colleagues.

Internal verifiers

Role and responsibilities

The Sector Skills Council, SummitSkills considers the main focus of IVs to be the quality assurance of assessment procedures. The IV is also required to have a minimum of occupational experience evidenced by having a Building Services Engineering sector related qualification or proven sector competence/experience plus access to relevant 'occupational expertise' to enable them to conduct their role as internal verifier appropriately. This evidence and access to 'occupational expertise' is quality assured by City & Guilds.

Internal verifiers must:

- be working towards or have achieved the V1 Standard and continue to practice to that standard or;
- have achieved D34 and possess CPD evidence of practicing to the V1 Standard and;
- demonstrate an understanding of the assessment process.

Internal verifiers continuing professional development

The occupational experience of IVs must be updated on a regular basis and be periodically reconfirmed via Continuing Professional Development (CPD) via the assessment centres and quality assured by City & Guilds.

It is the responsibility of each IV to identify and make use of opportunities for CPD, such as industry conferences, access to trade journals, and SSC and Professional Body/Trade Association events, at least on an annual basis to enhance and upgrade their professional development and technical knowledge. It is imperative that records are kept of all such CPD opportunities/occasions.

Expert witnesses

Where Expert Witnesses are used in the assessment process identified above they must be sector competent individuals who can attest to the learner's performance in the workplace. It is not necessary for expert witnesses to hold an assessor qualification, as a qualified assessor must assess the performance evidence provided by an expert witness. Evidence from expert witnesses must meet the tests of validity, reliability, authenticity and sufficiency.

Expert witnesses will need to demonstrate

- they have relevant current knowledge of industry working practices and techniques
- that they have no conflict of interest in the outcome of their evidence.

2.4 Candidate entry requirements

Candidates should not be entered for a qualification of the same type, content and level as that of a qualification they already hold.

There are no formal entry requirements for candidates undertaking these qualifications. However, centres must ensure that candidates have the potential and opportunity to gain the qualifications successfully.

Age restrictions

These qualifications are not approved for use by candidates under the age of 16, and City & Guilds cannot accept any registrations for candidates in this age group.

Other legal considerations

All legal requirements related to the subject matter must be met by candidates and centres.

2.5 Access arrangements, reasonable adjustments and special consideration

City & Guilds has considered the design of these qualification(s) and their assessments in order to best support accessibility and inclusion for all learners. City & Guilds understands 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.

Special consideration is a post examination adjustment to a candidate's mark or grade to reflect temporary injury, illness or other indisposition at the time of the examination/assessment.

Please refer to the documents 'Joint Council for Qualifications (JCQ) Access Arrangements and Reasonable Adjustments', 'JCQ – A Guide to the special consideration process' and 'Access arrangements – When and how applications need to be made to City & Guilds' for more information. All of these are available on the **City & Guilds website**

3 Course design and delivery

3.1 Initial assessment and induction

Centres will need to make an initial assessment of each candidate prior to the start of their programme to ensure they are entered for an appropriate type and level of qualification.

The initial assessment should identify:

- Any specific training needs the candidate has, and the support and guidance they may require when working towards their qualifications. This is sometimes referred to as diagnostic testing.
- Any units the candidate has already completed, or credit they have accumulated which is relevant to the qualifications they are about to begin.

City & Guilds recommends that centres provide an induction programme to ensure the candidate fully understands the requirements of the qualifications they will work towards, their responsibilities as a candidate, and the responsibilities of the centre. It may be helpful to record the information on a learning contract.

3.2 Recommended delivery strategies

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

SummitSkills expect knowledge units to be completed before performance units are undertaken by the candidate.

Centres may design course programmes of study in any way which

- best meets the needs and capabilities of their candidates
- satisfies the requirements of the qualifications.

When designing and delivering the course programme, centres might wish to incorporate other teaching and learning that is not assessed as part of the qualifications. This might include the following:

- literacy, language and/or numeracy
- personal learning and thinking
- personal and social development
- employability.

Where applicable, this could involve enabling the candidate to access relevant qualifications covering these skills.

3.3 Quality assurance

Approved centres must have effective quality assurance systems to ensure optimal 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 all verified and/or moderated assessments undertaken by City & Guilds, 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.

To carry out the quality assurance role, Internal Quality Assurers (IQAs) must:

- adhere to the requirements set out in the centre handbook
- have appropriate teaching and vocational knowledge and expertise
- have experience in quality management/internal quality assurance
- hold or be working towards an appropriate teaching/training/assessing qualification
- be familiar with the occupation and technical content covered within the qualification.

External quality assurance for the qualification will be provided by City & Guilds. External Quality Assurers (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:

- adhere to the requirements set out in the centre handbook
- provide advice and support to centre staff
- ensure the quality and consistency of assessments and marking/grading within and between centres using systematic sampling
- provide feedback to centres and to City & Guilds.

3.4 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 \(cityandguilds.com\)](https://www.cityandguilds.com)

3.5 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 help 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 and 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 and recycling of components is in place wherever possible)
- minimising water use and considering options for reuse/salvage as part of activities wherever possible.

4 Assessment

4.1 Summary of assessment methods

For these units, candidates will be required to complete the following assessments:

Unit	Title	Assessment method	Where to obtain assessment materials
201/ 501	Understand and carry out safe working practices in Building Services Engineering	City & Guilds Online multiple choice test (6187-201) Assignment (6187-501) Externally set assignment, locally marked and externally verified.	Examinations provided by City & Guilds online assessment. Go to www.cityandguilds.com and navigate to the 6187 webpage. Go to www.cityandguilds.com and navigate to the 6187 webpage. Password available on Walled Garden.
202	Understand how to communicate with others within Building Services Engineering	City & Guilds Online multiple choice test (6187-202)	Examinations provided by City & Guilds online assessment. Go to www.cityandguilds.com and navigate to the 6187 webpage.
203	Understand how to communicate with others within Building Services Engineering	City & Guilds Online multiple choice test (6187-203)	Examinations provided by City & Guilds online assessment. Go to www.cityandguilds.com and navigate to the 6187 webpage.
204	Understand how to apply scientific principles within MES	City & Guilds Online multiple choice test (6187-204)	Examinations provided by City & Guilds online assessment. Go to www.cityandguilds.com and navigate to the 6187 webpage.
210	Understand air conditioning and heat pump system installation, testing and maintenance techniques	City & Guilds Online multiple choice test (6187-210)	Examinations provided by City & Guilds online assessment. Go to www.cityandguilds.com and navigate to the 6187 webpage.

211	Install, test and maintain air conditioning and heat pump systems	Portfolio (6187-211) This unit will be assessed via observation and the development of a portfolio in a working environment and will be assessed to the assessment criteria set out in the unit.	The City & Guilds 6187 logbook can be downloaded from the City & Guilds website. Go to www.cityandguilds.com and navigate to the 6187 webpage. Alternatively centres may wish to use approved e-portfolios, with more details available at www.cityandguilds.com/eportfolio
219	Apply safe working practices in building services engineering working environment	Portfolio (6187-219) This unit will be assessed via observation and the development of a portfolio in a working environment and will be assessed to the assessment criteria set out in the unit.	The City & Guilds 6187 logbook can be downloaded from the City & Guilds website. Go to www.cityandguilds.com and navigate to the 6187 webpage. Alternatively centres may wish to use approved e-portfolios, with more details available at www.cityandguilds.com/eportfolio
228/ 528	Understand and carry out site preparation and pipework fabrication techniques for RAC systems	City & Guilds Online multiple choice test (6187-228) Assignment (6187-528) Externally set assignment, locally marked and externally verified.	Examinations provided by City & Guilds online assessment. Go to www.cityandguilds.com and navigate to the 6187 webpage. Go to www.cityandguilds.com and navigate to the 6187 webpage. Password available on Walled Garden
230/ 530	Handling fluorinated gases and ozone-depleting substances category I personnel	City & Guilds Online multiple choice test (6187-230) Assignment (6187-530) Externally set assignment, locally marked and externally verified.	Examinations provided by City & Guilds online assessment. Go to www.cityandguilds.com and navigate to the 6187 webpage. Go to www.cityandguilds.com and navigate to the 6187 webpage. Password available on Walled Garden
233	Understand refrigeration system installation, testing and maintenance techniques	City & Guilds Online multiple choice test (6187-233)	Examinations provided by City & Guilds online assessment. Go to www.cityandguilds.com and navigate to the 6187 webpage.

234	Install, test and maintain refrigeration systems	Portfolio (6187-234) This unit will be assessed via observation and the development of a portfolio in a working environment and will be assessed to the assessment criteria set out in the unit.	The City & Guilds 6187 logbook can be downloaded from the City & Guilds website. Go to www.cityandguilds.com and navigate to the 6187 webpage. Alternatively centres may wish to use approved e-portfolios, with more details available at www.cityandguilds.com/eportfolio
302/ 602	Understand and carry out electrical work on RAC systems and components	City & Guilds Online multiple choice test (6187-302) Assignment (6187-602) Externally set assignment, locally marked and externally verified.	Examinations provided by City & Guilds online assessment. Go to www.cityandguilds.com and navigate to the 6187 webpage. Go to www.cityandguilds.com and navigate to the 6187 webpage. Password available on Walled Garden
330/ 630	Understand and carry out electrical work on RAC systems and components	City & Guilds Online multiple choice test (6187-330) Assignment (6187-630) Externally set assignment, locally marked and externally verified.	Examinations provided by City & Guilds online assessment. Go to www.cityandguilds.com and navigate to the 6187 webpage. Go to www.cityandguilds.com and navigate to the 6187 webpage. Password available on Walled Garden

4.2 Evidence requirements

The evidence requirements and City & Guilds assessment strategy for these qualifications has been designed within the confines of the SSC SummitSkills 'Consolidated Assessment Strategy for units and Qualifications of 'Occupational Competence' in the Qualifications and Credit Framework (England, Northern Ireland and Wales) for the Building Services Engineering Sector' (April 2010 v2.1a 06.10)'.

There are three types of units within these qualifications:

Knowledge Unit	A unit that gives the learner the opportunity to demonstrate their knowledge and understanding of identified topics and subject areas.
Performance Unit	A unit that gives the learner the opportunity to demonstrate they have the practical skills that are in keeping with the relevant National Occupational Standards for identified activities.
Combination Unit	A unit that gives the learner the opportunity to demonstrate their understanding and application of specific knowledge and is assessed in simulated conditions using particularly identified 'relevant practical activities'.

'Knowledge' units must be undertaken in line with the City & Guilds assessment strategy for each unit as detailed in this handbook. All knowledge only units for the award are assessed by e-volve multiple choice tests.

Evidence that is sourced from the real working environment for Performance Units must be naturally occurring and can be generated by;

- direct observation of performance in the workplace by a qualified assessor and/or testimony from an expert witness subject to the activity being assessed. this will be the primary source of evidence.
- candidate's reflective account of performance.
- work plans and work based products eg diagrams, drawings, specifications, customer testimony, authorised & authenticated photographs / images and audiovisual records of work completed.
- evidence from prior achievements that demonstrably match the requirements of the performance unit.
- witness testimony.

Meeting the assessment requirements of Performance Units will need initial discussions and assessment planning between the learner and Assessor, as an essential activity to identify opportunities to assess real working environment evidence, gaps that need to be filled or opportunities to recognise the prior achievement of the learner.

Competence must be demonstrated consistently over a period of time and on more than one occasion. Unless specifically stated otherwise within the unit, there is no stipulation what that period of time might be as this is a decision for the Assessor. Based on their own professional judgement Assessors must be capable of identifying when competence has been demonstrated by the learner.

For the performance units the majority of evidence must be generated from an environment in which real work activities take place under real working conditions in keeping with real commercial situations.

Simulation can take place in those rare circumstances where the opportunities to collect naturally occurring evidence are limited or absent and the learner lacks evidence for completion of the unit. However, this scenario is anticipated to be rare in relation to the qualifications and the units to which this strategy applies given the inherent flexibility of the evidence-gathering process. Where simulation does take place it must be in a realistic working environment.

A simulated environment must replicate a real working environment. The criteria for which must be to supply fit-for-purpose tools, equipment, full-size components, realistic deadlines and other commercial requirements.

Simulation **must** take place for industry identified key-safety critical aspects of the qualification. A key safety-critical aspect is defined by SummitSkills as any 'technical' activity with the potential to harm/damage personnel/property if carried out incorrectly. The activities that will be undertaken to demonstrate competence in these areas are contained within each industry's 'Assessment of Occupational Competence' arrangement and this must **not** be undertaken until they are deemed ready to be assessed as competent. This underpins the assumption that the learner has sufficient technical expertise, knowledge, skill and maturity.

Key Safety-Critical Aspects are listed below:

- Activities relating to F Gas installations/service and maintenance
- Pressure testing
- Handling of refrigerants (ODS, Ammonia, HC and CO₂)
- Thermal pipe joining methods – welding; brazing; soldering activities
- Limited scope electrical work
- As relevant, the installation, connection and servicing/maintenance of fuel systems and equipment – gas; oil; solid fuel
- As relevant, the installation, connection and servicing/maintenance of hot/cold water systems and equipment – unvented water; backflow prevention

4.3 Recording forms

Candidates and centres may decide to use a paper-based or electronic method of recording evidence. City & Guilds endorses several ePortfolio systems. Further details are available at: www.cityandguilds.com/eportfolios.

City & Guilds has developed a set of *Recording forms* including examples of completed forms, for new and existing centres to use as appropriate. **NVQ Recording forms** are available on the City & Guilds website.

Although it is expected that new centres will use these forms, centres may devise or customise alternative forms, which must be approved for use by the external verifier, before they are used by candidates and assessors at the centre. Amendable (MS Word) versions of the forms are available on the City & Guilds website.

4.4 Recognition of prior learning (RPL)

Recognition of Prior Learning (RPL) recognises the contribution a person's previous experience could contribute to a qualification.

City & Guilds will recognise achievement of unit/qualifications through other awarding organisations which have the same content and assessment.

5 Units

Availability of units

The learning outcomes and assessment criteria are also viewable on the Register of Regulated Qualifications <http://register.ofqual.gov.uk/unit>

Structure of units

The units in this qualification are written in a standard format and comprise the following:

- City & Guilds unit number
- Title
- Level
- Credit value
- Unit Accreditation Number (UAN)
- Recommended Guided Learning Hours (GLH)
- Endorsement by a sector or other appropriate body
- Information on assessment
- Learning outcomes which are comprised of a number of assessment criteria

Unit 201/501 Understand and carry out safe working practices in Building Services Engineering

Level: 2
Credit value: 10
UAN: J/602/2479

Learning outcomes

There are **twelve** learning outcomes to this unit. The learner will

1. Know the health and safety legislation that applies to the building services industry
2. Know how to recognise and respond to hazardous situations while working in the building services industry
3. Know the safe personal protection measures while working in the building services industry
4. Be able to apply manual handling techniques
5. Know how to respond to accidents that occur while working in the building services industry
6. Know the procedures for electrical safety when working in the building services industry
7. Be able to apply basic electrical safety measures in the building services industry
8. Know the methods of working safely with heat producing equipment in the building services industry
9. Be able to safely work with gas heating equipment in the building services industry
10. Know the methods of safely using access equipment in the building services industry
11. Be able to safely use access equipment in the building services industry
12. Know the methods of working safely in excavations and confined spaces in the building services industry

Guided learning hours

It is recommended that **88** guided learning hours should be allocated for this unit, although patterns of delivery are likely to vary.

Support of the unit by a sector or other appropriate body

This unit is endorsed by Summit Skills.

Assessment

The unit will be assessed by:

- An on-line test
- Assignment

Unit 201/501 Understand and carry out safe working practices in Building Services Engineering

Outcome 1 Know the health and safety legislation that applies to the building services industry

Assessment criteria

The learner can

- 1.1 State the aims of health and safety legislation in protecting the workforce and members of the public
 - General legislation
 - Construction specific legislation
 - Building services specific legislation
- 1.2 Identify the responsibilities of members of the construction team under health and safety legislation
 - Employers (including employer representatives)
 - Designers
 - Main contractors
 - Sub-contractors
 - Employees
 - Self employed (labour only)
 - Clients (customers)
- 1.3 State the legal status of health and safety guidance materials
 - Acts of Parliament
 - Regulations
 - Approved codes of Practice
 - HSE guidance notes
- 1.4 State the role of enforcing authorities under health and safety legislation
 - Health and Safety Executive
 - Local Authority
- 1.5 Identify the powers of inspectors under health and safety legislation
 - Improvement notice
 - Prohibition notice
 - Powers of prosecution
 - Role in providing advice and guidance

Unit 201/501 Understand and carry out safe working practices in Building Services Engineering

Outcome 2 Know how to recognise and respond to hazardous situations while working in the building services industry

Assessment criteria

The learner can

2.1 Identify the types of general site hazards that maybe encountered while at work.

- Site/work area cleanliness
 - Tripping hazards
 - Slipping hazards
- Using equipment
 - Inadequate or lack of personal protective equipment
 - Defective (unsafe) equipment
- Personal conduct
 - Manual handling
 - Working at heights

2.2 State the potential dangers to the workforce and members of the public when work is carried out

- On construction sites (all property types)
- In industrial commercial premises (occupied and unoccupied refurbishment)
- In dwellings (occupied and unoccupied refurbishment)

2.3 Identify the methods that can be used to prevent accidents or dangerous situations occurring during work activities

- Working practices (use and understanding of)
 - Method statements
 - Permit to work systems
 - Risk assessments
- Safe notices (use and understanding of)
 - Mandatory signs
 - Prohibition signs
 - Hazard signs
 - Fire fighting signs
 - Safe condition signs
 - Combination signs

2.4 Identify how hazardous substance legislation classifies substances and direct precautions to be taken while working with those substances.

- Toxic
- Harmful
- Corrosive
- Irritant
- Oxidising

- Extremely flammable
- 2.5 Identify the general precautions necessary for working with commonly encountered substances.
- Lead – solid and flume
 - Solvents and lubricants
 - Fluxes
 - Jointing compounds
 - Sealants
 - Gases – LPG, oxy-acetylene and carbon dioxide
 - Cleaning agents
- 2.6 State the range of common building materials and services components that may contain asbestos
- 2.7 Identify the types of asbestos that may be encountered in the workplace
- White asbestos (Chrysotile)
 - Brown or grey asbestos (Amosite)
 - Blue asbestos (Crocidolite)
 - Asbestos cement materials
- 2.8 State the procedures that must be used to safely work with asbestos cement based materials
- Flue, soil, rainwater pipes and gutters
 - Tanks and cisterns
 - Artex
 - Small gaskets and seals
- 2.9 Identify the actions to be taken when asbestos is encountered while undertaking work activities
- Protection of the workforce and members of public
 - Licensing requirements for asbestos removal organisations
 - Safe disposal requirements

Unit 201/501 Understand and carry out safe working practices in Building Services Engineering

Outcome 3 Know the safe personal protection measures while working in the building services industry

Assessment criteria

The learner can

3.1 State the purpose of, and application of protective equipment

- Clothing protection including high visibility
- Eye protection
- Hand protection
- Head protection
- Foot protection
- Hearing protection
- Respiratory protection

3.2 Identify the procedures for manually handling heavy and bulky items

- Assessment of a safe load that a person can lift
- Application of safe kinetic lifting technique
- Use of simple mechanical lifting aids – sack trolley
- Application and use of mechanical lifting aids on large construction sites

Unit 201/501 Understand and carry out safe working practices in Building Services Engineering

Outcome 4 Be able to apply manual handling techniques

Assessment criteria

The learner can

4.1 Perform manual handling of heavy and bulky items

- Plan the lift
- Safely moving the load
- Assist in a two-person lift

4.2 Manually handle loads using mechanical lifting aids

Unit 201/501 Understand and carry out safe working practices in Building Services Engineering

Outcome 5 Know how to respond to accidents that occur while working in the building services industry

Assessment criteria

The learner can

5.1 Identify the requirements for first aid provision while working

- In small occupied properties
- On construction sites (new-build and refurbishment)

5.2 Identify the actions that should be taken when an accident or emergency is discovered

- Raising the alarm
- The role of the emergency services and contact methods
- Typical emergency evacuation procedures

5.3 State the procedures for dealing with minor injuries that can occur while working

- Cuts
- Minor burns
- Objects in the eye
- Exposure to fumes

5.4 State the procedures for dealing with major injuries that can occur while working

- Bone fractures
- Unconscious co-workers
 - Placing the casualty in the recovery position
 - Concussion
- Electric shock
 - Removal from the supply
 - CPR method

5.5 State the procedures for recording accidents and near misses at work

- Statutory requirements for the reporting of accidents/serious occurrences
- The use of company accident books
- The details to be recorded on a simple accident /incident report form

Unit 201/501 Understand and carry out safe working practices in Building Services Engineering

Outcome 6 Know the procedures for electrical safety when working in the building services industry

Assessment criteria

The learner can:

- 6.1 Identify the common electrical dangers encountered on construction sites and in private dwellings
 - Faulty electrical equipment
 - Signs of damaged or worn electrical cables – power tools and property hard wiring system
 - Trailing cables
 - Proximity of cables to services pipework
 - Buried/hidden cables
 - Inadequate over-current protection devices
- 6.2 Identify the methods of safely using electrical tools and equipment on site
 - battery powered supplies
 - 110 volt supplies
 - 230 volt supplies
- 6.3 Identify how to conduct a visual inspection of a power tool for safe condition before use
 - Checking for a valid PAT test
 - Inspection for general condition
- 6.4 State the procedure that should be applied for tools and equipment that fail safety checks
- 6.5 State the electrical industry safe isolation procedure that should be applied to building services equipment before carrying out work on them
- 6.6 State the use of temporary continuity bonding when working on pipework components

Unit 201/501 Understand and carry out safe working practices in Building Services Engineering

Outcome 7 Be able to apply basic electrical safety measures in the building services industry

Assessment criteria

The learner can

- 7.1 Demonstrate the electrical industry safe isolation procedure to safely isolate an item of fixed mechanical or electrical plant or equipment
- 7.2 Carry out a visual safety inspection of power tools before use and report on their condition
- 7.3 Demonstrate the application of temporary continuity bonding when cutting into a fixed metallic pipework systems

Unit 201/501 Understand and carry out safe working practices in Building Services Engineering

Outcome 8 Know the methods of working safely with heat producing equipment in the building services industry

Assessment criteria

The learner can:

8.1 Identify the various types of gases used in pipe and sheet jointing processes

- Bottle colours
- Properties of the gases used
- Uses within the industry

8.2 Identify how bottled gases and equipment should be safely transported and stored

8.3 Identify the various types of heat producing equipment and how to check them safely

- Hoses
 - Colours used
 - Thread directions
 - Flashback arrestors
- Control valves
- Gauges
- Blowpipes
- Direct connecting combined units (aeration in the nozzle)

8.4 Identify how gas heating equipment is safely assembled and used

- Bottle location and position
- Equipment assembly sequence
- Leak detection procedures
- Safe purging procedure
- Safe lighting and extinguishing procedure
- Actions in the event of leakage

8.5 Identify the three elements of the fire triangle and how combustion takes place

8.6 State the dangers of working with heat producing equipment and how to prevent fires occurring

8.7 State the method for fighting small localised fires that can occur in the workplace

- when to avoid tackling fires
- types of extinguisher
- selection of extinguisher by fire type
- method of use

Unit 201/501 Understand and carry out safe working practices in Building Services Engineering

Outcome 9 Be able to safely work with gas heating equipment in the building services industry

Assessment criteria

The learner can

9.1 Perform a safety check of gas heating equipment

- Transportation of gas bottles to the work area
- Assess components and equipment for safety

9.2 Perform the safe assembly of gas heating equipment for use

- hose and blowpipe or combined unit attachment
- leak detection procedures
- purging procedures
- lighting and extinguishing procedures

9.3 Demonstrate the use of a fire extinguisher in extinguishing a small solid fuel fire

Unit 201/501 Understand and carry out safe working practices in Building Services Engineering

Outcome 10 Know the methods of safely using access equipment in the building services industry

Assessment criteria

The learner can

- 10.1 Identify the situations where it may be necessary to work at height
- 10.2 Identify the types of equipment used to permit work at heights in the building services industry
 - Step ladders
 - Ladders
 - Mobile mini towers/scaffolds
 - Roof ladders and crawling boards
 - Mobile tower scaffolds
 - Fixed scaffolds and edge protection
 - Mobile elevated work platforms including scissor lifts and cherry pickers
- 10.3 Identify how to select suitable equipment for carrying out work at heights based on the work being carried out
- 10.4 State the range of safety checks to be carried out on access equipment before it is used
 - Step ladders
 - Ladders
 - Mobile mini towers/scaffold
 - Roof ladders and crawling boards
 - Mobile tower scaffolds
 - Fixed scaffolds and edge protection (appreciation only)
- 10.5 State the method of assembly and use of access equipment
 - Step ladders
 - Ladders
 - Roof ladders
 - Mobile tower scaffolds

Unit 201/501 Understand and carry out safe working practices in Building Services Engineering

Outcome 11 Be able to safely use access equipment in the building services industry

Assessment criteria

The learner can

11.1 Demonstrate the safe method of assembly and use of

- Step ladders
- Ladders

11.2 Demonstrate the safe method of assembly and use of mobile tower scaffolds

Unit 201/501 Understand and carry out safe working practices in Building Services Engineering

Outcome 12 Know the methods of working safely in excavations and confined spaces in the building services industry

Assessment criteria

The learner can

- 12.1 Identify the situations in which it may be necessary to work in excavations
- 12.2 State how excavations should be prepared for safe working
 - Safe access into the excavation
 - Trench support systems
- 12.3 State the measures that need to be applied to prevent persons or equipment falling into excavations
 - Use of warning signs
 - Use of barriers for pedestrians
 - Vehicle proximity to excavation edges
- 12.4 Identify where work in confined spaces may be required
- 12.5 State the potential dangers when working in confined spaces
 - Drainage systems
 - Plant rooms
 - Main service duct-rooms
 - In tanks, cylinders, boilers or cisterns
 - Under suspended timber floors
 - In roof spaces

Unit 202

Understand how to communicate with others within Building Services Engineering

Level: 2
Credit value: 3
UAN: J/602/2482

Learning outcomes

There are **three** learning outcomes to this unit. The learner will

1. Know the members of the construction team and their role within the building services industry
2. Know how to apply information sources in the building services industry
3. Know how to communicate with others in the building services industry

Guided learning hours

It is recommended that **28** guided learning hours should be allocated for this unit, although patterns of delivery are likely to vary.

Support of the unit by a sector or other appropriate body

This unit is endorsed by Summit Skills.

Assessment

The unit will be assessed by:

- An on-line test

Unit 202 Understand how to communicate with others within Building Services Engineering

Outcome 1 Know the members of the construction team and their role within the building services industry

Assessment criteria

The learner can:

1.1 Identify the key roles of the site management team

- Architect
- Project manager/Clerks of work
- Structural engineer
- Surveyor
- Building services engineer
- Quantity surveyor
- Buyer
- Estimator
- Contracts manager
- Construction manager

1.2 Identify the key roles of the individuals that report to the site management team

- Sub contractors
- Site supervisor
- Trade supervisor
- Trades
 - bricklayer
 - joiner
 - plasterer
 - tiler
 - electrician
 - H&V fitter
 - gas fitter
 - decorator
 - ground workers

1.3 Identify the key roles of site visitors

- building control inspector
- water inspector
- HSE inspector
- electrical services inspector

Unit 202 Understand how to communicate with others within Building Services Engineering

Outcome 2 Know how to apply information sources in the building services industry

Assessment criteria

The learner can

2.1 Identify the types of statutory legislation and guidance information that applies to working in the industry

- Legislation
 - data protection
 - equal opportunities
 - Health and safety
 - Employment
- Regulations
- British standards
- Codes of practice
- Manufacturers' guidance
 - installation instructions
 - services and maintenance instructions
 - user instructions

2.2 Identify the purpose of information that is used in the workplace

- Job specifications
- Plans/drawings
- Work programmes
- Delivery notes
- Time sheets
- Policy documentation – health and safety , environmental, customer service

2.3 Identify the purpose of information given to customers

- Quotations
- Estimates
- Invoices/statements
- Statutory cancellation rights
- Handover information

2.4 State the importance of company policies and procedures that affect working relationships

- Company working policies/procedures
 - behaviour
 - time keeping
 - dress code
 - contract of employment
- limits to personal authority
 - Apprentices
 - Level 2 qualified staff
 - Level 3 qualified staff
- Supervisor and management responsibilities

Unit 202 Understand how to communicate with others within Building Services Engineering

Outcome 3 Know how to communicate with others in the building services industry

Assessment criteria

The learner can:

- 3.1 Identify suitable communication methods for use in work situations
 - Oral communication
 - Written communication
 - E-mail
 - Fax
 - Letter
- 3.2 Define methods of effective communication for people with
 - Physical disabilities
 - Learning difficulties
 - Language differences
 - dialects
 - accents
 - foreign and second languages issues
- 3.3 State the actions to take to deal with conflicts between
 - Customers and operatives
 - Co-workers
 - Supervisors and operatives
- 3.4 State the effects that poor communication may have on the organisation
 - Between operatives
 - Between operatives and management
 - Company to customer

Unit 203

Understand how to apply environmental protection measures within Building Services Engineering

Level: 2
Credit value: 4
UAN: D/602/2486

Learning outcomes

There are **six** learning outcomes to this unit. The learner will

1. Know the energy conservation legislation that applies to the building services industry
2. Know the applications of energy sources used in the building services industry
3. Know the importance of energy conservation when commissioning building services systems
4. Know the methods of reducing waste and conserving energy while working in the building services industry
5. Know how to safely dispose of materials used in the building services industry
6. Know the methods of conserving and reducing wastage of water within the building services industry

Guided learning hours

It is recommended that **38** guided learning hours should be allocated for this unit, although patterns of delivery are likely to vary.

Support of the unit by a sector or other appropriate body

This unit is endorsed by SummitSkills.

Assessment

The unit will be assessed by:

- An on-line test

Unit 203

Understand how to apply environmental protection measures within Building Services Engineering

Outcome 1

Know the energy conservation legislation that applies to the building services industry

Assessment criteria

The learner can:

1.1 State the aims of energy conservation legislation

- General legislation
- Construction specific legislation
- Building services specific legislation

1.2 Identify the responsibilities of members of the construction team under energy conservation legislation

- Clients (customers)
- Designers
- Employers
- Employees

Unit 203

Understand how to apply environmental protection measures within Building Services Engineering

Outcome 2

Know the applications of energy sources used in the building services industry

Assessment criteria

The learner can:

2.1 Identify the types of energy used in properties

- High carbon
 - Natural Gas/LPG
 - Fuel oils
 - Solid fuels (coal and peat)
 - Electricity (from non-renewable sources)
- Low carbon
 - Solar thermal
 - Solid fuel (biomass)
 - Hydrogen fuel cells
 - Heat pumps
 - Combined heat and power (CHP)
- Zero carbon
 - Electricity – wind
 - Electricity – tidal
 - Hydroelectric
 - Solar photovoltaic

2.2 Identify the basic operating principles of installations containing environmental energy sources

- Solar thermal
- Solid fuel (biomass)
- Heat pumps (water, air and ground source)
- Combined heat and power (CHP)
- Combined cooling, heat and power (CCHP)
- Wind turbine
- Solar photovoltaic

2.3 Identify organisations which give guidance and advice on energy saving and conservation techniques

2.4 Identify how to use energy rating tables and their effect on component selection

2.5 State where to find information on alternative energy sources

Unit 203	Understand how to apply environmental protection measures within Building Services Engineering
Outcome 3	Know the importance of energy conservation when commissioning building services systems

Assessment criteria

The learner can:

- 3.1 State the role of the commissioning process in conserving energy usage
- 3.2 State the actions to be covered during the system handover procedure to the customer that will contribute to conserving energy usage

Unit 203

Understand how to apply environmental protection measures within Building Services Engineering

Outcome 4

Know the methods of reducing waste and conserving energy while working in the building services industry

Assessment criteria

The learner can:

- 4.1 Identify the working practices that can be employed to conserve energy and protect the environment
- 4.2 State the methods used for reducing material wastage
 - Planning work activities
 - Accurate measurement and cutting
- 4.3 Identify the methods of conserving material usage
 - Reducing material over ordering
 - Minimising damage to stored materials
 - Prevention of loss/theft

Unit 203

Understand how to apply environmental protection measures within Building Services Engineering

Outcome 5

Know how to safely dispose of materials used in the building services industry

Assessment criteria

The learner can:

5.1 Identify the statutory legislation for waste management on construction sites

5.2 State the methods of safely disposing of waste materials

- Licensed waste disposal
- Waste carriers license
- Recycling
- Specialist disposal – asbestos and other forms of hazardous waste

5.3 Specify the approved processes for recycling materials

- Metals
- Plastics
- Wood/cardboard

5.4 identify the disposal requirements of potentially hazardous materials

- Asbestos
- Electrical and electronic equipment
- Refrigerants (fluorinated gases)

5.5 Identify what action to take if work activities endanger the environment

Unit 203

Understand how to apply environmental protection measures within Building Services Engineering

Outcome 6

Know the methods of conserving and reducing wastage of water within the building services industry

Assessment criteria

The learner can:

- 6.1 Identify the statutory legislation for water wastage and misuse
- 6.2 State the criteria for water efficiency calculations for new dwellings
- 6.3 State the methods for reducing water wastage
 - Flow reducing valves
 - Spray taps
 - Low volume flush WC
- 6.4 Identify the methods available for capturing surface water and recycling used water
- 6.5 Identify the uses of captured and recycled water in properties
- 6.6 State the basic working principles of captured and recycled water systems
 - Rain water harvesting
 - Grey water systems

Unit 204

Understand how to apply scientific principles within MES

Level: 2
Credit value: 7
UAN: J/602/2496

Learning outcomes

There are **six** learning outcomes to this unit. The learner will

1. Know the standard units of measurement used in the mechanical services industry
2. Know the properties of materials used in the mechanical services industry
3. Know the relationship between energy, heat and power in the mechanical services industry
4. Know the principles of force and pressure and their application in the mechanical services industry
5. Know simple mechanical principles and their application in the mechanical services industry
6. Know the principles of electricity as they relate to the mechanical services industry

Guided learning hours

It is recommended that **66** guided learning hours should be allocated for this unit, although patterns of delivery are likely to vary.

Support of the unit by a sector or other appropriate body

This unit is endorsed by Summit Skills.

Assessment

The unit will be assessed by:

- An on-line test

Unit 204

Understand how to apply scientific principles within MES

Outcome 1

Know the standard units of measurement used in the mechanical services industry

Assessment criteria

The learner can:

1.1 State the application and use of Internationally recognised (SI) units of measurement

- Metre (length) m
- Kilogram (mass) Kg
- Second (time) s
- Kelvin (temperature) OK

1.2 State the application and use of SI derived units

- Area (m²)
- Volume (m³)
 - Litres (L)
- Density (Kg/m³)
- Velocity (m/s)

Unit 204

Understand how to apply scientific principles within MES

Outcome 2

Know the properties of materials used in the mechanical services industry

Assessment criteria

The learner can:

2.1 Calculate the relative densities of common materials

- Relative density to air
- Relative density to water

2.2 State the principle applications of solid materials used in the mechanical services industry

- Metals
 - Pure metals
 - Ferrous metals
 - Alloys including solders
- Plastics
 - Thermo plastics
 - Thermo-setting plastics
- Fireclays/ceramics

2.3 Identify the detailed properties of solid materials

- Strength – tensile and compressive
- Hardness
- Ductility
- Malleability
- Conductivity – heat and electricity

2.4 State the reasons why solid materials breakdown

- Atmospheric corrosion
 - Oxidisation of metals
- UV damage to plastics
- Heat damage to plastics
- Electrolytic corrosion
 - electromotive series
 - dissimilar metals in the presence of an electrolyte (water)
- Erosion corrosion
- Methods of preventing corrosion

2.5 State the principle applications and basic properties of liquids in the mechanical services industry

- Water
- Refrigerant
- Anti-freeze/glycol mixes
- Fuel oils
- Lubricants/greases

2.6 Identify the detailed properties of water

- Boiling/freezing point
- Change of state and molecular changes
 - Volume and pressure increase
 - Density at differing temperatures
 - To steam/super heated steam
- Capillarity
- Acidity/alkalinity (pH value)
- Water hardness
 - Soft
 - Temporary hard
 - Permanently hard

2.7 State the principle application of gases used in the mechanical services industry

- Air and steam
- LPG
- Natural gas
- Carbon dioxide
- Refrigerant gases

2.8 Identify the detailed properties of gas

- Pressure exerted by a gas
- Volume occupied by a gas
- Temperature of gases found within the industry
- Gas laws –
 - Charles's law
 - Boyle's law
- Heat pump/refrigeration cycle

Unit 204

Understand how to apply scientific principles within MES

Outcome 3

Know the relationship between energy, heat and power in the mechanical services industry

Assessment criteria

The learner can:

3.1 Identify the relationship between the Celsius and Kelvin temperature scales

- Units of temperature measurement
- Temperature measurement devices used

3.2 Identify the terminology associated with a change of state

- Melting
- Freezing
- Boiling
- Evaporating
- Condensing

3.3 Identify the terms latent and sensible heat as they apply to liquids and gases

3.4 Identify the methods of heat transfer

- Conduction in solids
- Convection in liquids and gases
- Radiation between two bodies

3.5 State how units of energy and heat are related and derived

- Energy – Joules (J)
- Specific heat capacity (kJ/Kg/°C)
- Power – Watts (W)

3.6 State how to carry out simple heat, energy and power calculations

- Simple temperature calculations
- Quantity of heat energy required to raise the temperature of a substance
- The amount of power required to heat a substance

Unit 204

Understand how to apply scientific principles within MES

Outcome 4

Know the principles of force and pressure and their application in the mechanical services industry

Assessment criteria

The learner can:

4.1 State how units of force and pressure are derived from SI units

- Acceleration (m/s^2)
 - Force due to gravity
- Force – Newton (N)
- Pressure (N/m^2)
 - Atmospheric pressure
 - Principles of the siphon
- Flow rate (m^3/s)

4.2 State the application and use of units of measurement of pressure and flow rate

- Pressure
 - Bar/millibar
 - kPa
 - Psi
 - Metre head
- Flow rate
 - m^3/s
 - l/s
 - Kg/s

4.3 State how to carry out simple force and pressure calculations

- Simple force calculations
- Pressure head
- Simple pressure calculations
 - Static pressure
 - Dynamic pressure

4.4 Identify the relationship between velocity, pressure and flow rate in systems

- Effects of increasing/reducing pressure on velocity and flow rate
- Effects of increasing /reducing pipe size on velocity and flow rate at constant pressure

4.5 Identify the reasons why pipework restricts the flow of liquids and gases

- Changes of direction, bends and tees
- Pipe size
- Pipe reductions
- Roughness of material surface
- Constrictions such as valves

Unit 204

Understand how to apply scientific principles within MES

Outcome 5

Know simple mechanical principles and their application in the mechanical services industry

Assessment criteria

The learner can:

5.1 State the principles behind simple machines

- Mechanical advantage
- Velocity ratio
 - Levers
 - Wheel and axle
 - Pulleys
 - Screws

5.2 Identify the principles of basic mechanics

- Theory of moments
- Action and reaction
- Centre of gravity
- Equilibrium

Unit 204

Understand how to apply scientific principles within MES

Outcome 6

Know the principles of electricity as they relate to the mechanical services industry

Assessment criteria

The learner can:

6.1 State the basic principles of electron flow theory

- Measurement of electrical flow
- Material conductivity and resistance
- Direct and alternating current

6.2 State the purpose and application of simple units of electrical measurement for use in the mechanical services industry

- Current (Amps)
- Voltage (Volts)
- Resistance (Ohms)
- Power (Watts)

6.3 State how to carry out simple electrical calculations

- Ohm's law
- Power consumption of electrical circuits
- Basic over-current protection device size
- Voltage, current and resistance in series and parallel circuits

6.4 Identify the requirements for earthing of electrical circuits

Unit 210

Understand air conditioning and heat pump system installation, testing and maintenance techniques

Level: 2
Credit value: 7
UAN: A/602/4987

Learning outcomes

There are **six** learning outcomes to this unit. The learner will

1. Understand the specific Health and Safety requirements which apply to the fitting and fixing, servicing and maintaining and de-commission of air conditioning and heat pump systems
2. Understand the legislative and organisational procedures for fitting and fixing , servicing and maintaining and de-commissioning of air conditioning and heat pump systems
3. Understand the working principles and layouts of air conditioning and heat pump systems
4. Understand the procedures for fitting, fixing and testing cooling systems equipment and components
5. Understand the service and maintenance procedures for cooling systems equipment and components
6. Understand the de-commissioning procedures for air conditioning and heat pump systems

Guided learning hours

It is recommended that **60** guided learning hours should be allocated for this unit, although patterns of delivery are likely to vary.

Support of the unit by a sector or other appropriate body

This unit is endorsed by SummitSkills.

Assessment

The unit will be assessed by:

- An on-line test

Unit 210 Understand air conditioning and heat pump system installation, testing and maintenance techniques

Outcome 1 Understand the specific Health and Safety requirements which apply to the fitting and fixing, servicing and maintaining and de-commissioning of air conditioning and heat pump systems

Assessment criteria

The learner can:

- 1.1 State the COSHH requirements of different refrigerants and other pressurised and flammable liquids
- 1.2 Assess the impact that working with refrigerants can have on the safety of individuals and wider environment
- 1.3 Specify the dangers associated with pressurised systems

Unit 210 Understand air conditioning and heat pump system installation, testing and maintenance techniques

Outcome 2 Understand the legislative and organisational procedures for fitting and fixing, servicing and maintaining and de-commissioning of air conditioning and heat pump systems

Assessment criteria

The learner can:

- 2.1 State the appropriate sources of health and safety information when fitting and fixing, servicing and maintaining and de-commissioning of air conditioning and heat pump systems
- 2.2 State the regulations, codes of practice, and industry recommendations appropriate to the fitting and fixing, servicing and maintaining and de-commissioning of air conditioning and heat pump systems, including working with refrigerants and other pressurised and flammable fluids
- 2.3 State the appropriate persons whom it may be necessary to advise before a system is isolated in order to undertake work
- 2.4 State the actions that should be taken to liaise with other persons upon completion of work procedures with regard to:
 - Safe system shutdown
 - Labelling of components
 - Recording refrigerant and oil use

Unit 210	Understand air conditioning and heat pump system installation, testing and maintenance techniques
Outcome 3	Understand the working principles and layouts of air conditioning and heat pump systems

Assessment criteria

The learner can:

3.1 Define the function and operating principles of:

- Compressors
- Condensers
- Expansion devices
 - Capillary tube
 - Thermostatic expansion valves
 - Electronic expansion valves
- Direct expansion and flooded evaporators
- Accumulators
- Air to air cooling only systems (aero thermal)
- Air to water heat pump systems (Hydrothermal)

3.2 Identify the features and characteristics of:

- Oil free compressors
- Four way valves
- Critical charge systems
- Inverter driven systems (2 and 3 pipe systems)
- Low ambient control systems
- Pipework insulation
- Air filters
- Condensate removal

3.3 State the properties, advantages and disadvantages of different refrigerants, including:

- Leakage implications (direct and indirect)
- TEWI (Total Environmental Warming Impact) effect

3.4 Specify how the following are designed or contribute towards helping to reduce the indirect Global Warming Potential of RAC systems

- Variable speed drives
- Defrost controls
- Capacity control
- Enhanced Capital Allowance (ECAs)
- Energy efficiency ratio (EER)

3.5 State the requirements for following work procedures to replace refrigerant types in RAC systems

3.6 State the procedures for plotting the following on a simple psychometric chart:

- Sensible heating
- Sensible cooling
- Humidification
- Dehumidification

3.7 Identify and calculate cooling and heating capacity in kW using system information and psychometric charts

3.8 Describe various environmental conditions in relation to the operation of air conditioning and heat pump systems

Unit 210 Understand air conditioning and heat pump system installation, testing and maintenance techniques

Outcome 4 Understand the procedures for fitting, fixing and testing cooling systems equipment and components

Assessment criteria

The learner can:

- 4.1 State the fitting and fixing procedures for air conditioning and heat pump systems, equipment and components, to include:
 - Indoor refrigeration units
 - Fresh and regenerated air systems
 - Outdoor refrigeration units
 - Water chillers
- 4.2 Define suitable methods for making pipework connections to:
 - Single and multiple indoor units
 - Outdoor units
- 4.3 Define requirements for the correct selection and use of the following items of specialist RAC equipment:
 - Gauges and regulators
 - Leak detection devices
 - Vacuum pumps
 - Weighing scales
- 4.4 State the methods and procedures for:
 - Strength integrity testing
 - Tightness testing
 - Leak testing
 - Evacuation and dehydration
- 4.5 Identify the requirements for the appropriate test results
- 4.6 State the procedures for charging blended (zeotropic blends) and single fluid refrigerants into systems
- 4.7 State the procedures for determining when charge is correct in air to air and air to water refrigeration systems.
- 4.8 State the records to be completed prior to handover
- 4.9 State the process for handing over systems to customers, including:
 - Operation of system and controls
- 4.10 State the procedures for completing appropriate employer and any required legislative documentation when work is complete.

Unit 210 Understand air conditioning and heat pump system installation, testing and maintenance techniques

Outcome 5 Understand the service and maintenance procedures for cooling systems equipment and components

Assessment criteria

The learner can:

5.1 Explain the effects on system efficiency of

- reduced cooling medium flow through condensers (dirty condensers, reduced fan speed or water flow)
- reduced cooling medium flow through evaporators (blocked evaporators, reduced fan operation or water flow)
- refrigerant leakage
- refrigerant overcharge

5.2 State the requirements for routing preventative maintenance of air conditioning and heat pump systems, including

- maintaining system efficiency to reduce indirect emissions of greenhouse gases
- maintaining system tightness to reduce direct emissions of greenhouse gases

5.3 State the importance of correct control settings to maintain systems efficiency, including how to adjust controls for:

- Thermostats
- Time clocks
- Multi-function electronic controls (covering defrost, temperature control fan speed etc)
- High pressure cut outs
- Low pressure cut outs
- Capacity control

5.4 Identify symptoms which relate to common systems faults associated with:

- Compressor and compressor motor failure
- Capacity control
- Condensers
- Evaporators
- Undercharge/overcharge
- Electrical control circuit
- Electronic boards
- Freezing of indoor/outdoor unit
- Noise and vibration
- Condensate leakage
- Blockages in various fluid systems (refrigerant, air, water, glycol etc)
- Superheat setting

5.5 State the requirements for completing records and reports on the servicing and maintenance of air conditioning and heat pump systems including completion of hazardous waste consignment documentation.

Unit 210 Understand air conditioning and heat pump system installation, testing and maintenance techniques

Outcome 6 Understand the de-commissioning procedures for air conditioning and heat pump systems

Assessment criteria

The learner can:

6.1 State the implications that the suspension of a system can have on other person(s), including:

- Customers/clients
- Other site workers
- Site visitors

6.2 Identify the safe procedures for handling potentially hazardous systems materials, including refrigerants and heavy/awkward items which require mechanical and manual handling

Unit 211

Install, test and maintain air conditioning and heat pump systems

Level: 2
Credit value: 4
UAN: D/602/5002

Learning outcomes

There are **six** learning outcomes to this unit. The learner will

1. Be able to plan and prepare for the installation, testing and maintenance of air conditioning and heat pump systems
2. Be able to carry out the installation of air conditioning and heat pump systems
3. Be able to carry out the testing of air conditioning and heat pump systems
4. Be able to carry out the maintenance of air conditioning and heat pump systems
5. Be able to handover air conditioning and heat pump systems
6. Be able to carry out the de-commissioning of air conditioning and heat pump systems

Guided learning hours

It is recommended that **4** guided learning hours should be allocated for this unit, although patterns of delivery are likely to vary.

Support of the unit by a sector or other appropriate body

This unit is endorsed by SummitSkills.

Assessment

The unit will be assessed by:

- Portfolio

Unit 211	Install, test and maintain air conditioning and heat pump systems
Outcome 1	Be able to plan and prepare for the installation, testing and maintenance of air conditioning and heat pump systems

Assessment criteria

The learner can:

- 1.1 Confirm that all information is available prior to planning installation or maintenance activities
- 1.2 Confirm that all tools, equipment and materials are available and fit for use prior to commencement of the work
- 1.3 Confirm that all persons relevant to the installation or maintenance activity are identified and that lines of communication are established
- 1.4 Ensure that all necessary risk assessment and safe working procedure development has been undertaken prior to work commencement
- 1.5 Carry out site survey to identify any variations or deviations to planned work on any structural or access issues which need to be resolved prior to work commencement
- 1.6 Identify safe storage arrangement for tools, equipment and materials prior to commencement of installation or maintenance activity
- 1.7 Plan safe access to work areas and confirm with responsible person on site
- 1.8 Complete preparatory work as necessary in relation to:
 - The location, siting and fixing of:
 - Outdoor unit/condensers
 - Indoor unit/evaporators
 - Piping (flow and return)
 - Jointing by brazing or flaring
 - Confirming requirements for:
 - cleanliness inside pipes by purging with OFN
 - Insulation
 - Electrical connection
 - Condensate disposal

Unit 211	Install, test and maintain air conditioning and heat pump systems
Outcome 2	Be able to carry out the installation of air conditioning and heat pump systems

Assessment criteria

The learner can:

- 2.1 Identify and interpret appropriate sources of information which impact upon the installation of air conditioning pipework, systems and components, including
 - Regulatory documents
 - Industry Codes of Practice
 - Manufacturers' instructions
 - Installation specifications
- 2.2 Assemble air conditioning system components to meet the requirements of the installation specification
- 2.3 Demonstrate appropriate methods for positioning and fixing
 - Indoor units
 - Outdoor units
 - Condensate drains
- 2.4 Demonstrate appropriate methods for interconnecting, fixing and insulating pipework
- 2.5 Complete the interconnection and fixing of electrical power and communication components
- 2.6 Confirm that installed system components and pipework are correctly installed in accordance with the installation specification
- 2.7 Confirm that the worksite has been cleared in preparation for system testing

Unit 211	Install, test and maintain air conditioning and heat pump systems
Outcome 3	Be able to carry out the testing of air conditioning and heat pump systems

Assessment criteria

The learner can:

- 3.1 Revisit risk assessment and safe working procedure to confirm currency and validity prior to commencement of testing
- 3.2 Carry out checks and tests in accordance with industry and safety requirements
- 3.3 Carry out the following tests in accordance with appropriate legislation:
 - Strength integrity test
 - Pressure tightness test
 - Leak test
 - Evacuation, dehydration and vacuum rise test
- 3.4 Compare pipework length with system factory charge and determine whether extra refrigerant charge is required
- 3.5 Add additional refrigerant charge by weight in accordance with manufacturers' instructions
- 3.6 Carry out basic electrical tests to confirm that system is safe to switch on:
 - Continuity
 - Insulation resistance
 - Polarity
 - Resistance to earth
 - Visual check
- 3.7 Open system valves and run system
- 3.8 Complete checks to confirm system is leak free
- 3.9 Confirm that the system provides cooling and/or heating by measuring air flow temperature difference across indoor and outdoor unit heat exchangers
- 3.10 Record temperature differences
- 3.11 Remove analysers/gauges from systems without refrigerant loss
- 3.12 Replace valve caps and confirm valves are leak free

Unit 211	Install, test and maintain air conditioning and heat pump systems
Outcome 4	Be able to carry out the maintenance of air conditioning and heat pump systems

Assessment criteria

The learner can:

- 4.1 Interpret maintenance schedules to identify required work activities
- 4.2 Perform the following service and maintenance tasks safely and efficiently:
 - Cleaning and checking the condition of
 - condensers
 - filters
 - indoor units
 - evaporators
 - Checking the condition of
 - pipework and its insulation
 - electrical wiring and connections
- 4.3 Check system operating conditions against control settings
- 4.4 Measure on/off temperature to check comfort conditions in respect of temperature and humidity in the controlled space
- 4.5 Reconnect or re-install system after maintenance and then carry out the following checks and tests before running the system
 - Tightness testing
 - Evacuation and dehydration
 - Electrical testing
- 4.6 Re-charge refrigerant to correct quantity and check for leakage
- 4.7 Complete system performance test
- 4.8 Complete appropriate maintenance documentation and records

Unit 211	Install, test and maintain air conditioning and heat pump systems
Outcome 5	Be able to hand over air conditioning and heat pump systems

Assessment criteria

The learner can:

5.1 Complete system records for hand over documentation, including those which detail

- Strength integrity test
- Pressure tightness test
- Leak test
- Evacuation and dehydration
- System refrigerant charge and type
- Performance testing
- Electrical testing

5.2 Demonstrate system operation and operating controls to customers

5.3 Pass over system documentation and records to customer

5.4 Report to line manager that installation is complete and fill in appropriate company documentation

Unit 211	Install, test and maintain air conditioning and heat pump systems
Outcome 6	Be able to carry out the de-commissioning of air conditioning and heat pump systems

Assessment criteria

The learner can:

- 6.1 Follow appropriate risk assessments and method statements to ensure decommissioning activities are completed safely
- 6.2 Demonstrate work sequences for permanently decommissioning
 - A complete air conditioning system or heat pump system
 - Part of an air conditioning system or heat pump system
- 6.3 Demonstrate how oil, refrigerant and cleaning solvents can be safely recovered from a system and disposed of in accordance with appropriate regulations

Unit 219

Apply safe working practices in building services engineering working environment

Level: 2
Credit value: 2
UAN: T/602/2493

Learning outcomes

There are **four** learning outcomes to this unit. The learner will

1. Be able to demonstrate personal health and safety precautions in the workplace
2. Be able to prepare and use access equipment in the workplace
3. Be able to check that the work area is safe in order to carry out work
4. Be able to liaise with those responsible for health and safety in the workplace

Guided learning hours

It is recommended that **4** guided learning hours should be allocated for this unit, although patterns of delivery are likely to vary.

Support of the unit by a sector or other appropriate body

This unit is endorsed by Summit Skills.

Assessment

The unit will be assessed by:

- Portfolio

Unit 219 Apply safe working practices in building services engineering working environment

Outcome 1 Be able to demonstrate personal health and safety precautions in the workplace

Assessment criteria

The learner can:

- 1.1 Demonstrate the appropriate personal protective equipment is used throughout work activities
- 1.2 Ensure that health and safety precautions are in place
 - First aid kit provision
 - Fire extinguisher provision
- 1.3 Demonstrate safe manual lifting techniques

**Unit 219 Apply safe working practices in
building services engineering working
environment**

**Outcome 2 Be able to prepare and use access
equipment in the work place**

Assessment criteria

The learner can:

- 2.1 Use risk assessments to identify safe methods of working at height
- 2.2 Check access equipment for safe conditions prior to use
- 2.3 Perform the safe erection of access equipment
- 2.4 Demonstrate the safe use of access equipment

Unit 219	Apply safe working practices in building services engineering working environment
Outcome 3	Be able to check that the work area is safe in order to carry out work

Assessment criteria

The learner can:

- 3.1 Carry out a check of the work location for health and safety hazards
- 3.2 Verify that access and exit routes to and from the immediate work location are safe and free from obstructions
- 3.3 Demonstrate safe working practices when working with heat producing equipment

Unit 219	Apply safe working practices in building services engineering working environment
Outcome 4	Be able to liaise with those responsible for health and safety in the workplace

Assessment criteria

The learner can:

- 4.1 Demonstrate methods of recording accidents in the accident book in accordance with company procedures
- 4.2 Demonstrate methods of reporting hazards and accidents in accordance with company procedures

Unit 228/528 Understand and carry out site preparation and pipework fabrication techniques for RAC systems

Level: 2
Credit value: 14
UAN: R/602/4994

Learning outcomes

There are **thirteen** learning outcomes to this unit. The learner will

1. Know how to complete general site preparation work for RAC pipework systems
2. Know how to apply leak tightness tests to RAC pipework
3. Be able to apply leak tightness tests to RAC pipework
4. Know how to de-commission RAC pipework
5. Be able to de-commission RAC pipework
6. Be able to apply general site preparation techniques to fit and fix, service and maintain, test and de-commission RAC pipework systems
7. Know how to implement general on site administration procedures required to fit and fix, service and maintain test and de-commission RAC pipework systems
8. Be able to apply general administration procedures required to fit and fix, service and maintain, test and de-commission RAC pipework systems
9. Know how to prepare to fit and fix, service and maintain, test and de-commission RAC pipework systems
10. Be able to apply techniques to fit and fix , service and maintain, test and de-commission RAC pipework systems
11. Know how to fabricate RAC pipework
12. Be able to fabricate RAC pipework
13. Be able to maintain RAC equipment and components

Guided learning hours

It is recommended that **120** guided learning hours should be allocated for this unit, although patterns of delivery are likely to vary.

Support of the unit by a sector or other appropriate body

This unit is endorsed by SummitSkills.

Assessment

The unit will be assessed by:

- An on-line test
- Assignment

Unit 228/528 Understand and carry out site preparation and pipework fabrication techniques for RAC systems

Outcome 1 Know how to complete general site preparation work for RAC pipework systems

Assessment criteria

The learner can:

- 1.1 Identify and use appropriate sources of information when preparing for RAC work activities, including:
 - Regulations and standards
 - Statutory Regulations
 - Codes of Practice
 - Industry standards
 - Industry Guides/Good Practice Guides
 - Sources of Information
 - Drawings, specifications and data
 - Common types of RAC drawing
 - Common graphical symbols and abbreviations used on RAC drawings
 - Specifications and standards used to communicate information
 - Service and maintenance records, programmes, schedules and specifications
 - Installation, operating and maintenance manuals
- 1.2 Define the preparatory work that is required for the work location in order to prepare, fit and fix, service and maintain and test then decommission RAC pipework systems, to include:
 - Preparing work sites
 - Identifying and selecting materials and equipment
 - Fit and fix cooling systems and components
 - Service and maintain and deal with faults on cooling systems and components
 - Soundness testing systems and components
 - Commissioning systems and components
 - Decommissioning systems and components – temporary and permanent
- 1.3 Define the building construction/local site features which may impact upon the work required to fit and fix, service and maintain and test then decommission RAC pipework systems, including:
 - Building construction methods and materials used in the RAC sector
 - Simple industrial/commercial building details
 - Main functions of the components that made up a simple building
 - Principle services required for a simple industrial/commercial building
- 1.4 State how to check for any pre-existing damage to customer/client property such as:
 - Building wall/floor fabric

- Appliances and components
 - Building décor and floor finishes
- 1.5 Define the measures required to protect the building fabric/customer property, before and throughout completion of work on RAC installations, including:
- Use of dust sheets
 - Protection from flame damage
 - Protection of customer/client
 - Protection of appliances and components before and during work activities
- 1.6 State the actions that should be taken to liaise with other persons during installation, servicing, maintenance, testing and de-commissioning of RAC pipework systems, including:
- Customers
 - Other site workers
 - Site visitors
- 1.7 State the implications that suspension of an RAC system can have on appropriate persons, including:
- Customers
 - Other site workers
 - Site visitors

Unit 228/528	Understand and carry out site preparation and pipework fabrication techniques for RAC systems
Outcome 2	Know how to apply leak tightness tests to RAC pipework

Assessment criteria

The learner can:

- 2.1 Identify appropriate equipment for applying a leak tightness test to a pipework
- 2.2 State the procedure for completing a leak tightness test on a pipework section in accordance with appropriate industry standards and record the leak tightness test procedure
- 2.3 Explain the action that must be taken when inspection and testing reveals defects in RAC pipework, including
 - Remedial work associated with leakage from RAC pipework systems

Unit 228/528 Understand and carry out site preparation and pipework fabrication techniques for RAC systems

Outcome 3 Be able to apply leak tightness tests to RAC pipework

Assessment criteria

The learner can:

- 3.1 Use appropriate equipment for applying a leak tightness test to a pipework section
- 3.2 Apply a leak tightness test to a pipework section in accordance with appropriate industry standards and record the leak tightness test procedure
- 3.3 Take appropriate action when inspection and testing reveals defects in RAC pipework, including:
 - Remedial work associated with leakage from RAC pipework systems

Unit 228/528 Understand and carry out site preparation and pipework fabrication techniques for RAC systems

Outcome 4 Know how to de-commission RAC pipework

Assessment criteria

The learner can:

- 4.1 State the procedures for confirming that a pipework section from an RAC system can be safely decommissioned
- 4.2 Specify the procedures for conditioning the safe de-commissioning of a pipework section from an RAC system

Unit 228/528	Understand and carry out site preparation and pipework fabrication techniques for RAC systems
Outcome 5	Be able to de-commission RAC pipework

Assessment criteria

The learner can:

- 5.1 Check and confirm that an RAC pipework section can be safely de-commissioned
- 5.2 Conduct the safe de-commissioning of a pipework section from an RAC system

Unit 228/528 Understand and carry out site preparation and pipework fabrication techniques for RAC systems

Outcome 6 Be able to apply general site preparation techniques to fit and fix, service and maintain, test and de-commission RAC pipework systems

Assessment criteria

The learner can:

- 6.1 Check the safety of the work location in order for the work to safely proceed
 - Safe access and exit
 - Immediate work location e.g. slips, trips and fall hazards
 - Appropriate risk assessments/method statements are available and worked to
- 6.2 Select Personal Protective Equipment relevant to the RAC work activity being carried out
- 6.3 Select the hand and power tools relevant to the RAC work activity being carried out
- 6.4 Check that tools and equipment selected for RAC work activity are safe to use and are correctly calibrated

Unit 228/528	Understand and carry out site preparation and pipework fabrication techniques for RAC systems
Outcome 7	Know how to implement general on site administration procedures required to fit and fix, service and maintain, test and de-commission RAC pipework systems

Assessment criteria

The learner can:

- 7.1 State the procedures for reporting problems that could delay progress of the work
- 7.2 State the procedures for the ordering, requisitioning and checking of RAC materials
- 7.3 State the procedures for the safe and secure storage of RAC materials, tools and equipment in the workplace
- 7.4 State the methods used to ensure that customers are fully briefed on all aspects of the work programme

Unit 228/528 Understand and carry out site preparation and pipework fabrication techniques for RAC systems

Outcome 8 Be able to apply general administration procedures required to fit and fix, service and maintain, test and de-commission RAC pipework systems

Assessment criteria

The learner can:

- 8.1 Implement the procedures for ordering, requisitioning and checking RAC materials
- 8.2 Implement the procedures for the safe and secure storage of RAC materials tools and equipment in the workplace

Unit 228/528 Understand and carry out site preparation and pipework fabrication techniques for RAC systems

Outcome 9 Know how to prepare to fit and fix, service and maintain, test and de-commission RAC pipework systems

Assessment criteria

The learner can:

9.1 Identify the drawings and specifications required to prepare for the fabrication of RAC pipework systems

9.2 Identify the appropriate materials and fittings required to complete and check them for damage, including

- Pipe
 - Copper
 - Steel pipe (for industrial refrigeration)
 - Insulation
 - Plastic or copper condensate pipe work
- Fittings
 - Flare nut fittings (implications of use – i.e. possibility of leakage)
 - Lime tap and schrader valves
 - Mechanical control devices
 - Electrical control components
 - Brazed fittings
 - Steel pipe fittings (for industrial refrigeration)
 - Electrical cables and associated component fittings

9.3 Identify the hand and power tools required to complete work, including

- tools for
 - Marking out
 - Cutting (pipe, cable and insulation)
 - Bending (copper pipe and plastic conduit)
 - Jointing (Electrical, Mechanical and Brazing)
- Specialist tools used in the RAC sector-
 - Brazing equipment
 - Torque wrenches
 - Electrical drills (110v and cordless)
 - Electrical test instruments
 - Pipe bending machines
 - Pipe cutters and Reamers
 - General hand tools
 - Levels (including Laser)
 - Core drills
 - Joint forming tools (Swage, brazing etc)
 - Relevant Mechanical and Electrical testing equipment

9.4 Identify Personal Protective Equipment relevant to the work activity

Unit 228/528 Understand and carry out site preparation and pipework fabrication techniques for RAC systems

Outcome 10 Be able to apply preparation techniques to fit and fix, service and maintain, test and de-commission RAC pipework systems

Assessment criteria

The learner can:

10.1 Use drawings and specifications to prepare for the fabrication of RAC pipework systems

10.2 Select the materials and fittings required to complete work and check them for damage, including materials for RAC pipework systems as identified in

- Pipe
 - Copper
 - Steel pipe (for industrial refrigeration)
 - Insulation
 - Plastic/copper condensate pipe work
- Fittings
 - Flare nut fittings
 - Line tap and Schrader valves
 - Mechanical control devices
 - Electrical control components
 - Brazed fittings
 - Steel pipe and fittings (for industrial refrigeration)
 - Electrical cables and associated component fittings

10.3 Select the hand and power tools required to complete work, including

- tools for
 - marking out
 - cutting (pipe, cable and insulation)
 - bending (copper, pipe and plastic conduit)
 - jointing (Electrical, Mechanical and Brazing)
- specialist tools used in the RAC sector
 - flame brazing equipment
 - torque wrenches
 - electrical drills including core drills (110v and cordless)
 - pipe bending machines and equipment
 - pipe cutters and reamers
 - general hand tools
 - levels (including Laser)
 - Joint forming tools (Swage, brazing etc)
 - electrical cable crimp tool
 - pressure and vacuum test instruments
 - electrical test instruments
 - thermometers (digital and manual)
 - weighing scales

10.4 Select Personal Protective Equipment relevant to the work activity

Unit 228/528 Understand and carry out site preparation and pipework fabrication techniques for RAC systems

Outcome 11 Know how to fabricate RAC pipework

Assessment criteria

The learner can:

11.1 State the methods and techniques for fabricating RAC pipework to industry standards and specifications including:

- Measuring and marking out
- Bending, hand springs and mechanical formers –
 - 90°
 - Off-set
 - Passover
- Cutting
- Drilling and fixing

11.2 State the material jointing techniques on pipework using:

- Mechanical methods
 - flare joints
- Heat methods
 - flame brazing and Gas welding
 - Silver soldering
- Solvent methods
 - Adhesives for insulation
- Joints for secondary refrigeration systems (glycol)

11.3 State the methods and techniques for using hand tools, power tools, drills and fixing devices for fixing to:

- Wood (timber, studding and wall board)
- Masonry (brick, block, concrete, plasterboard)
- Metal
 - and using appropriate fixing devices, including
- Nails Screws
- Heavy duty fixing devices
- Threaded rod and 'U' channel

11.4 State the methods and techniques for fixing pipework using clips and brackets for the following pipe materials as identified in

- Copper
- Steel
- Insulation
- Plastic/copper condensate pipe work

11.5 Determine appropriate bracket spacing intervals in accordance with pipework diameter requirements for horizontally and vertically mounted copper pipework

11.6 State the industry requirements for

- safe use of tools used for
 - marking out
 - cutting
 - bending
 - jointing (Mechanical and Brazing)
- tool maintenance
 - cleaning
 - servicing
 - PAT testing (confirmation of due date)
 - Sharpening
 - Calibration (confirmation of due date)

Unit 228/528 Understand and carry out site preparation and pipework fabrication techniques for RAC systems

Outcome 12 Be able to fabricate RAC pipework

Assessment criteria

The learner can:

12.1 Fabricate RAC pipework to industry standards and specifications to include:

- measuring and marking out of items identified
- bending, hydraulic and machine
 - 90°
 - Off-set
 - Passoverin copper and steel

- Cutting
- Drilling and fixing

12.2 Conduct material jointing techniques on pipework using

- mechanical methods
 - flare joints
- heat methods
 - brazing
 - silver soldering
- solvent methods
 - adhesives for insulation
- joints for secondary refrigeration

12.3 Select and use hand tools, power tools, drills and fixing devices for fixing to

- wood (timber, studding and wall/fibre board)
- masonry (brick, block, concrete)
- plasterboard
- metal

12.4 Apply the industry requirements for

- safe use of tools for
 - marking out
 - cutting
 - bending
 - jointing (Mechanical and Brazing)
- tool maintenance
 - cleaning
 - servicing
 - PAT testing (confirmation of due date)
 - sharpening
 - calibration (confirmation of due date)

12.5 Fabricate a pipework for an RAC system that includes

- bending, hand springs, hydraulic and mechanical
 - 90°
 - Off-set
 - Passover
- mechanical and thermal jointing methods

12.6 Apply fixings to vertically and horizontally mounted pipework in accordance with appropriate industry standards

Unit 228/528 Understand and carry out site preparation and pipework fabrication techniques for RAC systems

Outcome 13 Be able to maintain RAC equipment and components

Assessment criteria

The learner can:

- 13.1 Implement routine maintenance procedures including, cleaning, de-greasing, component replacement and testing on all of the following
- Refrigeration systems filter dryers
 - Fans and fan motors
 - Compressors
 - Evaporators and evaporator filters
 - Condensers and heat rejection devices
 - Expansion devices
 - Solenoid operated and mechanical valves
 - Pressure and temperature controls
 - Pressure relief valves
 - Controls and actuators
 - Air handling unit and associated components (fans, humidifiers, manometers)

Unit 230/530 Handling fluorinated gases and ozone-depleting substances (category I personnel)

Level: 2
Credit value: 3
UAN: D/502/0629

Learning outcomes

There are **nine** learning outcomes to this unit. The learner will

1. Be able to identify basic systems, terms, principles, units and how these relate to theory and thermodynamics of vapour compression cycles and refrigerants
2. Be able to identify the causes and effects of global warming and climate change
3. Be able to identify causes and effects of ozone depletion
4. Be able to identify stationary refrigerant, air conditioning and heat-pump system components, functions and leakage risk
5. Be able to identify the hazards and safe working practices for the installation, commissioning and handling of refrigerants
6. Be able to fabricate and examine pipework
7. Be able to undertake pressure testing, evacuation and record completion
8. Be able to undertake refrigerant charging, leak checking and record keeping
9. Be able to undertake recovery of refrigerant and oil and prepare for disposal

Guided learning hours

It is recommended that **30** guided learning hours should be allocated for this unit, although patterns of delivery are likely to vary.

Support of the unit by a sector or other appropriate body

This unit is endorsed by SummitSkills.

Assessment

The unit will be assessed by:

- An on-line test
- Assignment

Unit 230/530 Handling fluorinated gases and ozone-depleting substances (category I personnel)

Outcome 1 Identify basic systems, terms, principles, units and how these relate to theory and thermodynamics of vapour compression cycles and refrigerants

Assessment criteria

The learner can:

- 1.1 Identify the **standard units** relating to category I systems
- 1.2 Identify the terms and principles of **basic theory/thermodynamics** that relate to category I systems

Range

Standard units

- temperature
- pressure
- mass
- density
- enthalpy

Basic theory/thermodynamics

- basic vapour compression cycle – key terms – four major components/processes, plots and uses basic p-h diagram, function of each of the four major components (compressor, condenser, expansion device, evaporator)
- condition/state of refrigerant (eg superheated vapour/saturated two phase mix/subcooled liquid), by use of refrigerant comparator or service gauge
- reasonable operating conditions (sat. temps) for condenser and evaporator, for a range of applications (chill/frozen display/ storage, air conditioning/heat-pumping)
- features of zeotropic blends

Unit 230/530 Handling fluorinated gases and ozone-depleting substances (category I personnel)

Outcome 2 Identify the causes and effects of global warming and climate change

Assessment criteria

The learner can:

- 2.1 Identify the stated causes of climate change
- 2.2 Identify how the Kyoto Protocol aims to reduce the effect of greenhouse gas emissions
- 2.3 Identify direct and indirect Global Warming Potential (GWP) of the common hydrofluorocarbon (HFC) and hydrocarbon (HC) refrigerants
- 2.4 Identify the importance of energy efficiency on greenhouse gas emissions to atmosphere
- 2.5 Identify the basic requirements of Regulation (EC) No 842/2006 and other relevant regulations
- 2.6 Identify the equipment records/commissioning data requirements of Regulation (EC) No 842/2006 and all appropriate regulations and standards.

Unit 230/530 Handling fluorinated gases and ozone-depleting substances (category I personnel)

Outcome 3 Identify causes and effects of ozone depletion

Assessment criteria

The learner can:

- 3.1 Identify Ozone Depletion Potential (ODP) of hydrochlorofluorocarbon (HCFC) refrigerants
- 3.2 Identify the effect of chlorine on ozone depletion
- 3.3 Identify the basic requirements of Regulation (EC) 2037/2000
- 3.4 Identify the aims and impact of the Montreal Protocol

Unit 230/530 Handling fluorinated gases and ozone-depleting substances (category I personnel)

Outcome 4 Identify stationary refrigerant, air conditioning and heat-pump system components functions and leakage risk

Assessment criteria

The learner can:

- 4.1 Identify the function of and the role/importance of monitoring system performance for indications that leakage has occurred from **equipment (control and line components)** relating to category I systems
- 4.2 Identify potential leakage points of refrigeration/air conditioning and heat pump equipment
- 4.3 Identify the requirements and procedures for handling, storage, transportation and disposal of contaminated refrigerant and oil
- 4.4 Identify the function of stationary refrigeration, air conditioning and heat-pump system **equipment (major components)**
- 4.5 Identify how the state/condition of **equipment (major components)** can lead to refrigerant release
- 4.6 Identify the risks of refrigerant release associated with **equipment (major, control and line components)**

Range

Equipment (control and line components)

- valves – service, pressure relief
- thermostats/pressure controls
- liquid line, receiver sight glasses and indicators
- defrost controls
- overloads
- service gauge manifold and thermometer
- oil control and separator systems
- high pressure receivers
- low pressure accumulators

Equipment (major components)

- compressor
- condenser
- evaporator
- thermostatic expansion valves
- capillary tube restrictor

Unit 230/530	Handling fluorinated gases and ozone-depleting substances (category I personnel)
Outcome 5	Identify the hazards and safe working practices for the installation, commissioning and handling of refrigerants

Assessment criteria

The learner can:

- 5.1 Identify the **hazards** and **safe working practices** associated with **flame brazing**
- 5.2 Identify the **hazards** and **safe working practices** associated with **nitrogen pressure testing**
- 5.3 Identify the **hazards** and **safe working practices** associated with **refrigerant release**

Range

Flame brazing hazards

- hot burns
- combustion
- fire
- explosion

Flame brazing safe working practices

- correct selection and use of personal protective equipment (PPE)
- storage of flammable gas in line with manufacturers instructions and current regulations
- transportation of flammable gas in line with manufacturers instructions and current regulations
- safe working practices for flame brazing in accordance with current Health & Safety at Work Act

Nitrogen hazards

- explosion
- physical injury due to incorrect handling and lifting techniques
- asphyxiation

Nitrogen safe working practices

- selection and use of appropriate personal protective equipment (PPE)
- safe handling and lifting techniques
- pneumatic testing in line with recognised safe industry practices
- storage of nitrogen cylinders in line with manufacturers instructions and current regulations
- transportation of nitrogen cylinders in line with manufacturers instructions and current regulations
- gauge and regulator selection
- safe working practices for nitrogen in accordance with the Health & Safety at Work Act

Refrigerant release hazards

- cold burns
- asphyxiation
- thermal decomposition
- central nervous system (CNS) effect
- cardiac sensitization

Refrigeration release safe working practices

- correct selection and use of personal protective equipment (PPE)
- safe working practices for refrigerant handling in accordance with current Health & Safety at Work Act

Unit 230/530 Handling fluorinated gases and ozone-depleting substances (category I personnel)

Outcome 6 Fabricate and examine pipework

Assessment criteria

The learner can:

- 6.1 Fabricate pipework test piece by completing brazed mechanical joints to industry standards
- 6.2 Install pipework test piece to testing station
- 6.3 Visually examine pipework on testing station for signs of leakage
- 6.4 Remove fabricated test piece from the system and inspect for penetration by a cut and peel test, upon completion of refrigerant recovery

Unit 230/530 Handling fluorinated gases and ozone-depleting substances (category I personnel)

Outcome 7 Undertake pressure testing, evacuation and record completion

Assessment criteria

The learner can:

- 7.1 Determine appropriate test pressures to BS EN378 standards
- 7.2 Conduct strength test to BS EN378 standards
- 7.3 Undertake leak/tightness pressure tests to BS EN378 standards
- 7.4 Evacuate the system to below 2 Torr/2000 microns/m bar/270 Pa
- 7.5 Complete pressure testing and evacuation records

Unit 230/530	Handling fluorinated gases and ozone-depleting substances (category I personnel)
Outcome 8	Undertake refrigerant charging, leak checking and record keeping

Assessment criteria

The learner can:

- 8.1 Charge zeotropic blend into a system
- 8.2 Record the weight of refrigerant charged (3 Kg or more)
- 8.3 Run a charged system
- 8.4 Identify state of refrigerant in cylinder prior to charging
- 8.5 Identify state of refrigerant in system while running
- 8.6 Visually inspect the system for leaks
- 8.7 Use **equipment** to accurately determine that the charge is correct
- 8.8 Undertake an indirect leakage check
- 8.9 Use an electronic detector to carry out a direct leak check to EU commission standard leak checking requirements
- 8.10 Complete a leak check record
- 8.11 Connect and disconnect gauges to/from running system with minimal refrigerant loss (by reducing gauge pressure to safe minimum) using a **valve**

Range

Equipment

- gauges
- thermometers
- refrigerant comparator
- liquid level indicator
- sight glasses
- refrigerant log book

Valve

- service
- Schrader

Unit 230/530 Handling fluorinated gases and ozone-depleting substances (category I personnel)

Outcome 9 Undertake recovery of refrigerant and oil and prepare for disposal

Assessment criteria

The learner can:

- 9.1 Recover refrigerant from system into recovery cylinder
- 9.2 Record weight of refrigerant recovered
- 9.3 Drain oil out of a compressor to meet health and safety requirements

Unit 233

Understand refrigeration system installation, testing and maintenance techniques

Level: 2
Credit value: 7
UAN: M/602/4999

Learning outcomes

There are **six** learning outcomes to this unit. The learner will

1. Understand the specific health and safety requirements which apply to the fitting and fixing, servicing and maintaining and de-commissioning of refrigeration systems
2. Understand the legislative and organisational procedures for fitting and fixing, servicing and maintaining and de-commissioning of refrigeration systems
3. Understand the working principles and layouts of refrigeration systems
4. Understand the procedures for fitting, fixing and testing refrigeration systems equipment and components
5. Understand the service and maintenance procedures for cooling systems equipment and components
6. Understand the decommissioning procedures for refrigeration system

Guided learning hours

It is recommended that **60** guided learning hours should be allocated for this unit, although patterns of delivery are likely to vary.

Support of the unit by a sector or other appropriate body

This unit is endorsed by SummitSkills.

Assessment

The unit will be assessed by:

- An on-line test

Unit 233 Understand refrigeration system installation, testing and maintenance techniques

Outcome 1 Understand the specific health and safety requirements which apply to the fitting and fixing, servicing and maintaining and de-commissioning of refrigeration systems

Assessment criteria

The learner can:

- 1.1 State the COSHH requirements of different refrigerants and other pressurised and flammable fluids
- 1.2 Assess the impact that working with refrigerants can have on the safety of individuals and wider environment
- 1.3 Specify the dangers associated with pressurised systems
- 1.4 Identify the dangers associated with hazardous environments such as cold rooms (sub zero temperatures)

Unit 233	Understand refrigeration system installation, testing and maintenance techniques
Outcome 2	Understand the legislative and organisational procedures for fitting and fixing, servicing and maintaining and de-commissioning of refrigeration systems

Assessment criteria

The learner can:

- 2.1 State the appropriate sources of health and safety information when fitting and fixing, servicing and maintaining and de-commissioning of refrigeration systems
- 2.2 State the regulations, codes of practice, and industry recommendations appropriate to the fitting and fixing, servicing and maintaining and de-commissioning of refrigeration systems, including working with refrigerant and other pressurised and flammable fluids
- 2.3 State appropriate persons whom it may be necessary to advise before a refrigeration system is isolated in order to undertake work
- 2.4 State the actions that should be taken to liaise with other persons upon completion of work procedures with regard to:
 - Safe systems shutdown
 - Labelling of components

Unit 233

Understand refrigeration system installation, testing and maintenance techniques

Outcome 3

Understand the working principles and layouts of refrigeration systems

Assessment criteria

The learner can:

3.1 Define the function and operating principles of

- Compressors
- Oil separators
- Condensers
- Liquid receivers
- Expansion devices
 - Capillary tube
 - Thermostatic expansion valves
 - Electronic expansion valves
 - Low side and high pressure floats
 - Liquid level magnetic control
- Evaporators
- High pressure liquid receivers
- Electric and hot gas defrost systems
- Pump down cycle
- Suction line accumulators
- Surge drums

3.2 Identify the features and characteristics of

- Oil free compressors
- Inverter drive compressors
- Four way valves
- Critical charge systems
- Solenoid valves
- Liquid line driers
- Low ambient control systems
- Suction line driers
- Pipework insulation
- Condensate removal
- Suction line accumulators
- Liquid receivers
- Oil separators
- Oil types

- 3.3 State the properties, advantages and disadvantages of different refrigerants, including
- Leakage implications (direct and indirect)
 - TEWI (Total Environmental Warming Impact) effect
- 3.4 Specify how the following are designed or contribute towards helping to reduce the indirect Global Warming Potential of refrigeration systems
- Variable speed drives
 - Defrost controls
 - Capacity control
 - Enhanced Capital Allowance (ECAs)
- 3.5 State the properties of the 'ideal' primary refrigerant
- 3.6 State the procedures for plotting the basic vapour compressions cycle on a pressure enthalpy chart for a range of refrigerants
- Saturated cycle
 - Actual cycle with sub-cooling and superheating
- 3.7 State the requirements for following work procedures to replace refrigerant types in RAC systems
- 3.8 Identify and calculate values for
- Refrigerating effect
 - Work done
 - Condenser heat rejected
 - Dryness fraction
 - Discharge temperature
 - Specific volume at suction
 - Compression ratio
 - Coefficient of performance (COP)
- 3.9 Define the following terms and explain how they interrelate
- Refrigerant mass flow rate
 - Air mass flow rate
 - Cooling capacity
 - Heating capacity
 - Compressor volume flow rate
 - Coefficient of performance
 - Energy efficiency ratio
- 3.10 State the principles of heat transfer by
- Conduction
 - Convection
 - Radiation
 - Mass transfer
- 3.11 Describe storage conditions for
- Chilled foods
 - Frozen foods

Unit 233	Understand refrigeration system installation, testing and maintenance techniques
Outcome 4	Understand the procedures for fitting, fixing and testing refrigeration systems equipment and components

Assessment criteria

The learner can:

4.1 State the fitting and fixing procedures for refrigeration systems, equipment and components, including

- Evaporators
- Condensers
- Compressors
- Fan motors
- Filter dryers
- Sight glass
- Pressure controls and safety devices (PRV's)
- Temperature sensors and control devices
- Expansion valves
- Service valves
- Receivers

4.2 Define suitable methods for making pipework connections to

- Evaporators
- Condensers
- Compressors
- Filter dryers
- Sight glass
- Pressure controls and safety devices (PRV's)
- Expansion valves
- Service valves
- Receivers and suction accumulators

4.3 Define requirements for the correct selection and use of the following items of specialist RAC equipment

- Gauges and regulators
- Leak detection equipment
- Weighing scales

4.4 State the methods and procedures for

- Strength integrity testing
- Tightness testing
- Leak testing
- Evacuation and dehydration

- 4.5 Identify the requirements for the appropriate test
- 4.6 State the procedures for charging blended (zeotropic blends) and single fluid refrigerants into systems
- 4.7 State the procedures for determining when charge is correct
- 4.8 State the records to be completed prior to handover
- 4.9 State the process for handling over systems to customers, including
 - Operation of system and controls
- 4.10 State the procedures to be followed when work is complete, including
 - Complete hazardous waste consignment documentation
 - Complete appropriate employer documentation
 - Refrigerant use

Unit 233	Understand refrigeration system installation, testing and maintenance techniques
Outcome 5	Understand the service and maintenance procedures for cooling systems equipment and components

Assessment criteria

The learner can:

- 5.1 Explain the effects on system efficiency of
 - Reduced coolant flow over condensers (dirty condensers)
 - Reduced flow over evaporators (dirty/fouled evaporators)
 - Refrigerant leakage
- 5.2 State the requirements for routine preventative maintenance of refrigeration systems including
 - Maintaining system efficiency to reduce indirect emissions of greenhouse gases
 - Maintaining system tightness to reduce direct emissions of greenhouse gases
- 5.3 State the importance of correct control settings to maintain system efficiency, including how to adjust controls for
 - Thermostats
 - Time clocks
 - Multi-function electronic controls (covering defrost, temperature control fan speed etc)
 - High pressure cut outs
 - Low pressure cut outs
 - Sub-cooling
 - Superheat
 - Capacity control
- 5.4 Identify symptoms which relate to common system faults associated with
 - Compressor and compressor motor failure
 - Capacity control
 - Condensers
 - Evaporators
 - Undercharge/overcharge
 - Electrical control circuit
 - Electronic boards
 - Freezing of indoor/outdoor unit
 - Noise and vibration
 - Condensate leakage
 - Blockages in various fluid systems (refrigerant, air, water, glycol etc)
 - Superheat setting
- 5.5 State the requirements for completing records and reports on the servicing and maintenance of refrigeration systems

Unit 233	Understand refrigeration system installation, testing and maintenance techniques
Outcome 6	Understand the de-commissioning procedures for refrigeration system

Assessment criteria

The learner can:

- 6.1 State the implications that the suspension of a refrigeration system can have on other person(s), including
 - Customer/clients
 - Other site workers
 - Site visitors
- 6.2 Identify the safe procedures for handling potentially hazardous system materials, including refrigerants and mechanical and manual handling requirements
- 6.3 Identify work sequences for decommissioning and making safe a system in accordance with appropriate industry procedures

Unit 234

Install, test and maintain refrigeration systems

Level: 2
Credit value: 4
UAN: J/502/7932

Learning outcomes

There are **six** learning outcomes to this unit. The learner will

1. Be able to plan and prepare for the installation, testing and maintenance of refrigeration systems
2. Be able to carry out the installation of refrigeration systems
3. Be able to carry out the testing of refrigeration systems
4. Be able to carry out the maintenance of refrigeration systems
5. Be able to handover refrigeration systems
6. Be able to carry out the de-commissioning of refrigeration systems

Guided learning hours

It is recommended that **4** guided learning hours should be allocated for this unit, although patterns of delivery are likely to vary.

Support of the unit by a sector or other appropriate body

This unit is endorsed by SummitSkills.

Assessment

The unit will be assessed by:

- Portfolio

Unit 234

Install, test and maintain refrigeration systems

Outcome 1

Be able to plan and prepare for the installation, testing and maintenance of refrigeration systems

Assessment criteria

The learner can:

- 1.1 Confirm that all information is available prior to planning installation or maintenance activities
- 1.2 Confirm that all tools, equipment and materials are available and fit for use prior to commencement of the work
- 1.3 Confirm that all persons relevant to the installation or maintenance activity are identified and that lines of communication are established
- 1.4 Ensure that all necessary risk assessment and safe working procedure development has been undertaken prior to work commencement
- 1.5 Carry out survey to identify any variations or deviations to planned work or any structural or access issues which need to be resolved prior to work commencement
- 1.6 Identify safe storage arrangement for tools, equipment and materials prior to commencement of installation or maintenance activity
- 1.7 Plan safe access to work areas and confirm with responsible person on site
- 1.8 Complete preparatory work as necessary in relation to
 - the location, siting and fixing of
 - condenser units
 - evaporators units
 - piping (suction and liquid)
 - jointing by brazing or flaring
 - confirming requirements for
 - cleanliness inside pipes by purging with OFN
 - insulation
 - electrical connection
 - condensate disposal

Unit 234 Install, test and maintain refrigeration systems

Outcome 2 Be able to carry out the installation of refrigeration systems

Assessment criteria

The learner can:

- 2.1 Identify and interpret appropriate sources of information which impact upon the installation of refrigeration pipework, system and components, including:
 - Regulatory documents
 - Industry Codes of Practice
 - Manufacturers' instructions
 - Installation specifications
- 2.2 Assemble refrigeration system components to meet the requirements of the installation specification
- 2.3 Demonstrate appropriate methods for positioning and fixing
 - Condenser units
 - Evaporator units
 - Condensate drains
- 2.4 Demonstrate appropriate methods for interconnecting, fixing and insulating pipework
- 2.5 Demonstrate appropriate methods for interconnecting and fixing refrigeration system components, including
 - Sight glasses
 - Driers
 - Solenoid valves
 - Thermostatic expansion valves (valve body, sensing bulb and equalising of line as appropriate)
- 2.6 Complete the interconnection and fixing of electrical power and control components
- 2.7 Confirm that installed system components and pipework are correctly installed in accordance with the installation specification
- 2.8 Confirm that the worksite has been cleared in preparation for system testing

Unit 234

Install, test and maintain refrigeration systems

Outcome 3

Be able to carry out the testing of refrigeration systems

Assessment criteria

The learner can:

- 3.1 Revisit risk assessment and safe working procedure to confirm currency and validity prior to commencement of testing
- 3.2 Carry out the checks and tests in accordance with industry and safety requirements
- 3.3 Carry out the following tests in accordance with appropriate legislation:
 - Strength integrity test
 - Pressure tightness test
 - Leak test
 - Evacuation, dehydration and vacuum rise test
- 3.4 Compare pipework length with system factory charge and determine whether extra refrigerant charge is required
- 3.5 Add additional refrigerant charge by weight in accordance with manufacturers' instructions
- 3.6 Carry out basic electrical tests to confirm that system is safe to switch on:
 - Continuity
 - Insulation resistance
 - Polarity
 - Resistance to earth
 - Visual check
- 3.7 Run the system to complete the charge and set the correct superheat and sub cooling levels
- 3.8 Complete checks to confirm system is leak free
- 3.9 Confirm that the system provides cooling by measuring air flow temperature difference across the evaporator
- 3.10 Record temperature differences and confirm whether design temperature is achieved
- 3.11 Remove analysers/gauges from systems without refrigerant loss
- 3.12 Replace valve caps and confirm valves are leak free

Unit 234 Install, test and maintain refrigeration systems

Outcome 4 Be able to carry out the maintenance of refrigeration systems

Assessment criteria

The learner can:

4.1 Interpret maintenance schedules to identify required work activities

4.2 Perform the following service and maintenance tasks safely and efficiently

- Cleaning and checking the conditions of
 - condensers
 - evaporators
- Checking defrost effectiveness
- Checking the condition of
 - pipework and its insulation
 - electrical wiring and connections

4.3 Check system operating conditions against control settings and industry requirements

4.4 Check the security and placement of the thermostatic expansion valve bulbs and confirm superheat settings

4.5 Reconnect or re-install system after maintenance and then carry out the following checks and tests before running the system

- Tightness testing
- Evacuation and dehydration
- Electrical testing

4.6 Re-charge refrigerant to correct quantity and check for leakage

4.7 Complete system performance test

4.8 Complete appropriate maintenance documentation and records

Unit 234

Install, test and maintain refrigeration systems

Outcome 5

Be able to handover refrigeration systems

Assessment criteria

The learner can:

5.1 Complete system records for hand over documentation, including those which detail

- Strength integrity test
- Pressure tightness test
- Evacuation and dehydration
- Leak test
- System refrigerant charge and type
- Performance testing
- Electrical testing

5.2 Demonstrate system operation and operating controls to customer

5.3 Pass over system documentation and records to customer

5.4 Report to a line manager that installation is complete and fill in appropriate company documentation

Unit 234

Install, test and maintain refrigeration systems

Outcome 6

Be able to carry out the de-commissioning of refrigeration systems

Assessment criteria

The learner can:

- 6.1 Follow appropriate risk assessments and method statements to ensure de-commissioning activities are completed safely
- 6.2 Demonstrate work sequences for permanently de-commissioning
 - a complete refrigeration system
 - part of a refrigeration system
- 6.3 Demonstrate how oil, refrigerant and cleaning solvents can be safely recovered from a system and disposed of in accordance with appropriate regulations

Unit 302/602 Understand and carry out electrical work on RAC systems and components

Level: 3
Credit value: 12
UAN: K/602/4998

Learning outcomes

There are **thirteen** learning outcomes to this unit. The learner will

1. Know the electrical standards that apply to the mechanical services industry
2. Know the inspection and testing requirements of electrically operated mechanical services components
3. Be able to inspect and test electrically operated mechanical services components
4. Know the procedures for safely diagnosing and rectifying faults in electrically operated mechanical services components
5. Be able to safely diagnose and rectify faults in electrically operated mechanical services components
6. Know the principles of electricity supply to buildings
7. Know the layout features of electrical circuits in buildings
8. Understand the electrical industry safe isolation procedure
9. Be able to carry out the electrical industry safe isolation procedure
10. Know the site preparation techniques for the electrical connection of mechanical services components
11. Be able to demonstrate and apply site preparation techniques for the electrical connection of mechanical services components
12. Understand the installation and connection requirements of electrically operated mechanical services components
13. Be able to install and connect electrically operated mechanical services components

Guided learning hours

It is recommended that **102** guided learning hours should be allocated for this unit, although patterns of delivery are likely to vary.

Support of the unit by a sector or other appropriate body

This unit is endorsed by SummitSkills.

Assessment

The unit will be assessed by:

- An on-line test
- Assignment

Unit 302/602 Understand and carry out electrical work on RAC systems and components

Outcome 1 Know the electrical standards that apply to the mechanical services industry

Assessment criteria

The learner can:

- 1.1 State the statutory legislation and guidance information that applies to electrical supply and control of domestic mechanical services systems and their components
 - General legislation
 - Construction specific legislation
 - Mechanical services specific legislation
 - Professional body guidance
 - Codes of practice
 - Manufacturer installation and service/maintenance instructions
 - Manufacturer user instructions
- 1.2 Identify the range of information that would be detailed on a minor works certificate for an electrical system or component
- 1.3 Specify the procedure for notifying works carried out to the relevant authority

Unit 302/602 Understand and carry out electrical work on RAC systems and components

Outcome 2 Know the inspection and testing requirements of electrically operated mechanical services components

Assessment criteria

The learner can:

- 2.1 Specify the requirements of a visual inspection of completed electrical installation work for mechanical services systems prior to electrical inspection and testing
- 2.2 Define the equipment used for electrical testing of mechanical services components and its calibration requirements
- 2.3 Identify the importance of carrying out tests on dead circuits wherever possible
- 2.4 State the purpose of the electrical testing procedures for new and existing circuits
 - Polarity
 - Earth continuity
 - Insulation resistance
 - Earth fault loop impedance
 - Residual current device
- 2.5 Clarify the requirements for carrying out functional testing of electrical components
- 2.6 Clarify the procedures for final handover of electrical circuits that supply electrically operated domestic mechanical services components
 - Installation completion of certification
 - Demonstration to the user

Unit 302/602 Understand and carry out electrical work on RAC systems and components

Outcome 3 Be able to inspect and test electrically operated mechanical services components

Assessment criteria

The learner can:

3.1 Carry out the inspection and testing of a completed refrigeration or air conditioning controls system

- Visual inspection
- Selection and use of appropriate test equipment
- Appropriate circuit testing
 - Polarity
 - Earth continuity
 - Insulation resistance
- Functional testing
- Completion of a minor works certificate

3.2 Carry out the inspection and testing of existing electrical circuits following replacement of electrical conductors, to

- refrigeration or air conditioning systems and/or equipment components

Unit 302/602 Understand and carry out electrical work on RAC systems and components

Outcome 4 Know the procedures for safely diagnosing and rectifying faults in electrically operated mechanical services components

Assessment criteria

The learner can:

- 4.1 State the methods of obtaining details of system faults from end users
- 4.2 Identify and use manufacturer instructions and industry standards to establish the diagnostic requirements of electrical system components
- 4.3 Identify the electrical test equipment used to undertake fault diagnostics
- 4.4 Identify the situations in which dead testing of components can be carried out
- 4.5 Identify the situations in which live testing of components may be necessary and the safety precautions required
- 4.6 Define how to perform a range of routine checks and diagnostics on electrical system components as part of a fault finding process. Checking for correct operation of
 - Appliance components
 - Flame rectification devices
 - Flame suppression devices
 - Solenoid valves
 - Thermistors
 - Thermocouples
 - Micro switches
 - Relays
 - Pressure switches
 - Printed circuit boards
 - Pumps
 - Fans
 - Compressors
 - Evaporators
 - Leak detection
 - Control components
 - thermostats
 - programmers/timers
 - electrically operated control valves
 - Wiring centres
 - Switches
 - Rocker plate (with/without cpc) – single and double pole
 - Pull cord
 - Pressure operated

4.7 State the methods of correcting deficiencies in electrical components

- Inadequate earthing provision
- Defective cable positioning (aged cables/proximity to other services)
- Failed electrical components
- Incorrect polarity
- Provision of inadequate circuit protection devices

Unit 302/602 Understand and carry out electrical work on RAC systems and components

Outcome 5 Be able to safely diagnose and rectify faults in electrically operated mechanical services components

Assessment criteria

The learner can:

- 5.1 Safely isolate electrical systems or components to prevent them being brought into operation before the work has been fully completed
- 5.2 Carry out diagnostic checks to electrical circuits
 - Inadequate earthing provision
 - Defective cable routing
 - Defective termination
 - Incorrect polarity
 - Provision of inadequate circuit protection devices
- 5.3 Carry out diagnostic tests to locate faults in electrical components and carry out repair work
 - Refrigeration components replacement
 - Air conditioning components replacement
 - Control components
 - Thermostats
 - Programmers/timers

Unit 302/602 Understand and carry out electrical work on RAC systems and components

Outcome 6 Know the principles of electricity supply to Buildings

Assessment criteria

The learner can:

6.1 Specify the methods by which electricity is generated

- Basic power station operation
- Principles of generation
- Types of supply
 - Single phase
 - Three-phase and neutral

6.2 Specify the methods by which generated electricity is distributed to non-dwelling and commercial properties

- Basic operation of the national grid and local distribution systems
 - Sub-stations
 - Supply transformers
 - Local distribution of three – and single-phase supplies to premises

6.3 State the purpose of electrical components at entry to the property

- Main fuse (single phase) and cable head connection
- Meter
- Consumer unit
- Main earth terminal

Unit 302/602 Understand and carry out electrical work on RAC systems and components

Outcome 7 Know the layout features of electrical circuits in Buildings

Assessment criteria

The learner can:

- 1.1 Define the system layout features for electrical circuits in non-dwellings and commercial properties
 - Ring main circuit
 - Radial circuit
 - Fixed equipment supplies
 - Spurs and fused outlets
- 1.2 Specify the types of cables and conductors used for installation of electrical equipment in mechanical services systems
- 1.3 State the applications and limitations of the types of cable and conductors used for the installation of electrical equipment in mechanical services systems
- 1.4 Clarify the difference between class 1 and class 2 electrical equipment
- 1.5 Define the function of electrically operated components used in mechanical services systems
 - Flame rectification devices
 - Flame suppression devices
 - Solenoid valves
 - Thermistors
 - Thermocouples
 - Micro switches
 - Relays
 - Printed circuit boards
 - Pressure switches
 - Pumps
 - Fans
 - Compressors
 - Evaporators
 - Leak detection
 - Control components
 - Thermostats
 - Programmers/timers
 - Electrically operated control valves
 - Wiring centres
 - Switches
 - Rocker plate (with/without cpc) – single and double pole
 - Pull cord
 - Pressure operated

1.6 Define the operating principles of electrical circuit protection devices

- Miniature circuit breakers
- Residual current devices including RCBOs
- Fuses
 - Re-wireable
 - Cartridge
 - High breaking capacity

1.7 Clarify the need for, and requirements of earthing systems

- Main earthing systems
 - TT system
 - TN-S system
 - TN-C-S system
- Protective equipotential bonding
- High risk rooms (zones) in dwellings
- Supplementary earthing (bonding)
- Temporary continuity bonding

1.8 Identify the warning notices to be applied

Unit 302/602 Understand and carry out electrical work on RAC systems and components

Outcome 8 Understand the electrical industry safe isolation procedure

Assessment Criteria

The learner can:

8.1 Identify the test equipment required to prove that circuits to be worked on are dead

- Approved voltage indicating device
- Proving unit

8.2 Specify the electrical industry agreed procedure for safe isolation of electrical circuits

- Select the approved voltage indicating device and test on a known supply
- Locate and identify the isolation point for the equipment to be worked on
- Isolate the supply and prevent re-energisation
- Verify that the equipment is dead
- Fit warning labels
- Re-check the approved voltage indicating on a known supply for correct function

8.3 Clarify the methods of ensuring that circuits cannot be re-activated while work is taking place on them

- Use of locking devices
- Device retention (fuse removal)

Unit 302/602 Understand and carry out electrical work on RAC systems and components

Outcome 9 Be able to carry out the electrical industry safe isolation procedure

Assessment Criteria

The learner can:

9.1 Check to ensure that test equipment is safe to be used

9.2 Carry out the safe isolation procedure to industry standards

Unit 302/602 Understand and carry out electrical work on RAC systems and components

Outcome 10 Know the site preparation techniques for the electrical connection of mechanical services components

Assessment Criteria

The learner can:

- 10.1 Identify the required sources of information when carrying out work on electrical systems
 - Statutory regulations
 - Industry standards
 - Manufacturer technical instructions
- 10.2 Identify the preparatory work required to be carried out to the building fabric in order to install, commission, decommission or maintain electrical systems or components
- 10.3 State the types of pre-existing damage to the existing building fabric or customer property that may be encountered before commencing work on electrical systems and components
 - Building wall/floor surfaces
 - Existing electrical system components
 - Building décor and carpets
- 10.4 Identify the protection measures to be applied to the building fabric or customer property, during and on completion of work on electrical systems and components
 - Building wall/floor surfaces
 - Existing and new electrical systems and kitchen furniture / components and hygiene
 - Building décor and carpets
- 10.5 Identify the cable, materials and fittings required to complete work on electrical systems
- 10.6 Identify the hand and power tools required to complete work on electrical systems

Unit 302/602 Understand and carry out electrical work on RAC systems and components

Outcome 11 Be able to demonstrate and apply site preparation techniques for the electrical connection of mechanical services components

Assessment Criteria

The learner can:

- 11.1 Check the safety of the work location in order for the work to safely proceed
 - Safe access and exit
 - Immediate work location e.g. tripping hazards
 - Appropriate risk assessments/ method statements are followed
- 11.2 Wear Personal Protective Equipment relevant to the installation, decommissioning, servicing or maintenance tasks being carried out

Unit 302/602 Understand and carry out electrical work on RAC systems and components

Outcome 12 Understand the installation and connection requirements of electrically operated mechanical services components

Assessment Criteria

The learner can:

- 12.1 Define the method used to identify that existing electrical supplies and circuits are suitable for the proposed installation of electrical equipment used in domestic mechanical services systems
- 12.2 State the procedure for sizing electrical materials and components
 - Basic cable sizing procedure type cables and conductors
 - Basic circuit protection device sizing procedure –circuit types
- 12.3 Specify the method used to select suitable cables and cords for components and circuits
 - Selection of appropriate multi-core cables
 - Selection of appropriate multi-core cords
 - Selection of pvc single conductors
- 12.4 Specify the requirements for protecting cables installed in the building fabric and terminating in enclosures
 - Protection methods in wall and floor surfaces
 - Embedded (sheathing) – depth of cover, application of RCD protection
 - Exposed (mini-trunking)
 - Within ducting
 - Within timber stud partitions
 - Within timber floor structures
 - Junction boxes
 - Switch/socket boxes
 - Countersunk
 - Pattresses
 - Surface mounted
 - Wiring centres
- 12.5 Define the types of cable termination methods approved for use in dwellings
 - Screw terminals
 - Pillar terminals
 - Claw and washer terminals
 - Crimping
 - Strip connectors

12.6 Specify the method of installation and wiring termination for fixed electrical equipment

- From consumer unit
 - Air Conditioning Units cassette / free standing
 - Free standing chiller / cooler
 - Refrigeration cabinet
 - Refrigeration control unit
 - Refrigeration compressor / pack
 - Refrigeration evaporators
- From fused-spur connection unit
 - Air Conditioning Units cassette / free standing
 - Free standing chiller / cooler
 - Refrigeration cabinet
 - Refrigeration control unit
 - Refrigeration compressor / pack
 - Refrigeration evaporators
- From existing appliance supply point
 - Air Conditioning Units cassette / free standing
 - Free standing chiller / cooler
 - Refrigeration cabinet
 - Refrigeration control unit
 - Refrigeration compressor / pack
 - Refrigeration evaporators

Unit 302/602 Understand and carry out electrical work on RAC systems and components

Outcome 13 Be able to install and connect electrically operated mechanical services components

Assessment Criteria

The learner can:

- 13.1 Carry out the electrical wiring of a mechanical / refrigeration or air conditioning control system from an existing supply
- Refrigeration or air conditioning system incorporating all necessary control components
 - Positioning and fixing of all necessary enclosures, switches and circuit protection devices
 - Correct routing, installation and termination of appropriate cables and conductors to control system components
 - Correct earthing provision for all components and exposed metallic parts of the system
- 13.2 Apply temporary continuity bonding to metallic pipework prior to making pipework connections

Unit 330/630 Understand and carry out electrical work on RAC systems and components

Level: 3
Credit value: 12
UAN: T/504/0305

Learning outcomes

There are **eleven** learning outcomes to this unit. The learner will

1. Know the electrical standards that apply to the mechanical services industry
2. Know the inspection and testing requirements of electrically operated mechanical services components
3. Be able to inspect and test electrically operated mechanical services components
4. Know the procedures for safely diagnosing and rectifying faults in electrically operated mechanical services components
5. Be able to apply the procedures for safely diagnosing and rectifying faults in electrically operated mechanical services components
6. Know the fundamental principles of electrical supply to mechanical services and components
7. Know the features of electrical circuits and components in buildings
8. Understand the principles, regulatory requirements and procedures for completing the safe isolation of an electrical circuit
9. Be able to apply the principles, regulatory requirements and procedures for completing the safe isolation of an electrical circuit
10. Know the techniques and requirements for the preparation, installation and connection of electrical systems for the supply and control of industrial and commercial mechanical services systems and their components
11. Be able to demonstrate and apply the techniques and requirements for the preparation, installation and connection of electrical systems for the supply and control of industrial and commercial mechanical services systems and their components

Guided learning hours

It is recommended that **102** guided learning hours should be allocated for this unit, although patterns of delivery are likely to vary.

Support of the unit by a sector or other appropriate body

This unit is endorsed by SummitSkills.

Assessment

The unit will be assessed by:

- An on-line test
- Assignment

Unit 330/630 Understand and carry out electrical work on RAC systems and components

Outcome 1 Know the electrical standards that apply to the mechanical services industry

Assessment criteria

The learner can:

- 1.1 State the statutory and non-statutory regulations, legislation and guidance information that applies to electrical supply and control of industrial and commercial, mechanical services systems and their components, including those for:
 - health and safety
 - construction specific requirements
 - mechanical services
 - professional body guidance
 - codes of practice
 - industry standards
 - manufacturers' installation and service/maintenance instructions
 - manufacturer technical/user instructions
- 1.2 Identify the range of information that would be detailed on a minor works certificate, for an installation of an electrical supply and control of industrial and commercial mechanical services systems and their components

Unit 330/630 Understand and carry out electrical work on RAC systems and components

Outcome 2 Know the inspection and testing requirements of electrically operated mechanical services components

Assessment criteria

The learner can:

- 2.1 Specify the requirements of a visual inspection of completed electrical installation work for mechanical services systems, prior to electrical inspection and testing
- 2.2 Define the equipment used for electrical testing of mechanical services components and its calibration requirements
- 2.3 Identify the importance of carrying out tests on dead circuits wherever possible
- 2.4 Interpret meter readings to inform decisions to be made in reference to safety and functionality of systems and components
- 2.5 State the purpose of the electrical testing procedures for new and existing circuits:
 - polarity
 - earth continuity
 - insulation resistance
 - earth fault loop impedance
 - residual current device
- 2.6 Clarify the requirements for carrying out functional testing of electrical components
- 2.7 State the procedure for final handover of electrical circuits that supply electrically operated industrial and commercial mechanical services components:
 - confirmation with appropriate competent personnel that the circuit(s) is in accordance with relevant statutory and non-statutory requirements
 - demonstration to the user
 - electrical installation completion certification (purpose only).

Unit 330/630 Understand and carry out electrical work on RAC systems and components

Outcome 3 Be able to inspect and test electrically operated mechanical services components

Assessment criteria

The learner can:

- 3.1 Carry out the inspection and testing of a completed electrical system for the control of mechanical / refrigeration or air conditioning systems and their components from an existing supply outlet:
 - visual inspection
 - selection and use of appropriate test equipment
 - appropriate circuit testing
 - polarity
 - earth continuity
 - insulation resistance
 - functional testing.
- 3.2 Carry out the inspection and testing of existing electrical circuit for electrically operated mechanical services components following the replacement of electrical conductors and/or components
- 3.3 Apply the procedure for final handover of electrical circuits that supply electrically operated industrial and commercial mechanical services components, including:
 - confirmation with appropriate competent personnel that the circuit(s) is in accordance with relevant statutory and non-statutory requirements
 - demonstration to the user
 - providing information for the completion of an electrical installation completion certification.

Unit 330/630 Understand and carry out electrical work on RAC systems and components

Outcome 4 Know the procedures for safely diagnosing and rectifying faults in electrically operated mechanical services components

Assessment criteria

The learner can:

- 4.1 State the methods of obtaining details of system faults from end users
- 4.2 Identify and use manufacturer instructions and industry standards to establish the diagnostic requirements of electrical system components
- 4.3 Identify the electrical test equipment used to undertake fault diagnostics
- 4.4 State the appropriate test equipment scales for the range of electrical tests
- 4.5 Identify the situations in which dead testing of components can be carried out
- 4.6 Identify the situations in which live testing of components may be necessary and the safety precautions required
- 4.7 Define how to perform a range of routine checks and diagnostics on electrical system components as part of a fault finding process. Checking for correct operation of:
 - appliance components:
 - printed circuit boards
 - motors (single and three-phase)
 - pumps
 - fans
 - compressors
 - heaters
 - coils
 - solenoid valves
 - relays and contactors
 - lights
 - transformers
 - control components:
 - over temperature
 - over current
 - protection devices
 - time and sequence control
 - electrically operated control valves
 - thermistors
 - motor starting devices
 - switches:
 - pressure operated
 - temperature operated
 - time operated.
- 4.8 State the methods of correcting deficiencies in electrical components:
 - inadequate earthing provision
 - defective cable positioning (aged cables/proximity to other services)
 - failed electrical components
 - incorrect polarity
 - provision of inadequate circuit protection devices

- incorrect phase-sequence.

Unit 330/630 Understand and carry out electrical work on RAC systems and components

Outcome 5 Be able to apply the procedures for safely diagnosing and rectify faults in electrically operated mechanical services components

Assessment criteria

The learner can:

- 5.1 Safely isolate electrical systems or components to prevent them being brought into operation before the work has been fully completed
- 5.2 Carry out diagnostic checks to electrical circuits to identify:
 - Inadequate earthing provision
 - Defective termination
 - Incorrect polarity
 - Provision of inadequate circuit protection devices
 - Incorrect phase-sequence
- 5.3 Carry out diagnostic tests to locate faults in electrical components and carry out repair work:
 - Refrigeration components replacement
 - Air conditioning components replacement
 - Heat pump component replacement.

Unit 330/630 Understand and carry out electrical work on RAC systems and components

Outcome 6 Know the fundamental principles of electricity supply to mechanical services and components

Assessment criteria

The learner can:

- 6.1 Describe the **fundamental principles** of electrical supply and control in relation to RAC and heat pump systems in terms of:
- Voltage
 - Resistance
 - Impedance
 - Current:
 - Alternating
 - Direct
 - Power
 - Capacitance
 - Inductance
 - Conductors
 - Insulators
 - Magnetism
 - Frequency
 - Generation:
 - Single phase
 - Three-phase.

Unit 330/630 Understand and carry out electrical work on RAC systems and components

Outcome 7 Know the features of electrical circuits and components in buildings

Assessment criteria

The learner can:

- 7.1 Describe the potential hazards of working with or near electrical supply systems:
 - Electrical shock
 - Fire
 - Water
- 7.2 Define the operating principles of electrical circuit protection devices:
 - miniature circuit breakers
 - residual current devices including RCBO's
 - fuses:
 - rewirable
 - cartridge
 - high breaking capacity
- 7.3 Define types of electrical circuits in buildings:
 - Ring main
 - Radial
 - Spurs and fused-spur outlets
- 7.4 State conductor identification requirements in accordance with the current edition of BS7671
- 7.5 State the **applications** and **limitations** of the types of cable and conductors used for the installation of electrical equipment in mechanical services systems
 - **Applications:** low temp; high temp; defrost; signal; control; data
 - **Limitations:** fire risk; explosion; corrosion; environment
- 7.6 Clarify the difference between class 1 and class 2 electrical equipment
- 7.7 Define the function of electrically operated components used in mechanical services systems:
 - Appliance components:
 - Printed circuit boards
 - Motors (single and three-phase):
 - Pumps
 - Fans
 - Compressors
 - Heaters
 - Coils:
 - Solenoid valves
 - Relays and contactors
 - Lights
 - Transformers

- Control components:
 - Over temperature
 - Over current
 - Protection devices
 - programmers/timers
 - electrically operated control valves
 - Thermistors
 - Motor starting devices
- Switches:
 - Pressure operated
 - Temperature operated
 - Time operated

7.8 Clarify the need for, and requirements of earthing systems.

- Main earthing systems:
 - TT system
 - TN-S system
 - TN-C-S system
- Protective equipotential bonding
- High risk rooms (zones) in dwellings
- Supplementary earthing (bonding)
- Temporary continuity bonding

7.9 Identify the warning notices to be applied.

Unit 330/630 Understand and carry out electrical work on RAC systems and components

Outcome 8 Understand the principles, regulatory requirements and procedures for completing the safe isolation of an electrical circuit

Assessment Criteria

The learner can:

- 8.1 Specify the correct procedure for completing safe isolation of an electrical circuit with regard to:
 - Carrying out safe working practices
 - Correct identification of circuit(s) to be isolated
 - Identifying suitable points of isolation
 - Selecting correct test and proving instruments in accordance with relevant industry guidance and standards
 - Correct testing methods
 - Selecting locking devices for securing isolation
 - Correct warning notices
 - Correct sequence for isolating circuits
- 8.2 State the implications of carrying out safe isolations to:
 - Other personnel
 - Customers/clients
 - Public
 - Building systems (loss of supply)
- 8.3 State the implications of not carrying out safe isolations to:
 - Self
 - Other personnel
 - Customers/clients
 - Public
 - Building systems (presence of supply).

Unit 330/630 Understand and carry out electrical work on RAC systems and components

Outcome 9 Be able to apply the principles, regulatory requirements and procedures for completing the safe isolation of an electrical circuit

Assessment Criteria

The learner can:

- 9.1 Carry out the safe isolation of an electrical circuit (s) in accordance with regulatory requirements for:
- Correct identification of circuit(s) to be isolated
 - Identifying suitable points of isolation
 - Selecting correct test and proving instruments in accordance with relevant industry guidance and standards
 - Correct testing methods
 - Selecting locking devices for securing isolation
 - Correct warning notices
 - Correct sequence for isolating circuits.

Unit 330/630 Understand and carry out electrical work on RAC systems and components

Outcome 10 Know the techniques and requirements for the preparation, installation and connection of electrical systems for the supply and control of industrial and commercial mechanical services systems and their components

Assessment Criteria

The learner can:

- 10.1 Identify the preparatory work required to be carried out in order to install, commission, decommission or maintain electrical systems or components for mechanical services
- 10.2 Identify the protection measures to be applied to the building fabric or customer property, during and on completion of work on electrical systems and components:
 - Building wall/floor surfaces
 - Existing and new electrical systems
 - Building décor and carpets
- 10.3 Identify the hand and power tools required to complete work on electrical systems
- 10.4 Define the method used to identify that existing electrical supplies and circuits are suitable for the proposed installation of electrical equipment used in industrial and commercial mechanical services systems
- 10.5 State the factors which effect the selection of cables and conductors:
 - length
 - load
 - ambient temperatures
 - grouping of cables
 - protective device
 - insulation
- 10.6 Identify the cable, materials and fittings required to complete work on electrical systems
- 10.7 Specify the requirements for protecting cables installed in the building fabric and terminating in enclosures:
 - Protection methods in wall and floor surfaces:
 - Embedded (sheathing) – depth of cover, application of RCD protection
 - Exposed (mini-trunking)
 - Within ducting
 - Within timber stud partitions
 - Within timber floor structures
 - Junction boxes
 - Switch/socket boxes:
 - Surface mounted
 - External influences:
 - IP rating

- 10.8 Define the application and limitations of cable termination methods:
- Screw terminals
 - Pillar terminals
 - Claw and washer terminals
 - Crimping
 - Strip connectors
- 10.9 Specify the method of installation, connection and termination for fixed electrical equipment:
- From a switched-fuse unit (single-phase and triple-pole neutral)
 - Air conditioning units cassette / free standing
 - Free standing chiller / cooler
 - Refrigeration cabinet
 - Refrigeration control unit
 - Refrigeration compressor / pack
 - Refrigeration evaporators
 - From fused-spur connection unit:
 - Air conditioning units cassette / free standing
 - Free standing chiller / cooler
 - Refrigeration cabinet
 - Refrigeration control unit
 - Refrigeration compressor / pack
 - Refrigeration evaporators.

Unit 330/630 Understand and carry out electrical work on RAC systems and components

Outcome 11 Be able to demonstrate and apply the techniques and requirements for the preparation, installation and connection of electrical systems for the supply and control of industrial and commercial mechanical services systems and their components

Assessment Criteria

The learner can:

- 11.1 Check the safety of the work location in order for the work to safely proceed:
 - Safe access and exit
 - Immediate work location e.g. tripping hazards
 - Appropriate risk assessments/ method statements are followed
- 11.2 Wear personal protective equipment relevant to the installation, decommissioning, servicing or maintenance tasks being carried out
- 11.3 Carry out the wiring and connection of an electrical system for the control of mechanical refrigeration or air conditioning systems and their components from an existing supply outlet:
 - Refrigeration or air conditioning system incorporating all necessary control components
 - Positioning and fixing of all necessary enclosures, switches and circuit protection devices
 - Correct routing, installation and termination of appropriate cables and conductors to control system components
 - Correct earthing provision for all components and exposed metallic parts of the system
- 11.4 Apply temporary continuity bonding to metallic pipework prior to making pipework connections.
- 11.5 Safely carry out the disconnection of an electrical supply to:
 - Air Conditioning Units cassette / free standing
 - Free standing chiller/cooler
 - Refrigeration cabinet
 - Refrigeration control unit
 - Refrigeration compressor / pack
 - Refrigeration evaporators
- 11.6 Safely carry out the connection of an electrical supply to:
 - Air Conditioning Units cassette / free standing
 - Free standing chiller/cooler
 - Refrigeration cabinet
 - Refrigeration control unit
 - Refrigeration compressor / pack
 - Refrigeration evaporators.

Relationships to other qualifications

Links to other qualifications and frameworks

This qualification will be contained within the Summit Skills Apprenticeship framework. Please visit Summit Skills website at **www.summitskills.org.uk** for more details

Literacy, language, numeracy and ICT skills development

This qualification includes opportunities to develop and practise many of the skills and techniques required for success in the following qualifications:

- Functional Skills (England) – see **www.cityandguilds.com/functionalskills**
- Essential Skills (Northern Ireland) – see **www.cityandguilds.com/essentialskillsni**
- Essential Skills Wales – see **www.cityandguilds.com/esw**

There might also be opportunities to develop skills and/or portfolio evidence if candidates are completing any Key Skills alongside this qualification.

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 **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 qualifications that feature centre-assessed components.

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 guidance on administering portfolios and controlled assessments, including a definition of supervised conditions.

Access arrangements: when and how applications need to be made to City & Guilds

This 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

For almost 150 years, we have worked with people, organisations and economies to help them identify and develop the skills they need to thrive. We understand the life-changing link between skills development, social mobility, prosperity and success. Everything we do is focused on developing and delivering high-quality training, qualifications, assessments and credentials that lead to jobs and meet the changing needs of industry.

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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